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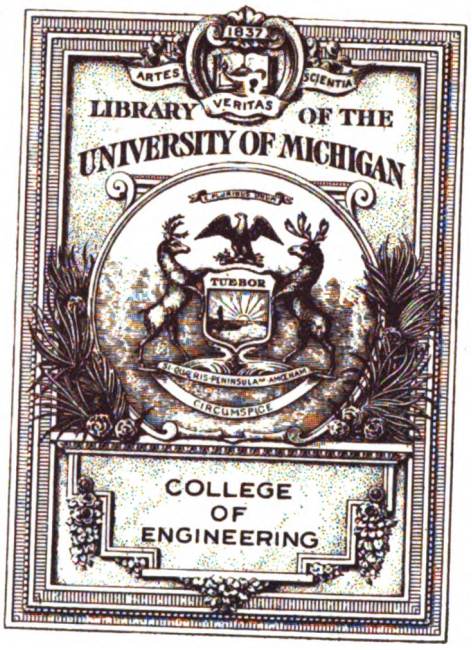
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VOL. XII. JANUARY-FEBRUARY, 1920 NO. 61

The Military Engineer

Formerly PROFESSIONAL MEMOIRS



Light railways on the line of battle. Shell-fire cannot stop the American engineer

JOURNAL OF
THE SOCIETY OF AMERICAN MILITARY ENGINEERS

IN THIS ISSUE

"ENGINEER CONSTRUCTION IN FRANCE"
"ENGINEER DUTIES IN THE FIELD IN WAR"
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William Murray Black

Major General, Chief of Engineers
U. S. Army

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Engineer Construction in France

Work of the Division of Construction and Forestry, A. E. F.

By

Lieut. Col. J. A. Woodruff

Corps of Engineers, U. S. Army

Discussion and Comment by Maj. Gen. W. C. Langfitt, Maj. Gen. M. M. Patrick Brig. Gen. Edgar Jadwin, Col. J. B. Cavanaugh, Col. Ernest Graves, and an Extract from the Final Report of General Pershing

[See Index Map, Page 67]

WITH the exception of a few barracks erected in the Gondrécourt area by troops of the 1st Division immediately after their arrival in their training area, the actual work of construction by the American forces in France was commenced by the 15th (Railway) Engineers, Col. Edgar Jadwin, C. E., commanding. This regiment was one of those raised in May, 1917, as a result of the Joffre Mission to the United States. It arrived at Vierzon July 28, 1917; its equipment, which consisted of about a trainload of tools and plant brought from America, also arrived promptly. The regiment at once began surveys, and construction detachments were distributed without delay to Issoudun, Bordeaux, Gondrécourt, and other important points between the Atlantic ports and the combat sectors.

The 17th Engineers (Railway), Col. J. S. Sewell, Engineers, commanding, arrived at St. Nazaire August 17, 1917; the 16th Engineers (Railway) Col. Harry Burgess, C. E., commanding, arrived at Is-sur-Tille August 26, 1917; the 18th Engineers (Railway), Col. J. B. Cavanaugh, C. E., commanding, arrived at Bordeaux August 20, 1917; the 10th Engineers, (Forestry), Col. J. A. Woodruff, C. E., commanding, arrived at Nevers October 9, 1917 (later consolidated with the 20th Engineers, Forestry). Other regiments, such as the 11th, 23d, 25th, 33d, 55th, 32d, 106th, 109th, 309th, 311th, 312th, 318th, 319th, and many other regiments and battalions performed valuable service during the time they were in the S. O. S., but the 15th, 16th, 17th, 18th, 10th and 20th, by virtue of their early arrival and long service may be considered as having formed the backbone of the field construction forces of the Services of Supply.

The organization as modified by General Jadwin in May, 1918, consisted of a central office at Tours, the headquarters of the Services of Supply, organized into four sections, viz: Administration, General Construction, Railroads and Docks, and Forestry, all in charge of a deputy director.

The construction work in the field was carried on through Section Engineer Officers whose territory corresponded with that of the sections of services of supply and consisted of an advance section, an intermediate section (divided into two construction sections on account of its extent) and seven base sections, each embracing the territory around a port of debarkation.

The forestry work in the field was carried on through district commanders, each of whom also com-

[The Division of Construction and Forestry in France in its final form was one of the four great departments of the engineer organization under the Chief Engineer of the American Expeditionary Forces. Its history began with the arrival of General Pershing in France when General Taylor, the Chief Engineer, assigned to one of his assistants the duty of directing the construction immediately necessary and planning for that ultimately to be required by the American forces.

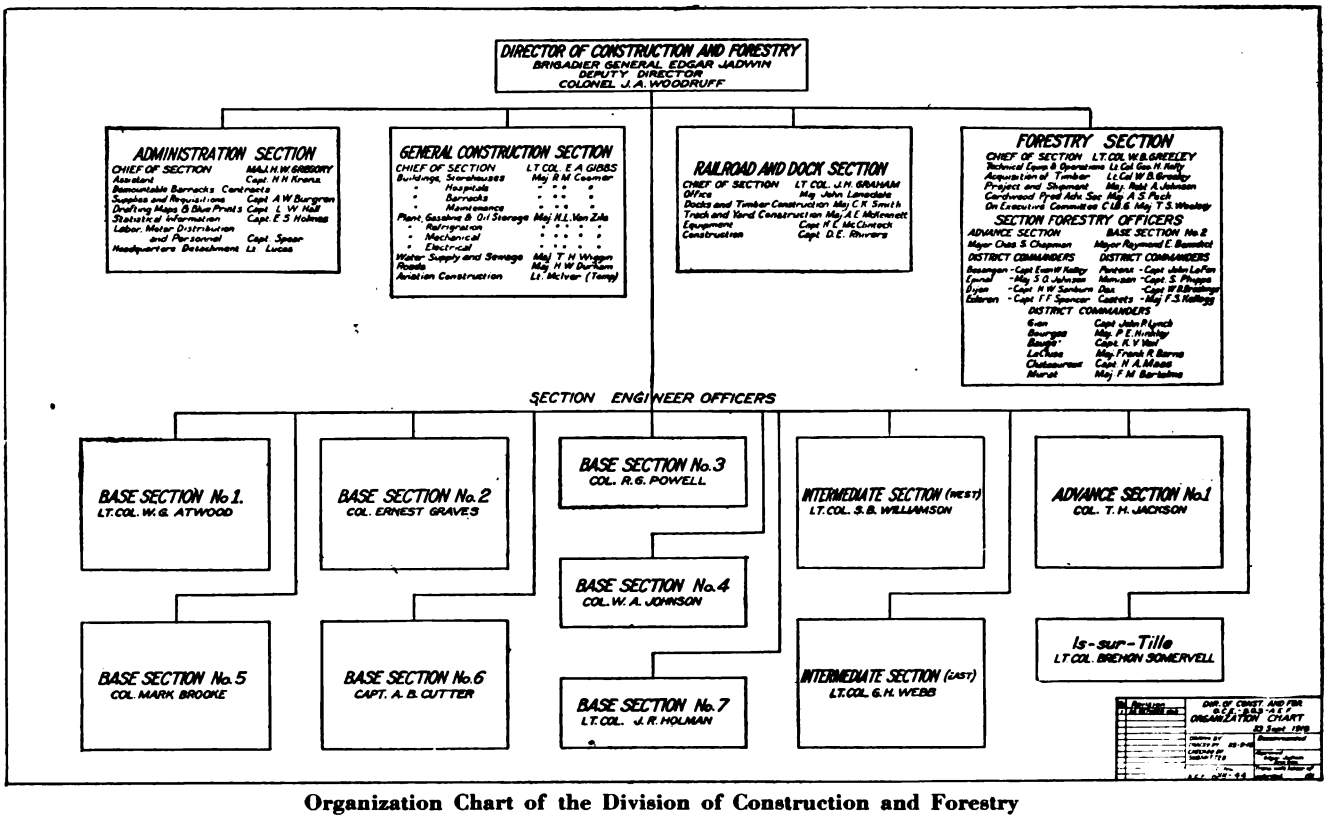
In August of 1917 the Lines of Communication were formally organized to handle all phases of supply, housing and transportation in rear of combat sectors. Construction devolved upon the Chief Engineer of the Lines of Communication and was so continued until by a reorganization in February of 1918, the Lines of Communication were designated as the Services of Supply. This included as one of its great operating divisions, a Service of Utilities, with Maj. Gen. William C. Langfitt at its head as Chief of Utilities. This service included among other functions a Department of Construction and Forestry and a Department of Light Railways and Roads. In July of 1918, the Service of Utilities was discontinued as such and the two departments named were merged with the previously existing Engineer Department. The chief of utilities became the head of the consolidated department and succeeded to the title of the Chief Engineer, A. E. F. The previously existing activities connected with military engineering operations, engineer supply, construction and forestry, and light railways and roads, were continued as operating divisions of the new and enlarged engineer organization with a director at the head of each.

For brief periods in the summer months of 1917, Col. C. W. Kutz and Brig. Gen. C. H. McKinstry served successively as Chief Engineer, Lines of Communication. Brig. Gen. M. M. Patrick was appointed Chief Engineer, Lines of Communication, in September, 1917, and discharged the duties of the position until May 22, 1918, the title having been changed in the meantime to that of Director of Construction and Forestry, with no material change in duties. General Patrick having been appointed Chief of the Air Service, A. E. F., he was succeeded as Director of Construction and Forestry by Brig. Gen. Edgar Jadwin, who remained in charge of the construction work of the A. E. F. until demobilization of the forces had been practically completed in July, 1919.—Ed.]

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manded a battalion of the forestry troops which operated from two to eight saw-mills. The districts in the advance section and those in Base Section No. 2, where most of the forestry operations were located, were combined under a section forestry officer. These officers acted directly under the central office for production and shipments outside their own section, but filled local requisitions on orders of the section engineer officer in whose section they were located.

The changing and rapidly increasing force, together with the size which it had attained at the time of the armistice—150,823 men, of which 127,000 were



Organization Chart of the Division of Construction and Forestry

available for work—and its wide distribution, called for an elastic and adaptable organization and methods.

This was obtained by means of a decentralized organization and the use of type plans as far as practicable. The work was handled by the Director of Construction and Forestry with a central office at Tours, operating through a section engineer officer in each of the sections. General instructions were originally given to the S. E. officers, who were supported consistently so long as they observed the general policies of the director and of higher authority. Every possible help was given them by the central office in the securing of men and materials. The central office, under the immediate charge of the deputy director, carried on continuously along established policies and precedents. The director was thereby enabled to spend considerable time in inspections and consultations with the officers in the field, and the consideration of special suggestions, recommendations and requests made by the various section engineer officers and others concerned.

The results confirm this as a satisfactory type of organization for handling a large construction force under such varying and trying conditions.

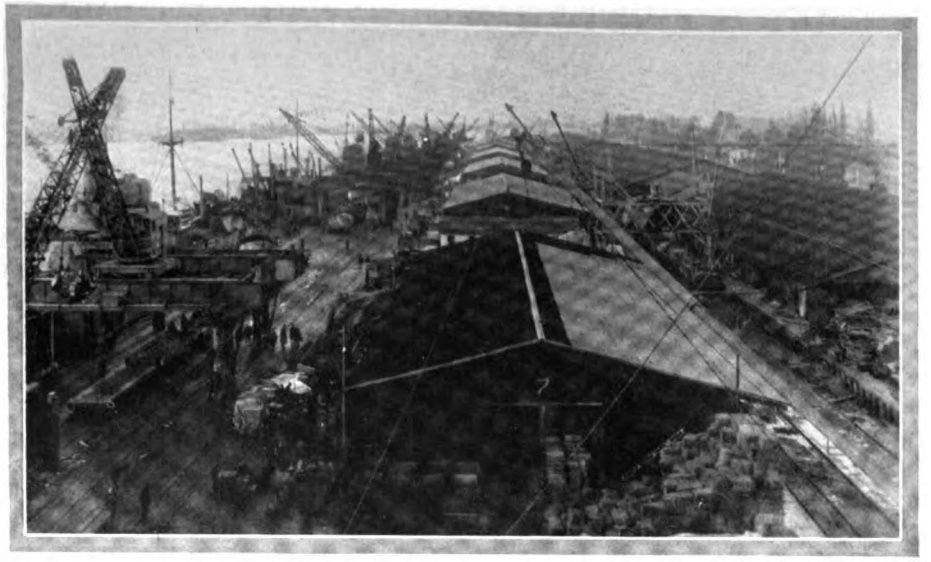
Throughout the entire period of construction the labor forces available were inadequate. There was in particular a shortage of technical troops. It was necessary to use combatant troops and general labor organizations to perform special construction work. Such technical troops as were available were necessarily used for purpose of supervision. Requests were repeatedly made on the United States for the selection and organization of technical troops, but the need for them and combatant troops at the front and the inadequate transportation facilities made it impossible to obtain adequate technical troops and common labor. The use of civilian labor recruited from men not physically suited for service at the front was not a success. Because of this constant shortage, it was necessary to curtail the construction program at all times and to limit it to bare necessities.

The various classes of construction work carried on may be sub-divided into—

(1) *Shelter for troops,* including camps of various types such as rest and depot division areas, embarkation camps, camps for stevedores, women's camps, enclosures for American prisoners and prisoners of

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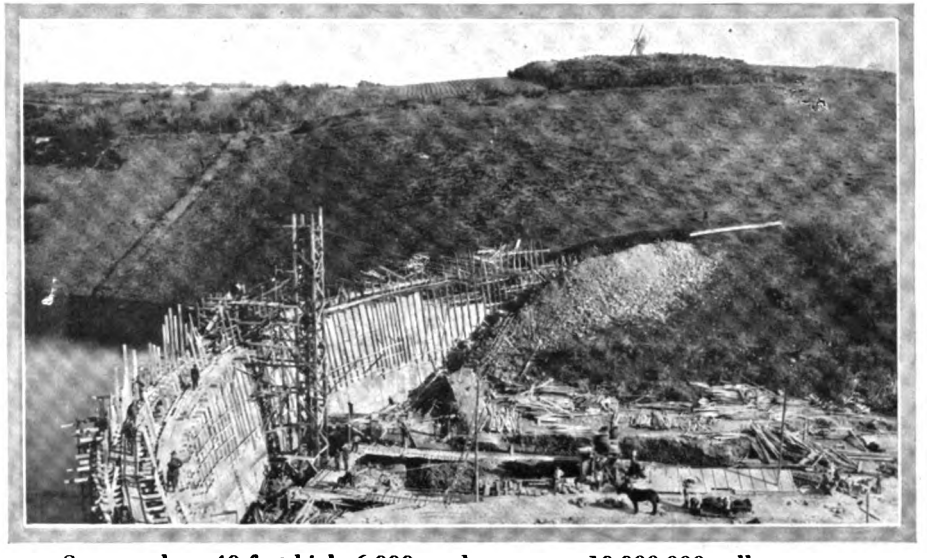
Some of the Works of the American Engineers in France



The great docks at Bassens with up-to-date facilities—built and equipped by American engineers at a speed that caused the French to marvel



The great refrigerating plant at Gievres under construction. Capacity 7,500 tons of meat, and 500 tons of ice daily



Saveney dam, 40 feet high, 6,000 yards concrete, 10,000,000 gallons storage



The railroad bridge at Nevers. Built in "jig-time" to carry the heaviest loads

Great engineering projects of every kind are indispensable to victory in modern war. The Engineers with the A. E. F. undertook vast works of every conceivable class, including water and rail terminals, docks, light and standard railways, bridges, roads, buildings of all kinds and all materials, machine shops, dams, water supply, sewerage, electrical installations, refrigeration, etc. With unlimited zeal, enthusiasm and patriotism, joyously surmounting all the difficulties resulting from inadequate personnel, plant and materials, and the necessity of conducting difficult work in a foreign land across the seas, they rapidly and successfully accomplished every task assigned to them, and contributed to the great victory of civilization.

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war, instruction centers and schools for army, corps, artillery, aviation, tank, motor transport, ordnance, chemical warfare service, etc.

(2) *Hospitalization*, consisting of base, camp, evacuation and red cross hospitals and convalescent camps.

(3) *Ports*, comprising the construction of docks and warehouses thereon, railroad connections, and lighters.

(4) *Railroads*, including engine terminals, regulating stations, double-tracking at various congested points, cut-offs, receiving, classification and departure yards and tracks in storage depots, and their connections with the ports.

(5) *Storage depots*, including large storage depots required at the ports and in the intermediate and advance sections; also special ammunition and aviation depots, coal storage yards, gasoline and oil stations, motor transport centers, remount depots, veterinary hospitals, refrigerating plants and salvage plants.

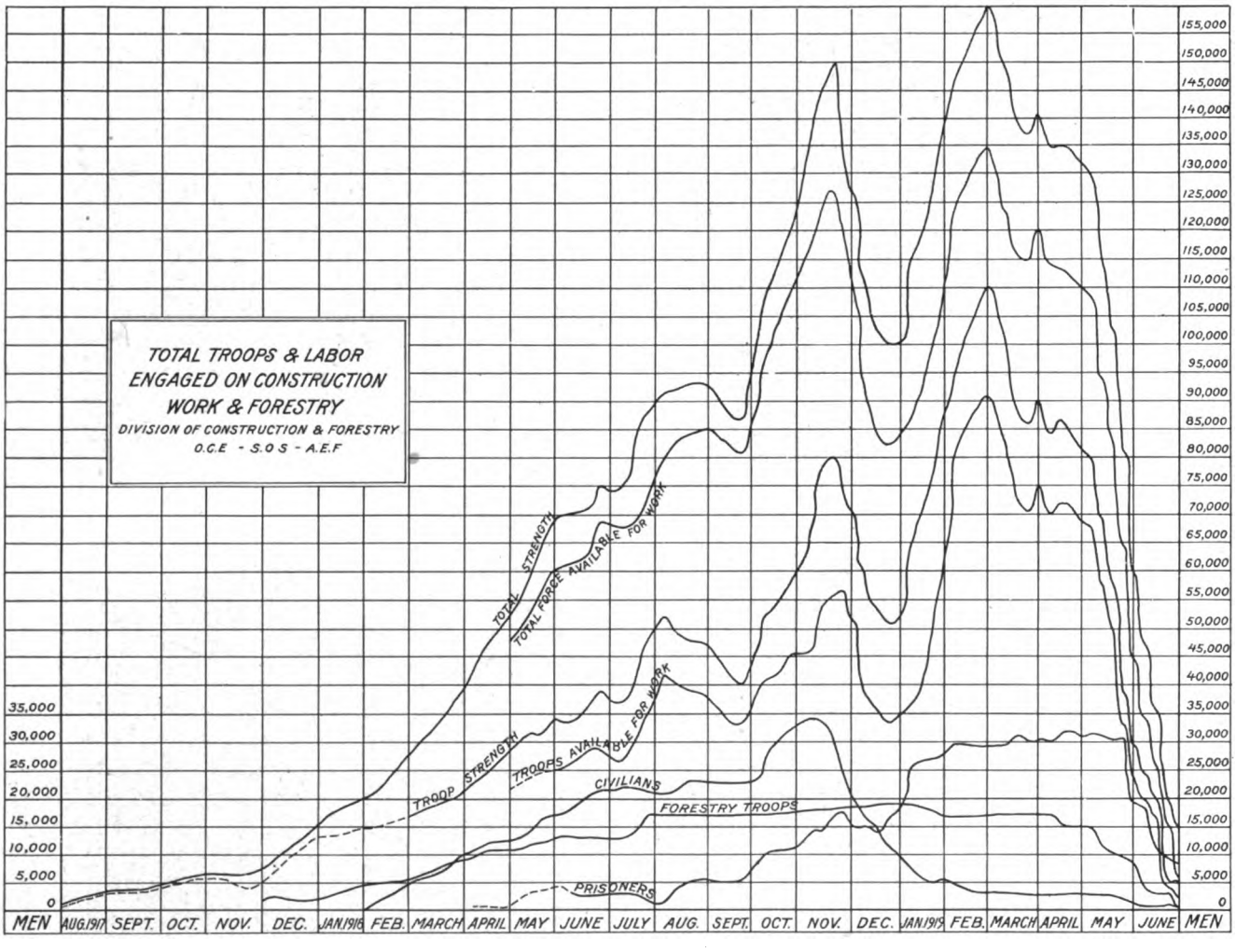
(6) *Roads*.

All of the above work was in sole charge of the D. C. & F. from its beginning, except the following:

(*a*) Railroad construction, which was in charge of the C. E., L. of C., up to September 14, 1917, when it was turned over to the transportation department. It was again placed under the D. C. & F. on March 12, 1918. Of the 1,035 miles of railroad constructed, 62 miles, or 6 per cent, were constructed while the work was in charge of the transportation department.

(*b*) Air service construction, taken over by the D. C. & F. on December 31, 1917, when approximately 7 per cent of the total work had been completed.

(*c*) Ordnance construction, assumed by the D. C. & F. on January 17, 1918. About 1 per cent of this work had been completed before that date.

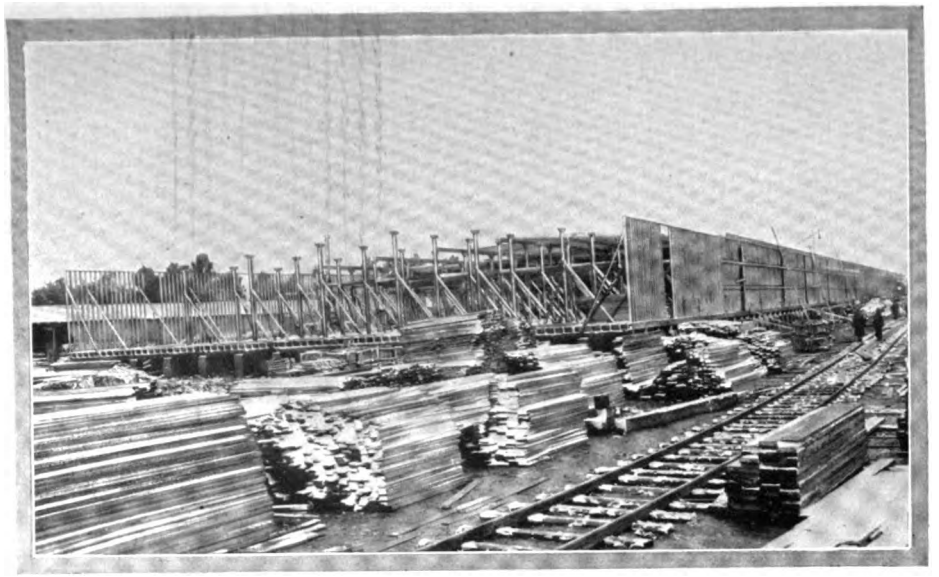


Shelter for Troops

Both in scope and general character of construction, the problem of providing shelter for troops had many features in common with the one of building hospitals. In fact, it was generally the erection of demountable barracks that served to initiate engineer troops newly arrived in France into actual construction work on foreign soil. Towns were flooded far beyond their billeting capacity as the stream of American soldiers came to flow inland from base ports, so that additional

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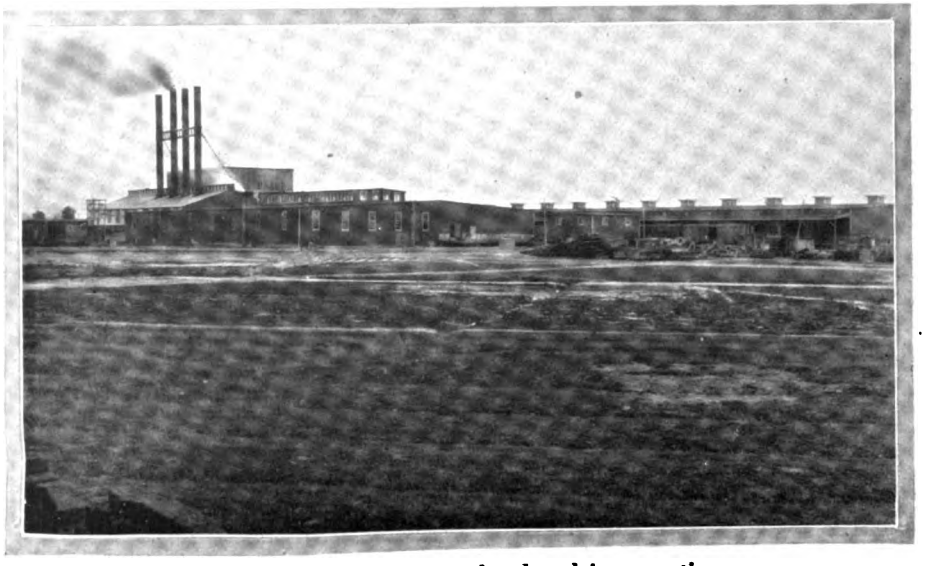
Buildings for the Great Depot at Gièvres



Large storage warehouse under construction



Large warehouse, Type D, under construction



Refrigerating plant, completed and in operation



Veterinary hospital

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accommodations on a large scale in the form of camps of various types had to be furnished. The engineer department undertook the task of supplying barracks for one-third of the United States troops in France, assuming that the remainder would be billeted.

According to G. O. No. 46, G. H. Q., A. E. F., 1917, prescribing the allowance for troops as 20 square feet per man, in addition to kitchens and mess halls, 16 barracks 20 by 100 feet were required for 1,000 men. Contracts were made for demountable barracks with the French and British governments and with civilian contractors in France and Switzerland. A total of approximately 23,000 barracks were contracted for, of which 15,000, including 4,500 hospital barracks, were delivered. Most of these were of the demountable type. Deliveries were very slow except during August, September, and October, 1918, when over 1,000 barracks per month were received. On account of these slow deliveries, it was necessary to construct barracks in place from lumber furnished by forestry troops. Two types of barracks were developed, utilizing the minimum of lumber. Type "B" barracks required only 6,100 feet b. m. of lumber, and the type "C" barracks using corrugated iron roof and sides, with frame of wood, requiring only 1,600 feet b. m. of lumber. These barracks were furnished with 4-man bunks and would accommodate about 100 men.

A total of approximately 17,120 barracks were erected, which represents 324 miles of barracks.

The largest camp involving the construction of barracks and other facilities was the Pontanezen Camp at Brest, for 80,000 men—25,000 in tents and 55,000 in barracks—for which over 500 barracks for officers and men were constructed. There were also constructed for this camp 15 mess halls and kitchens, each with a rated capacity for 4,500 men per hour; a complete bathing, delousing and laundry plant and numerous administration, storage and welfare buildings. The tendency at the larger concentration and embarkation camps has been towards large kitchens operated by permanent personnel. There have been several types of these kitchens developed, the largest of which are those at Pontanezen camp, where, although these have a rated capacity of 4,500 men per hour, one of these kitchens has a record of 7,000 men served in 58 minutes.

Hospitalization

In August, 1917, instructions were issued to provide for hospitalization on the lines of communication for 300,000 men. In September, 1917, nine French hospitals were taken over, each of which was a nucleus for a hospital center, the original total capacity being about 6,000 beds, which were finally developed into about 34,800 beds.

During the fall of 1917 it was found impossible to obtain many existing hospitals from the French, so that preparations were made to construct a large number of barrack hospitals. Meanwhile, hospitalization had been tentatively authorized for 10 per cent of the strength of the A. E. F. A great deal of time was consumed in determining upon the sites, due to the necessity of meeting the conditions proposed by French and American services interested. Plans of the standard type barrack hospital were developed. A type "A" standard hospital provided for 1,000 normal beds and 1,000 beds by crisis-expansion in tentage, and a type "B" camp hospital provided 300 beds.

The experiences of both the French and English were freely consulted in original type plans and much attention given in the preparation of revised plans to economy of materials and personnel. For further economy in personnel, administration, and supply, hospitals were grouped, as far as local conditions would permit, into centers of hospitalization. Those centers were usually developed in multiples of the Type "A" 1,000-bed base-hospital to any size required.

Contracts were at once made for hospital barracks, but deliveries were slow and resort was had to construction in place, using materials most available. Most hospitals were constructed of lumber, but in some cases light masonry walls and concrete floors were used. At first a number of contracts for this work were let, as the contractors were then able to obtain materials, supplies and labor not available to the A. E. F. This advantage steadily decreased during 1918 as the A. E. F. obtained access to all markets for materials and as the quantity of troop-labor increased, while at the same time it became increasingly difficult for the contractors to get labor and materials and to obtain transportation.

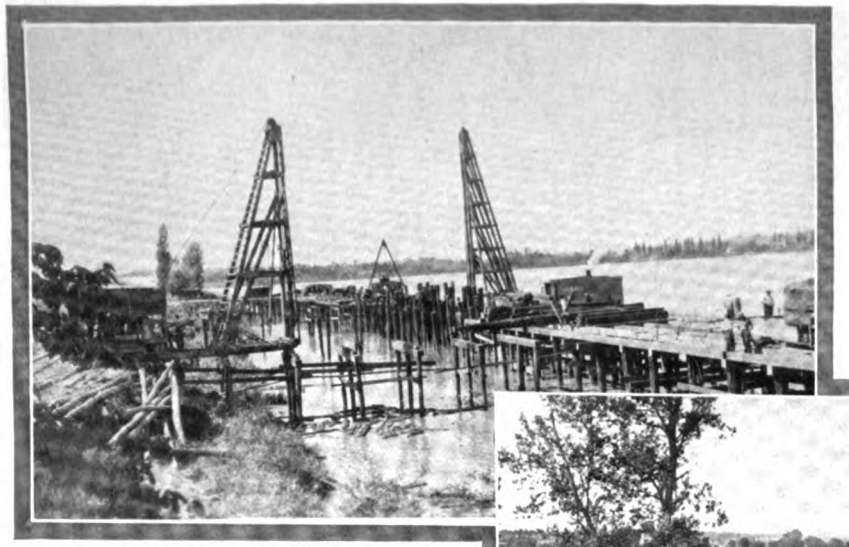
In May, 1918, the rate of troop arrivals was doubled and on June 1, 1918, the commander-in-chief directed that there be maintained an actual current bed status aggregating 15 per cent of the A. E. F. strength in Europe. The immediate effect was to triple the necessary rate of hospital construction. This increased rate was more than met.

On November 14, 1918, due to the cessation of hostilities, the authorized capacity of hospitalization was reduced to 7½ per cent. At that date bed space had been provided for 280,000, or 14.2 per cent of the strength of the A. E. F.

Of the hospital space of 280,000 beds provided on armistice day, 139,000 beds were in French buildings, and space for 141,000 beds had been provided by construction. In other words, slightly over one-half of the total hospitalization was provided by construction. This amounted to 7,700 hospital barracks, which represents 127 miles of wards.

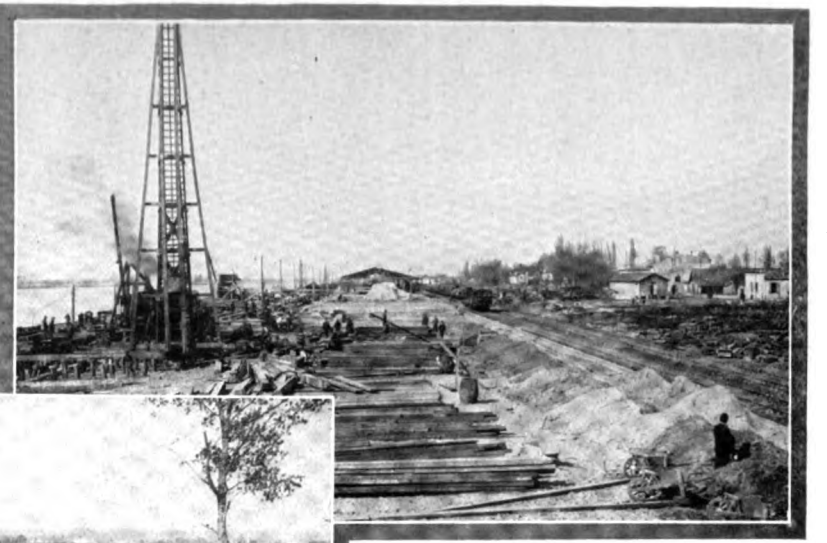
In the 1,000-bed base hospitals spacing of beds provided for 3 feet 4 inches between beds. This gave

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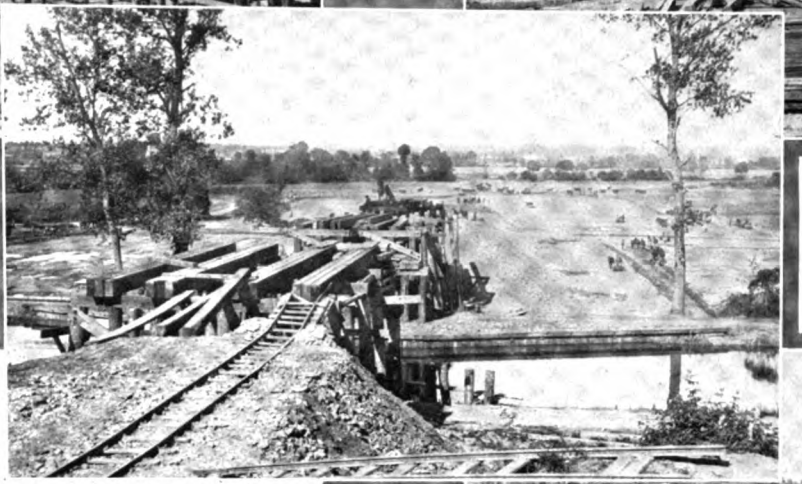


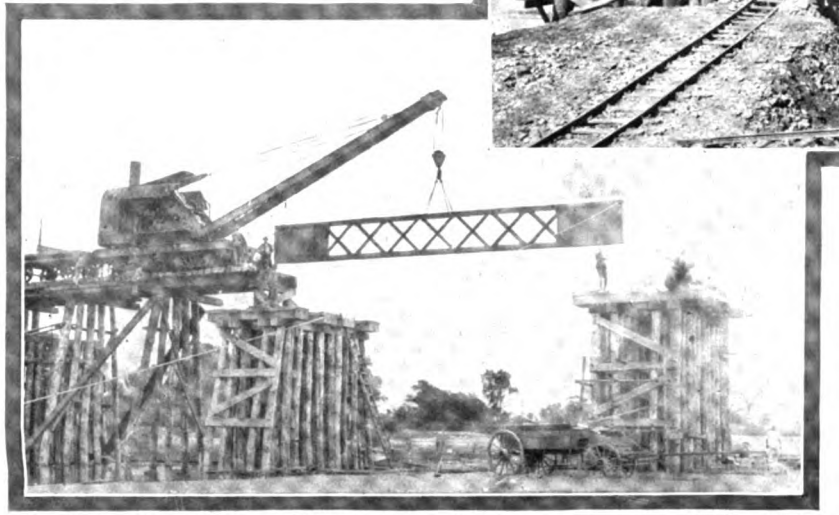
Driving piles for the American docks at Bassens

Inset—A hasty trestle bridge, designed for rapid erection and heavy duty. A typical piece of military engineering, adapted to the materials available, to meet the situation promptly without unnecessary elaboration or permanence.

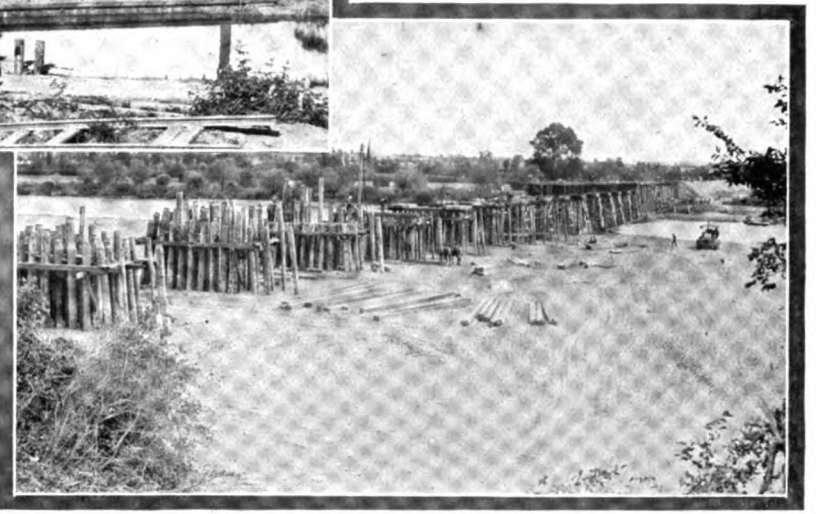


The American docks at Bassens, in course of construction





The Loire River bridge. Placing the steel girders. Note the solidity of this structure, designed to carry heavy loads, while permitting rapid construction

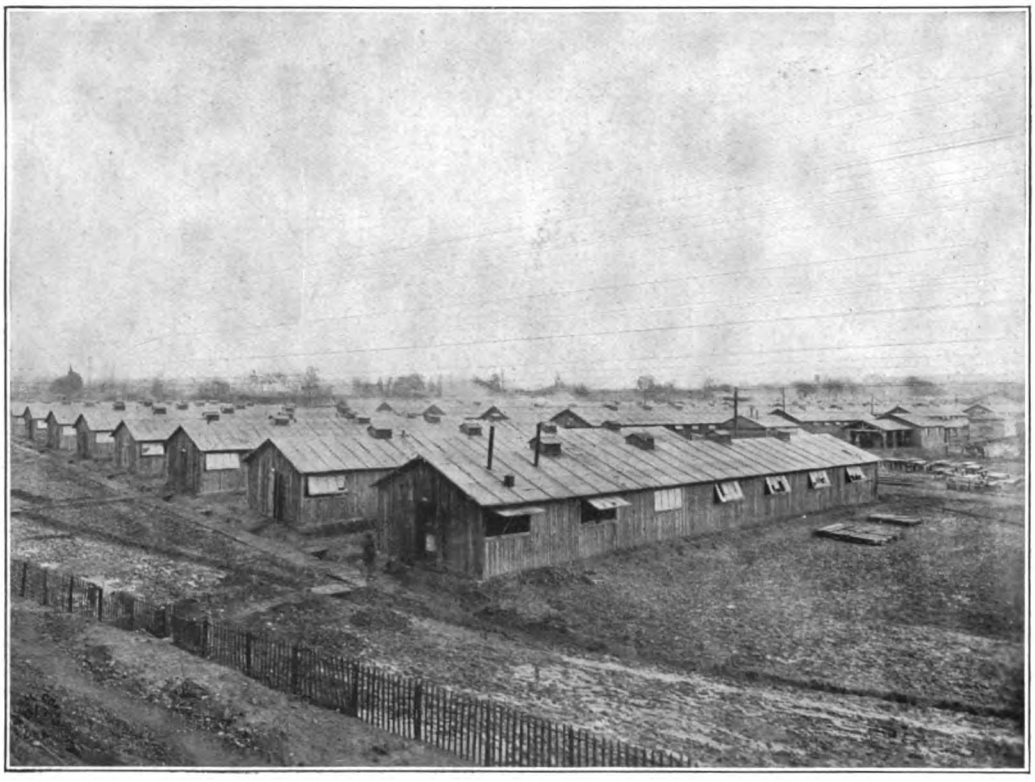


The Loire bridge, showing pile piers and steel girders in place. Pile piers lack permanence but are ideal for military emergencies

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1,000 patients per unit; unit consisting of 20 ward buildings and other buildings necessary for administration, feeding, operating, etc., and 13 buildings for personnel.

As indicated above, the D. C. & F. was always able to keep ahead of the number of patients on the standard basis, taking into consideration the French hospitals secured and tents erected. The standard 1,000 bed hospital unit contemplated tentage to the same amount, so that 2,000 men would be handled in these units in emergencies with the same general facilities intended, in normal times, for 1,000. Due to the lack of sufficient medical personnel and equipment to operate all the hospitals, particularly those in French buildings, and to the shortage of tents, there were frequently more than 1,000 men placed per unit of the base hospitals, as those units enabled the largest number of men to be taken care of with the minimum medical personnel. At times the number thus handled per unit was as great as 1,500.



Wooden barrack buildings at Camp No. 4, near Bordeaux



Type of steel-frame warehouse; corrugated-iron roofing and siding, employed at Montoir yards

The maximum number of beds occupied by sick, wounded, and convalescent never exceeded 10 per cent, and the available bed space since the first week in July, 1918, was at all times at least 50,000 beds in excess of the number of beds occupied, although tentage for crisis expansion and operating personnel was not provided in sufficient amount to match the bed space provided by construction.

The large scale of hospital construction is typified by the 20,000 bed type "A" base hospital centers at Mars and Mesves

Continued on page 49

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The Airplane in Surveying and Mapping

By

Col. E. Lester Jones[1]
Superintendent U. S. Coast and Geodetic Survey

IT is not believed that the aeroplane unsupported by other surveying can give the final accuracy required in original surveys; but by its means can be made a map that will be much better than the maps which may be in existence today in the areas which have not been topographically mapped. In order that the remaining 60 per cent of the country might be mapped by aeroplane it would be necessary to have a great amount of triangulation and traverse run with a view to furnishing the horizontal control for the photographs to be made by the aeroplane. With this control, it would be possible to fit the photographs on the map into their proper positions.

It is not possible to run many miles with aeroplane photographs and expect to have a very high degree of accuracy in the resulting maps and here I wish to give a word of caution to the advocates of aeroplane mapping, that everything can not be expected of aeroplane mapping. The development of this science will undoubtedly be rather slow for a few years. After it has been developed methods must, of course, be thoroughly tested before they can be adopted. It is well that this is so, for otherwise haste might cause mistakes which would discredit the method to such an extent that it would take years to recover.

. . . . . .

From the experience of the engineers of the Coast and Geodetic Survey the revision of an area that does not need contouring is almost as expensive and takes almost as much time as the original survey, for it is necessary to make a test of the position of each feature. It is here that the aeroplane will be of the greatest service, for if a portion of the shore line should be inspected with a view to learning whether or not the map of it should be revised, we could have a series of photographs made by an aeroplane along the coast and a comparison of the photographs with the original map would enable one to locate definitely each area within which there are new features or where old ones have changed. It is believed that in most cases the details on an airplane photograph could be placed on the map from the photograph with all the accuracy that is needed in the topography shown on the coast charts.

It is a debatable question as to whether the aeroplane photograph made over a water area will show any outline of dangers to navigation when the plates are developed. If they are shown, there is a vast field for the aeroplane in making photographs over water areas where it is known that many obstructions exist. With the usual surveying methods, it is difficult at times to locate every obstruction. One or more on any chart might be missed. The fact has been proved a number of times in a most disastrous way by vessels running on uncharted rocks both along our eastern and our western coasts and especially in Alaska.

The Coast and Geodetic Survey is now making wire drag surveys of all doubtful areas along the coast but it will be many years before the bureau can assure the navigating public that all obstructions have been found and accurately charted.

It may be possible that an aeroplane photograph will indicate submerged rocks or other dangers that are close to the surface of the water. It would be a question of differences in shade in the photograph. If such a detection of danger can be made then one must be very cautious to make the photographs only on perfectly clear days. Otherwise, the cloud passing over makes its shadow on the water which might show on the photograph and cause uncertainty as to whether the spot is a cloud or an actual obstruction.

There are many hundreds of square miles of area along the coast that consist of salt marshes with many streams of little or no importance but which should be shown in their proper relation to other topographic features. These marshes can be photographed from aeroplanes and the streams running through them would probably show in such a way that they could be fitted into the map from the photograph. Here might be a large saving of time for the surveyor in the field.

There are other cases where there are extensive mud flats, when the tide is low, as in Jamaica Bay, New York. To survey the outline for these flats is rather laborious, with the usual instrumental methods, but it is believed that it might be possible to photograph them from an aeroplane and have the results placed on charts. It will undoubtedly be possible to get

[1]Extracts from an address delivered before the Second Pan-American Aeronautic Convention at Atlantic City, New Jersey. Reprinted by permission, from the *Journal of The Engineers' Club of St. Louis*, May-June, 1919.

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these located on the chart from aeroplane photographs with all the accuracy that is necessary for the navigator.

In making photographs from the water, for the purpose of discovering obstructions to navigation at low tide it will be necessary to have some means to properly locate photographic features on the chart. This probably can be done by anchoring two or three small boats within the area of the photograph and locating them with relation to triangulation stations. The location could be done in the usual way in which the sounding boat is today given its position, that is, by taking two sextant angles simultaneously from a boat to three control points. It can readily be seen that if two or three accurately located boats are clearly shown on the aeroplane photograph, it will be possible to place the topographic details on the map in their proper positions.

I do not wish to convey the idea that the aeroplane photography will supersede the usual methods of hydrographic surveying, but it would supplement those methods by making it possible to discover channels running through mud flats, also coral heads, shoals, and other obstructions which might be close to the surface of the water and which may be missed by the usual methods of conducting hydrographic surveying.

There has been a rather positive statement made above that the aeroplane can be used to advantage in the work of the Coast and Geodetic Survey. This is undoubtedly true but only time and the development of the methods can show just how much the aeroplane can be used by this Bureau.

. . . It is hoped that aeroplane surveying can be developed at least to supplement the usual surveyors' methods in mapping the interior on a comparatively large scale map with high accuracy.

It would appear that if the aeroplane photograph will be of so much assistance in the topographic work along the shores of the country that it would really be of some value in the interior.

Whether or not it is possible to make contours from aeroplane photographs is a question that has not yet been decided. Many persons who have studied the question claim that it is impossible to locate accurately contours from aeroplane photographs. Others claim that they can be located with great accuracy. The chances are that some mean position will be found to be the true one. It is possible that the stereoscopic method can be applied to two photographs taken by two cameras on the same airplane or by cameras on two different airplanes together to obtain a rough idea of the configuration of the country.

With regard to surveying the interior of the country for the purpose of making an accurate large scale, contoured map, I may say that here the aeroplane photographs can undoubtedly supplement the usual surveying methods, but can not entirely supplant them.

. . . . . .

It seems to be absolutely necessary in making the contoured survey to do the work with the present methods. One can readily understand that it would be impossible to show contours at intervals of 20 feet (that is, the difference between two contours will be that amount) over a wooded area, where trees in different parts of the forest varied in height. The area photographed will not show the difference of elevations of trees in a wood, for the low trees and bushes, not more than 20 feet in height, would show about the the same on a photograph as a primitive forest where the trees may be 70 to 100 feet high.

The contoured map must be of such accuracy as to enable the highway engineers, and engineers engaged on irrigation projects, to lay out their work accurately. It can be readily seen that with an accurately contoured map, the engineer could plan the railway, the highway, etc., from one place to another, and not make great mistakes in grades and alignment. It is believed that this would be impossible from contoured maps made from aero-photographs. It is possible that some method may be discovered by which the difference in elevation between two points shown on each of two separate photographs can be computed, but if one considers that the work involved, if it can be done at all, will be very great, he will see that it will probably be more economical to put the contours on the map by the usual methods, than to compute innumerable elevations from photographs.

The possible method of computing distances and elevations from photographs may be supplemented by using the stereoscopic method which would give one an idea of the configuration of the ground. This would enable the draftsman in the office to select critical points whose elevation could be determined. Such critical points would be crests of hills or ridges and the bottoms of slopes. If the elevations of critical points are determined then contours could be interpolated between them.

I am giving these statements with a good deal of reservation on my part, for the method of contouring by aeroplane photography has not been developed and it may be that very little can be accomplished where accurate contouring is desired.

But this accurate large-scale contoured map can undoubtedly be made by combining the usual methods of surveying with the aero-photographs. The aero-photograph will usually give a great deal of detail which may facilitate the progress of the map by the topographer using the plane table. It will be necessary of course for the topographer to select a number of definite points on his map, such as road crossings, large buildings, groups of buildings, bridges and other features which can be identified from photographs. Those features would serve as control points for the topographic details shown on the photographs. Without such points located by the

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usual methods, it would be necessary to place certain conspicuous objects on the ground near the triangulation and traverse stations. Most any kind of object that would show in the photograph, and have a distinct shape, could be used. But the placing of these objects would be expensive. It is believed that the location of the conspicuous features referred to above could be done by the topographer at a much smaller cost than the cost of placing objects for the aero-photographs, at the triangulation and traverse stations.

It is possible that the topographer would be able to place the topographic details on his map from the photographs before going into the field to do the contouring. Much of the work of the topographer by the usual methods consists in placing the topographic features on the map in their proper locations, but a great deal of this might be obviated by the use of the photographs. Then he could go into the field and place the contours with greater rapidity than if he attempted to do so previous to using the details of the photographs.

. . . I feel confident in stating that even on the highest grade of topographic maps the aero-photographs can be used to a great degree in revising and bringing up to date maps of that character which have already been made. . . .

. . . In order to test such a map and learn whether it was up to date, it would be necessary, by the usual methods, to send a surveyor into the field to go over the area in great detail. Of course an inspection could be made of an area by driving over it, but many changes might be overlooked by this method of inspection.

How much simpler and more reliable it would be to send an airplane over the area in question and make a series of photographs. These photographs would show, at a glance, the exact areas where changes in the features had occurred, and if the changes were not too complicated it is possible that we would be able to place the new features on the map directly from the photographs. The process would be to fit in the new features between unchanged old features, which of course would also be shown on the photographs.

. . . . . .

I feel that the aeroplane can now furnish maps of a low order of accuracy, so far as scale and position of features are concerned, which will be of considerable value in many branches of industry and commerce. They will undoubtedly be extensively used in unmapped areas in this and other countries in the very near future, in these reconnaissance surveys and maps. But I hope they may be of great use in more accurate work.

Aeroplane Photography as an Adjunct to Military Mapping

By

Maj. J. H. Wheat

Engineers, U. S. A.; Topographic Engineer
U. S. Geological Survey

THERE is no doubt whatever of the great value of air photographs as an adjunct to map making in war. Accurate large scale maps were absolutely necessary for the type of fighting developed by the war with Germany. It was soon realized that the ordinary methods of surveying the battle area could not be carried out.

Special instruments were constructed and numerous methods were tried out to find means by which accurate maps of enemy works could be made from ground positions. All proved inadequate for the degree of accuracy required. Finally, the air photograph solved the problem so far as detail was concerned. The French *Plans Directeurs* furnished the base for control and the vertical photograph gave all the detail necessary for any map scale required.

The rectification or restitution of the photograph to eliminate the errors due to tilt of the photographic negative from the horizontal plane, during exposure proved to be somewhat of a problem. This problem developed three general methods for restitution: One, which was used by map makers of all the armies, is a graphical method. Four points are selected on the photographic print which are common to both photograph and map. These points are connected by straight lines forming a quadrilateral. By means of the intersection formed by the diagonals and with the apices of the triangles, this figure can be divided into as many small triangles as will be found necessary for the amount of detail desired. The same number of lines and figures must be drawn on both map and photograph. The features on the photograph are then transferred to the map by compilation.

An optical method by which the image of the pho-

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tograph is reflected by means of a prism upon the base map was also used where small bits of detail were needed.

A third method involved the use of an enlarging and reducing camera equipped with special adjustments by means of which an oblique image from the negative of the tilted vertical photograph could be superimposed upon the base map or a tracing of control points. This oblique copy represents a correct image of the ground such as the original photograph would have done if the camera had been rigidly vertical at the time of exposure.

There is a tendency toward misconception of the value of air photographs in regard to maps. This impression is received through various articles published in popular magazines and newspapers. The mere pasting together of a number of photographs to form a "mosaic" does not make a map. The errors arising from tilt and relief must be considered, and then corrected by restitution and adjusted to proper control.

The air photograph needs control to fix its correct position on the planimetry. Therefore where no base maps are available, it will be necessary to do a certain amount of triangulation and from this primary control to establish a secondary control graphically, by means of the plane table, locating road junctions, church spires, bridges, etc., which may be easily identified on the photographs. The restitution of the photograph may then be accomplished.

There is a limitation of the air photograph, other than the one of control, which should be noted. An ordinary vertical photograph shows the width and direction of roads, lines of railways and course and width of streams, with the size and density of woods on their banks. It also shows the boundaries of swamp areas, the shore line of lakes and ponds and the demarcation of woodland borders. In the case of wooded areas, such details as the relative heights of trees, density of growth, glades within heavily wooded country and brush are easy to pick out, but when the relief of the terrain, in the sense of accurate elevation is needed, the vertical photograph fails.

It is true that shadows will show steep slopes; indicating hills or valleys and that sometimes the furrows of cultivated land will indicate the contour form (a hairpin-shaped road or the alignmnt of a railway will also indicate slopes), while elongated shadows cast by trees growing on hill slopes are also to be noted.

With the use of the stereoscope a fairly good "form" map may be shown, either by means of shading or hachures.

A combination with the plane table seems to be about the only way by which contour sketching can be carried on with vertical photographs. By means of the plane table, intersections of salient points and vertical angle elevations to the same, could be obtained and the details of form drawn in from the photograph. Major Brock, of the Canadian Survey, suggests a combination of the photo-topographic method with aerial photography or a combination of all three, plane table, photo-topography and aerial photography, depending upon the character of the varying topographic features encountered in area to be mapped.

This matter of the limitations of the vertical photograph in regard to relief applies of course only to ground forms. The plans of all objects on the ground are well shown and their shapes indicated by their shadows. It is also possible to note their dimensions by comparison with other objects of known size.

It is apparent that in making use of the air photograph for map construction, the personnel must be specially trained for rapid and accurate work. A thorough knowledge of interpretation and the methods of restitution is required. It is a waste of good material to distribute photographs to those who cannot read them and who generally look upon them merely as souvenirs. For accurate topographic mapping well trained and experienced topographic engineers are required.

The Army Surveying and Printing Battalion is the logical organization to take up all work pertaining to map making. During the war this organization furnished topographers, and the personnel for the restitution of aerial photographs to armies, corps and divisions. In the division the map making was confined to compilation of new work on existing French maps or those furnished by the Base Printing Plant. This was done by divisional G-2-C.[1] If exigencies should arise requiring new surveys a detail from the army topographic unit could be called upon to do the work.

It does not seem to be practicable to attempt the training of all Engineer troops in methods of accurate large scale map making. Too much time is required for such training and it would be to the detriment of other branches of military engineering for which their services are needed: furthermore a special technical education is necessary as a basis for training, and it will be difficult to get men with such qualifications.

The above suggestions are not intended, of course, to do away with ordinary map making such as all engineer troops should be able to do—road sketching, position sketching, traversing, etc. Every soldier should be able to read a map intelligently, and one way to become familiar with maps is to practice sketching them in the field. When considering future training for troops, special emphasis should be placed upon the subject of *map reading*. Experience in the Topographic Section of the Army Engineer Schools and the Army Intelligence School, A. E. F., proved the necessity of a more thorough training on this subject, which is a vitally important auxiliary to a soldier's education.

[1] G-2-C is the abbreviation for the Map Division of the Intelligence (2nd) Section of the General Staff.

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Construction of Lock D, Cumberland River

By

Rufus W. Pafford

Junior Engineer

LOCK D is located 105 miles by river below Nashville, Tenn., and 87 miles above the mouth of the Cumberland River, and is one of six locks comprising the project for the improvement of that part of the river from Nashville to the mouth, called the "Lower Cumberland," by which a maximum stage of 6.5 feet is to be maintained throughout the year. Old Fort Donelson, which was captured from the Confederate Army by General Grant during the Civil War, is on a high hill immediately back of the lock.

Sand and gravel for making the concrete masonry were obtained from the river in the vicinity of the work by a suction dredge. The timber for building the storage bins for the sand and gravel was purchasd from a local sawmill and delivered on the job. Ties and poles suitable for trestles and rough lumber for temporary buildings were also obtained locally. Cement, coal, form lumber, machinery, supplies, etc., were either brought down from Nashville by boat to the site or by rail to Bear Spring, a point on the river about 7 miles above the lock, and either hauled through the country with teams or brought down the river from there in boats. The contractors built a switch from the tracks of the Tennessee and Cumberland River Railroad at Bear Spring to the river, a distance of about ½ mile. This switch was used for delivering cement, coal, lumber, and supplies to the river when boats could operate from this point to the lock, but on account of the difficulty of getting over the Dover shoals at low water, and because of the fact that the 1913 working season, when most of this work was done, was very dry, it became necessary to haul all supplies from Bear Spring, the terminus of the Tennessee and Cumberland River Railroad, a distance of about 6 miles.

Lack of funds prevented the award of one contract for the completion of this lock and dam, so it was decided to ask for bids for building the lock walls, upper and lower guide walls, guard wall, and for the removal of about 6,000 cubic yards of rock from the lower approach. The contract for accomplishing this work was signed February 25, 1913. This article will have to do with the part of the work covered by the first contract only.

The contract mentioned above was awarded to the Foster-Creighton-Gould Company, who immediately after signing the contract began to overhaul their old machinery and to purchase new equipment suitable for doing the work covered by this contract. A steamboat, two barges, a derrickboat, and a gasoline towboat were bought and three barges and a sand dredge were built by the company.

About the middle of March, 1913, the work of towing the plant, together with lumber and other supplies, from the company's headquarters at Nashville, was begun; the boat having landed at the lock site on March 20 on her first trip. The small gang of men which came at this time was employed for the first few weeks in clearing the site, building tool-houses, temporary quarters for the men, and a house for the inspectors which is to be used later for a dwelling for one of the men operating the lock. As soon as the river was low enough to be out of the way of the laying of tracks, construction of trestles and sand and gravel bins, and the erection of derricks and general plant construction, the work was started.

A study of the gage readings in the vicinity of the work for the 6 years just prior to the advertising for bids would indicate that the contractor could count on from 190 to 250 days per year during which the river would be below the top of the cofferdam, plans of which were exhibited with the rest of the plans for the lock when bids were being asked. The records kept on the work show that the river conditions since the contract was let have been just about what one might have expected or forecasted from the hydrographs of the river for the 6 or 7 years previous to that time.

The following is a list of the quantities of the work, as estimated by the engineers previous to advertising for bids, compared with the actual quantities of work performed by the contractors:

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Classification.	Quantities as per office estimate	Actual quantities
Earth excavation .....cu. yd...	4,000	6,387
Rock excavation—		
Inside cofferdam.....cu. yd...	8,900	8,781
Outside cofferdam.....cu. yd...	6,900	6,980
Backfill .....cu. yd...	9,000	10,061
Concrete—		
In lock .....cu. yd...	13,100	13,312
In guard and guide walls.cu. yd.	4,500	4,353
Puddling .....cu. yd...	500	138
Cofferdam.....lin. ft...	650	654
Bolt holes.....lin. ft...	300	607
Handling and placing iron..ton..	62	73
Inspector's house.....No...	1	1

It can be seen, at a glance, that the office estimate was very near in most cases to the actual quantities. The extra amount of earth excavation was due principally to sediment in the cofferdam, payment for which was allowed as earth excavation. The differences in the figures on iron and steel, puddling, and bolt holes was due to slight changes in plan, which cause was possibly also responsible for the difference in the case of backfill.

A very thorough examination was made of the foundations for the different parts of the work covered by this contract, borings being made on two different occasions under the supervision of two different men. All investigations showed the foundation to be rock of a very solid and dependable character, with no crevices or earth seams. After the excavation had been carried to the elevation which the plans called for in each foundation, test holes were put down several feet, and in no case was any condition encountered which was not considered most satisfactory.

The contractors' plant consisted of one steam towboat, one gasoline towboat, one sand dredge, two 80 by 20 foot barges, one 22 by 120 foot barge, one 18 by 65 foot barge, one 14 by 40 foot barge, one derrickboat, two 10-inch centrifugal pumps, two 6-inch centrifugal pumps, two steamboat boilers, three locomotive type boilers (one 40, one 50, and one 80 horsepower), one steel derrick with 60-foot mast and 108-ft. boom, 3 timber derricks with 30-ft. masts and 90-foot steel booms, one timber derrick with 30-foot mast and 60-foot boom (used for unloading material from barges), one timber derrick with 30-foot mast and 40-foot boom—each derrick being supplied with hoisting engine—one channeler with engine complete, one dynamo with engine complete, one 1-yard concrete mixer with engine complete, one ½-yard mixer with engine complete, two haulage engines, one duplex supply pump and 4,000-gallon water tank, one diving outfit complete, two 1-yard steel-bottom dump concrete buckets, three steam drills, and two air drills, besides a sufficient supply of home-made flat cars, side-dump cars and skips, and steel tilting-derrick buckets to handle the earth and rock.

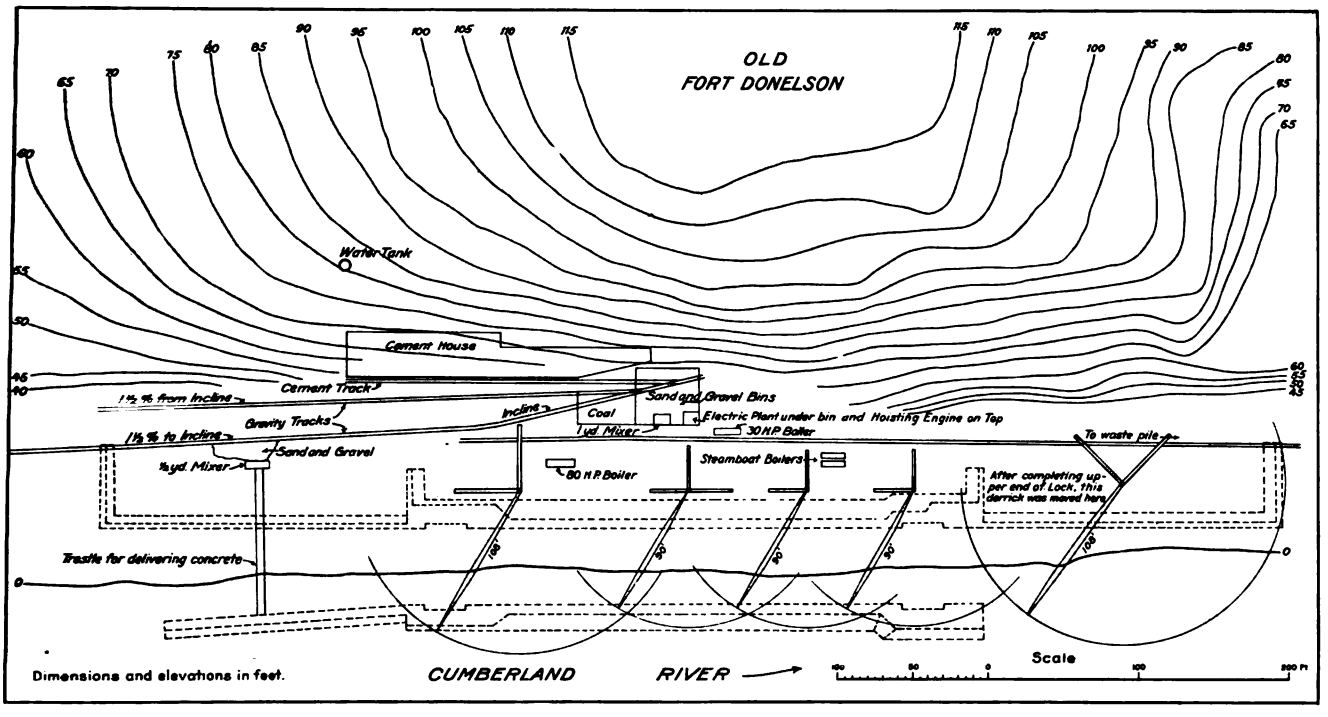
The time specified in the contract for completing the work was 3 years. With the plant that was on the job, the contractors should have have had no difficulty in completing the work in 2 years. The delay in completing the work was due to the fact that the cofferdam around the lower approach excavation was insufficient. This is responsible for the unfinished condition of the excavation in the lower approach now, and was the cause of the lower guide wall not being built earlier.

The first contract work to be started was earth excavation for the land wall of the lock, which was begun early in May, 1913. This excavation was light, and as no derricks had been placed in commission yet, it was done with wheelbarrows. The waste material was wheeled up the bank and deposited back of its original position to be used later as backfill behind the wall. This was a slow and expensive operation, but was considered profitable, inasmuch as the material could be placed as backfill very cheaply when the wall was built. Some of this work was done with a skip and derrickboat by fastening a snatch block to a stump on the bank above where it was intended to deposit the material. The skip was brought back by a line from one drum of the hoisting engine on the derrickboat.

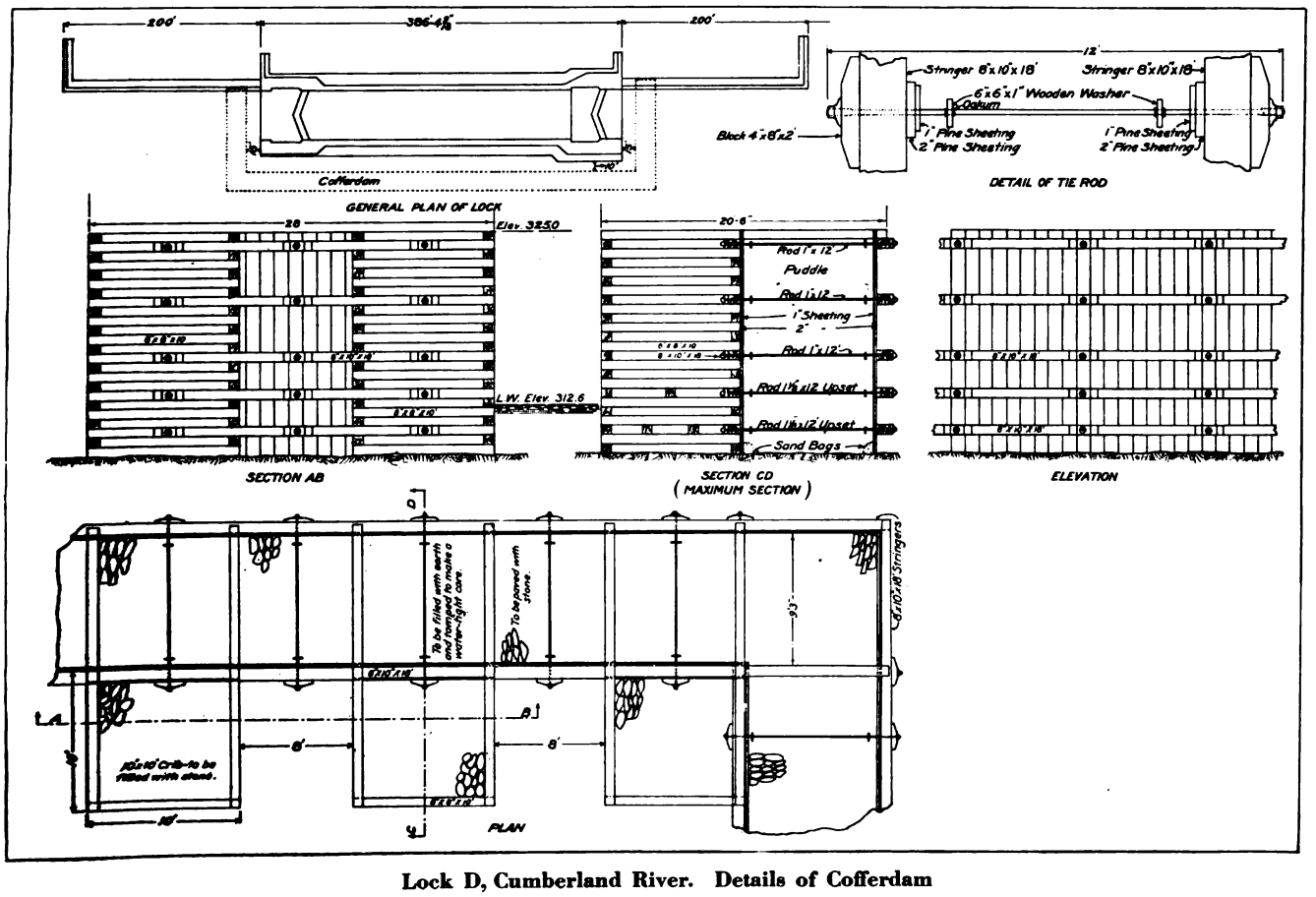
About two weeks after the earth excavation was started a beginning was made on the rock excavation for the land wall of the lock. Although the cofferdam had not been built, the stage of the river made this work possible. As no steam drills had been received on the job, this work was started with churn drills. The holes were loaded with small charges, so as not to scatter the stone so badly nor shatter it too finely. The excavated stone was piled along the edge of the water, where it could be reached conveniently later for use as filling in the stone compartments of the cofferdam.

While the river was too high to start actual construction of the cofferdam, the contractors' steamboat and barges were being used to take advantage of the favorable towing conditions and bring cofferdam timber down from Nashville. This timber was unloaded with flat cars on an incline on the top of the bank and stored about 300 feet up the river from where the upper end of the cofferdam was to be built. These cars were operated with the derrick-boat by putting down a "dead man" on top of the bank and fastening a snatch-block to it. This incline, though a temporary affair, was allowed to remain here and the timber was carried back down the bank where it was needed for use in the cofferdam over this track. In order to facilitate construction of the cofferdam when the stage of the river should become favorable, it was decided to frame the timber on the bank, so this work was started on May 10th. Actual construction of the cofferdam was started June 5th, when the first crib of the upper bank corner was placed and filled with

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Lock D, Cumberland River. General Plan and Layout of Plant



Lock D, Cumberland River. Details of Cofferdam

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stone. However, in a day or two the river had risen until the surface of the water was higher than the proposed cofferdam, and the work of placing cribs was ncessarily suspended. After about one week, though, the river fell sufficiently, and this work was resumed and carried to completion without any further interruption caused by high water. Before placing any of the cribs a sufficient number of boats and barges were tied together and drawn up on the edge of the crib lines and the lines of sheathing to reach their entire length. The corners of the cribs that came on this line were located and accurate soundings taken; then the boats were moved to the next line and the crib corners located and sounded. When the cribs had been sounded, the points under the rods on the two lines of sheathing were sounded, as the sheathing on both lines that the rods pass through must be bored and put on the rods as the cribs are built and before the stringers are put on After these soundings were taken, a sketch of the bottom of each crib was made and the amount of blocking necessary to make the crib set level when it rested on the bottom of the river was determined.

The cribs were built on a gently sloping part of the bank just above the site of the lock and at the foot ot the incline that had been used to unload the cofferdam timber, which made the work of transferring the material to the proper place a very cheap and fairly rapid operation. Several of these cribs were built together, the connections being made while that part of the crib was above water. As timber was added, forcing the cribs on the bottom, they would be pushed farther out into the river where the water was deeper. When they were as high as it was thought they could be floated into place without any of them hanging on the bottom, they would be checked down the river to their positions next to the ones that had previously been set, lined with an instrumnt, weighted down with heavy stone until they rested on the bottom, the remainder of the timbers required to bring the cribs to the proper elevations drifted on, the tops leveled by dapping out, and this section connected to the one previously set. The principal reason for building several cribs in one section before they were set was in order that the connections between cribs could be made above water as much as possible. When this had to be done under water, it proved to be a difficult proposition and one that only a diver could handle satisfactorily.

The cribs were filled with the stone excavated from the foundation of the land wall of the lock referred to above. As a considerable amount of this had been piled along the edge of the water for the entire length of the cofferdam, it was an easy matter to deposit the stone in the cribs by the use of the derrick-boat and a tilting bucket of 1-yard capacity, since the stone pile was at no point farther than 70 feet from the cribs. Wheelbarrows were used in filling the cribs across the lower end of the cofferdam, as the derrick-boat had to be removed from the cofferdam before the closure was made. After the stone filling in the cribs was above the surface of the water, an effort was made to have it as compact as possible by using two men in the cribs to place the stone by hand as it was dumped from the bucket.

Great care was exercised in putting the sheathing on the puddle compartment. Where the depth of water would permit, the carpenters would examine the bottom, which was practically all rock, with their bare feet, and if this was not possible, careful soundings were made on both sides of the plank which was about to be placed, so that the proper slope of the bottom could be determined, and just prior to nailing the plank was sharpened and struck several blows on the end with a large hammer, in order to broom the bottom and thereby secure a closer joint between the sheathing and the rock bottom. Another precaution taken to seal this joint was to place a continuous line of cement bags about half-filled with sand along each side of the puddle compartment on the bottom before placing the clay puddle. Practically all of the bags of sand were placed by a diver, who worked as a carpenter when he was not in the diving suit.

After digging test holes in a number of different places, it was found that clay suitable for making the puddle for the cofferdam could be gotten from the river bank only a short distance from the government reservation on the up-river side, provided a small amount of the top soil be stripped.

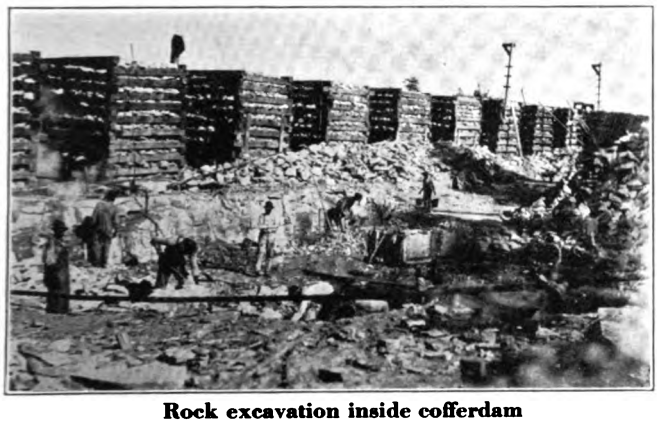
A string of pile bents about 100 feet long was driven in the river near the proposed clay pit with the top of the caps well below the floor of the clay pit and wide enough to allow a barge to float in under the bents and between the piles. Two 36-inch gage tracks were laid from the clay pit out to these bents. As previously stated, these tracks sloped to the river. Two home-made side-dump 1-yard cars were operated on these tracks, and by fastening one end of a line of the proper length to each car and passing the bight of it through a snatch-block fastened to a "dead man" at the back of the clay pit, the loaded car going to the trestle would pull the empty car back into the pit. By dumping these cars from both tracks, the barges could be loaded without doing any shovel work at all. The clay in the pit was loosened by shooting with black powder and was loaded into the cars with shovels. As soon as a barge was loaded, it was towed by the contractor's boat to the cofferdam to be unloaded, and an empty barge put in its place, so that the operation was continuous. For a portion of the time that this puddle work was going on, three 8-hour shifts were employed. At first these barges were unloaded with shovels, but this method was soon abandoned and the derrick-boat with ½-yard clam-shell bucket was used. The clam-shell was operated with a two-drum hoist by working the derrick with a fixed boom and moving the

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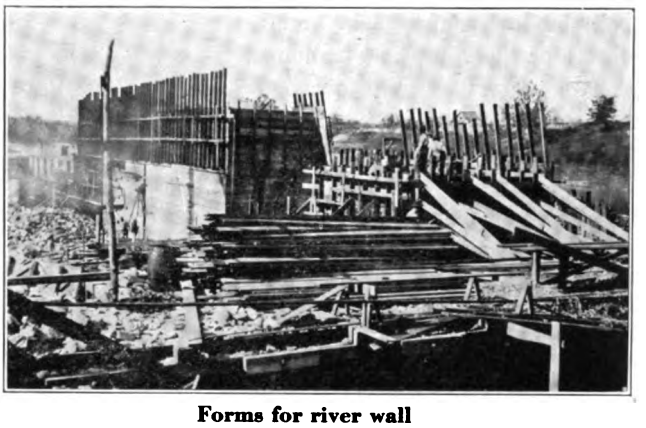
boat instead of the boom. A supply pump was kept running all the time when clay was being unloaded, and a continuous stream of water played on the dry clay. In addition to this, men were kept puddling the clay with their feet while it was being placed.

After the puddle had been allowed a few days in which to dry out and stiffen up, it was covered with riprap ranging in thickness from 12 to 18 inches, consisting mainly of 1-man stone set on edge with some spalls and smaller stone to fill the voids.

The cofferdam was finished July 31 and pumped out on that same day without any trouble whatever. No leaks of any consequence developed, and the work of unwatering covered only a few hours. It is the opinion of the writer that 30 minutes per week of actual running for a 10-inch centrifugal pump would have taken care of the leakage from the day it was first pumped, July 31, until the following February, when it was flooded for the first time. Even after the river had risen almost to the top of the cofferdam, no leaks developed, and work could have been carried on inside the cofferdam until water actually began to flow over the top.



Rock excavation inside cofferdam



Forms for river wall

While the conditions here were very favorable for building a good cofferdam, on account of the rock foundation, and especially since the rock was not covered with gravel or earth, yet it is thought the design is very good; and, furthermore, the contractors exercised considerable care in the construction of the cofferdam and appeared anxious to obtain the very best results possible.

Immediately after completing the cofferdam and pumping out the water, a large force of men was put to work excavating the approximately 9,000 cubic yards of rock inside the inclosure. Four stiff-leg derricks had been erected on a line parallel to the axis of the lock and 25 feet back of the face of the land wall, and so spaced that with 90-foot booms on three of them and a 108-foot boom on the other, all of the excavation could be reached by them, as well as the 36-inch gauge track behind the line of derricks and parallel thereto. This track extended for the entire length of the cofferdam and also for several hundred feet down the river where the waste from this excavation was piled. Cars used on this track for disposing of this material were built on the job and had detachable bodies, which served as skips and were used in connection with the derricks for hoisting the rock from the cofferdam. A train of four of these cars was operated by means of rope haulage, which was driven by a 6¼ by 10 inch reversible haulage engine from the derricks to the dump, where they were unloaded in the same manner as an ordinary side-dump car.

It is believed that a dinkey could have handled this waste from rock excavation much more economically than did the haulage engine. In the case of the haulage engine, the track must be straight, the long and expensive line must be bought, maintained, and installed, and after the material piles up to the track it must be shoveled or moved from the track by hand, causing a heavy expense; whereas, the dinkey track could be made as crooked as necessary and could be kept on the edge of the dump where the cars could be unloaded easily and without rehandling any of the material.

It is thought that some time was lost in breaking the stone unnecessarily fine, a large per cent of it being handled with shovels both into the skips and away from the track at the dump. Another practice which is thought lost the contractors money on this excavation was the congesting of the men instead of scattering them so that each man would have ample room to work. Three of the four derricks which handled this excavation were equipped with home-made swinging appliances, which required one or two extra men to operate. These same derricks were used to place the concrete with the same extra force. The money paid these men would have gone far toward equipping these derricks with steam swinging appliances.

Another feature of this rock excavation which gave considerable trouble was channeling. The specifications required that the vertical surface on the land side of the rock cut from the upper end of the lock to

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the lower end of the lower guide wall should be made with a channeler. The stone was very hard and had pockets of flint in it which increased the difficulties of the channeling. When one of these pockets was encountered, the bits would slide to one side of it and make a crooked cut. After the channel had been cut a few feet deep, it was so crooked that it became practically impossible to operate the machine until the stone in front was shot out of the way as far down as it had been channeled, and then the machine was started again. Progress on this part of the work was slow, an average of thirteen and a fraction square feet being cut per eight-hour shift; besides the results were unsatisfactory. With this hard flinty limestone, it is impossible to get even fairly good alignment, and, besides, a large amount of work must be done in bringing the top of the rock to a line on the showing edge, as it breaks off unevenly where the channeler is started. In the case of the lower guide wall, the contractor asked to be allowed to remove the rock for two feet back of the face of the wall and down to the grade of the lower approach, and replace same with concrete at their expense in lieu of the channeling. The change in plan was approved by Major H. Burgess, Corps of Engineers, the officer in charge, and it is the opinion of the writer that all parties concerned profited thereby. The contractors saved money and did the work much more quickly, and the job is just as good and much neater in appearance.

However, as a whole, rock excavation progressed very satisfactorily during the month of August; in fact, nothing else of much consequence was being attempted at this time, and a large force of men was employed. At one time during this month the force ran up to 240, which was the largest number employed on the work at any one time. At the time when the force was largest, two shifts were being worked on rock excavation. In addition to the stone that was taken out, a large amount was piled along the center line of the lock pit, to be used later as plums in the concrete for the walls. These plum stones were to be handled into the forms with the same derricks as were used to place the concrete. This operation was carried on successfully and profitably from the contractors' viewpoint, as the stone was quarried in the pit and could be placed in the concrete practically, if not quite, as cheaply as it could be disposed of in the usual manner. When the rock excavation had progressed to the point where it was thought advisable to do so, the work of placing concrete was started. A large part of the force was changed to form building and mixing and placing concrete, which naturally caused the rock work to progress much more slowly during the remainder of the year. However, it was carried on when river conditions were favorable until the part inside the cofferdam was completed.

The rock excavation for the upper guide wall, guard wall, and upper approach was handled differently. No derricks were used for handling this waste material. The foundations for the upper guide wall and the upper approach were high and could be prepared without cofferdams. This material was wheeled toward the river and dumped so as to keep the waste pile as much as one foot below the upper miter sill. While the foundation for the guard wall was considerably lower than these other two just mentioned, no provisions were made in the specifications for a cofferdam. Work on this wall was not started until the river had gotten very low and only a small coffer was necessary. The one built was of 8-foot tie lumber, with 4 by 4 inch wales, and the two sides were held together with wire, forming a puddle space of about 4 feet. Practically no excavation was necessary here, as the rock was found to be clean and solid when the water was pumped from the cofferdam, and no definite grade was required for the foundation.

The lower approach has proven the most troublesome and most productive of delay of any part of the excavation. Here also the specifications did not provide for any cofferdam, but allowed the contractors to build whatever in their judgment the case demanded in the way of a cofferdam. The season of 1913, when this cofferdam was built, was a very dry one, and the river was exceptionally low, which is thought to be largely responsible for the light cofferdam that was built and for the fact that this work, as well as the entire contract, was not completed at least two years ago. This cofferdam was constructed of two thicknesses of 1 inch by 8 foot oak lumber, nailed to two lines of 4 by 4-inch wales. The two sides of the 4-foot puddle compartment were held together with wire. This dam was probably adequate for the stage of water when it was built, and had this excavation work been pushed to completion that season, it is possible that it might have served its purpose very well; but it was allowed to drag while an extra effort was being made to get the concrete work on the lock walls above an ordinary winter stage so that it could be carried on during the winter, and it proved to be a very expensive mistake, as no such season as 1913 has been had since that time, and this work yet remains to be completed. Several efforts have been made since that season to complete this part of the contract, but always the river rises and floods the cofferdam before it is finished. The foundation for the lower guide wall is included within this coffer. Excavation for this wall was done in the latter part of the season of 1914. Excavation for the entire lower guide wall foundation was handled to the haulage track with the steel derrick having the 108-foot boom, which had been set opposite the middle of the wall and between it and the haulage track. This derrick, which is one of the four from the line back of the lock wall, has also handled a large part of the earth and rock that

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have been excavated from the lower approach and wasted from the haulage track. However, some of it has been hauled with wagons and deposited several hundred feet below the property of the United States, and a small amount of the rock excavation has been loaded on barges with a derrick-boat, towed to deep water and unloaded.

The forms used for the concrete work consisted of 1⅝-inch pine sheathing, dressed on four sides; 2 by 8-inch studs, dressed on two sides, and spaced 30 inches center to center; 4 by 8-inch wales, rough, spaced 48 inches center to center vertically, with 8-inch dimension horizontally; and ⅝-inch tie rods, spaced 60 inches horizontally, and placed in the forms diagonally, having a sleeve nut at each side of the forms and at least 2 inches inside of the wall, for the purpose of removing the part of the rod that is outside of the concrete work. This can very easily be done by breaking the bond on this 2 inches of concrete and screwing the rod out of the sleeve nut. These rods not only held the forms together, but, by using horizontal struts in connection with them, it was possible to get very good alignment of the forms. For lock walls, guard wall, and upper guide wall, the sheathing was put on continuously, and the forms torn down and rebuilt after they had been filled and the concrete had been given time to set properly. In the case of the lower guide wall, it was necessary for the water to be low on account of the low and insufficient coffer which inclosed this wall along with the lower approach. Owing to the fact that it was necessary to build the forms very rapidly when a suitable stage of the river should be reached, the contractors requested permission to use panel forms and were allowed to do so. Accordingly, during the summer of 1914, while the water was too high to start the foundation work for the wall, quite a number of panels 10 by 15 feet were made, and in November of that year, when the river did get low enough, the contractors were enabled to place all the foundation for this wall and to then proceed with the work even if the river was high. The same system of rodding and strutting was used with the panels as had been used with the other style of forms. The plan of building continuous forms and tearing them down and rebuilding with the system of bracing and rodding used on this work gives splendid results. The sheathing was used an average of about three times. Good results were obtained with the panels also, but they were not used so extensively, and it is difficult to compare the two methods of forming. However, where a derrick is convenient for handling the panels, the writer is inclined to think that they would be preferable in point of speed and economy, but is not so sure about the results.



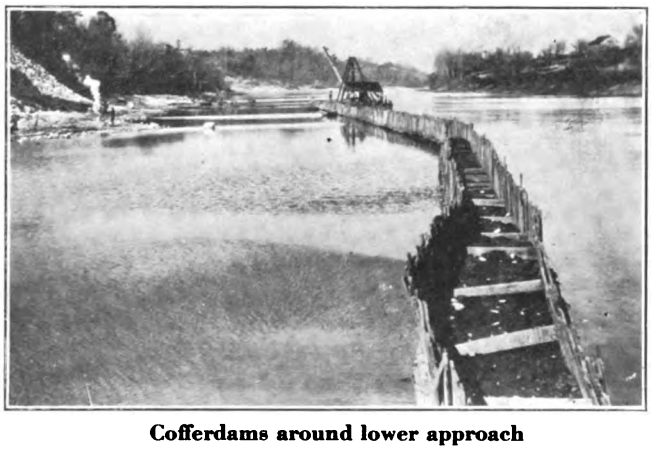
Forms for lower guide walls

Concrete for the lock walls and the lower guide wall was mixed in a 1-yard Ransome mixer, which was arranged under the sand and gravel bin and near enough to the cement house, so that these materials could be placed into it by gravity, and it was also in such a position relative to the 36-inch track back of the line of derricks, referred to above, that the concrete could be deposited directly from the mixer into buckets set on flat cars on this track. After the bucket was filled with concrete the car was moved until it was in reach of the derrick being used; then the bucket was raised and brought over the forms, lowered to the proper elevation and dumped. The flat cars used for this purpose were large enough to accommodate two buckets, and while one was being dumped the other was carried back to the mixer on the car and was filled with another batch of concrete. Two of the derricks were so near to the mixer that the car could be dispensed with and the buckets handled directly from the mixer into the forms. The buckets used were of the Insley bottom-dump type, of 1-yard capacity. It is thus seen that the same derricks and

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haulage outfit that disposed of the rock excavation from the cofferdam delivered and placed the concrete in the lock walls and lower guide wall. Concrete for the upper guide wall and the guard wall was mixed in a ½-yard cube mixer and delivered to the forms in Ransome 2-wheel concrete carts drawn by men.

The concrete was a 1 : 3 : 5 mixture, made from river sand and gravel and Speed Portland cement. The sand and gravel were dug from the bed of the river near the lock site with a 10-inch suction dredge. The dredge was built for this job and was provided with means of screening and washing the material, so that it could go directly from the dredge to the storage bins ready for use in concrete. The chutes from the screens on the dredge were so arranged that sand could be loaded into a barge on one side of it and gravel into another on the other side. These barges, loaded with sand and gravel, were towed to the job by the contractors' boats. Considerable difficulty was experienced in getting coarse aggregate of the proper size, as most of the bars in this locality furnished a material too small to meet the requirements of the specifications, which called for a coarse aggregate that would pass through a screen having 2½-inch holes, and be retained on one having ¼-inch holes. However, by adding an extra screen and wasting some of the small or pea gravel, a very good quality of coarse aggregate was obtained.



Cofferdams around lower approach

The walls were built in blocks of about 30 feet in length, the full width of the wall, and at least 5 feet in height; the first run being made in block No. 3 of the river wall of the lock on September 9, 1913. In accordance with the specifications, alternate blocks were built, leaving the omitted block to be built in later without end forms. This plan required that more form lumber be tied up on account of forming for the wall continuously and allowing the omitted block to get behind; however, by having the work scattered in this way over different parts of the job, it enabled the carpenters to keep forms built so that the concrete gang could work continuously. Only about 5 suitable working days were lost from the time the concrete work started, September 9, until February 3, when the cofferdam was flooded for the first time. The largest number of batches of concrete placed during any one eight-hour day was 120. Better progress was made for shorter periods of time, but more than that amount was never placed in eight hours. The trouble seemed to be in getting the concrete gang to work eight hours at a hitch. This was seldom done for various reasons, such as frozen steam and water pipes in the morning, lack of steam during the day, mixer breakdowns, failure to clean out forms, etc.

For a job similar to this, where the specifications allowed the use of chutes, it is the opinion of the writer that it would be a better plan for handling the concrete. It is thought, at least, that they offer fewer chances for delay to the work.

While the daily output was not so great, yet, as has been stated, the mixer ran practically every day for several months; in fact, both mixers ran almost every day for some time, and very good progress was made, the best month being October, 1913, when 2,600 cubic yards of concrete were placed. The plan of placing some concrete every day is favored, in preference to making one or two big runs each week, and not placing any the rest of the time. The upper guide wall was finished during the fall of 1913, and the guard wall was practically so, but the lock was not completed until August of 1914; and the concrete work on the lower guide wall was not started until November of that same year, on account of the necessity for low water to get to the foundation. This wall was finished in April, 1915, which completed the concrete work for this contract.

The valves used for emptying and filling this lock chamber are called cylindrical valves, from their shape. This valve consists of a cylindrical ring 5 ft. in diameter and about 18 in. high, sliding up and down in a second ring above the latter having a closed and water-tight cover. The seat is set before the concrete forming the floor of the valve chamber is placed, and this concrete is finished level with the top of the seat so that when the valve is closed it rests on this ring or valve seat and cuts off the water. The valve is opened by pulling the ring up into the covered second ring by means of machinery on the lock wall. The joint between these two rings is made water-tight by a leather packing-ring.

Four of these valves are used to fill the pit and four to empty it. The ones used for filling are located opposite the gate recesses at the upper end of the walls, and each one has a separate culvert leading under the

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Engineer Duties in the Field in War

By

Col. R. R. Ralston

Engineers, U. S. A., Corps Engineer, 4th Corps, A. E. F.

IN 1912 the Board on Engineer Troops was directed by the Chief of Engineers to make a comprehensive study of the proper organization, equipment, and training of engineer troops for the United States Army, and to submit their recommendations thereon, basing the latter on the needs of the engineer service in case of war with a first-class power. The board completed this work in 1913, and its recommendations on these and other related matters were approved by the general staff with minor modifications on being submitted to that body as representing the views of the Chief of Engineers. The engineer regimental and mounted battalion organizations authorized by the National Defense Act of June 3, 1916, were as recommended by the board, and the board's recommendations as to the duties of engineers in war resulted in C. A. R. No. 46, which placed on them duties of general construction and railway construction and operation in the theatre of war which hitherto had not been definitely assigned to any branch of the service.

The board's recommendations formed the basis of the policy of the Corps of Engineers relative to military preparedness for the mobile army prior to the war with Germany; but, as was to be expected in a pre-war study of this kind, it was deficient in a number of features, due to an inadequate conception of the magnitude of engineer operations incident to modern warfare; and further to the fact that it was based on a defensive war in the United States, as the carrying of an offensive war to European soil was considered at that time to be beyond the bounds of probability. The great engineering undertakings incident to the service of supply in the American Expeditionary Forces, it was assumed, would, in a theatre of operations in the United States, be carried out largely by civil means, and the organization of special military units for this purpose would not be necessary. The recommendations of the board relative to engineer troops were accordingly limited to divisional engineer troops, except that a tentative organization was recommended for engineer railway troops for the operation of railroads under military control.

Division Engineers

It is generally conceded by engineer officers that our regimental organization during the late war was satisfactory, and it has been favorably commented on by engineer officers of foreign services. The only part of the divisional engineer organization that did not function exactly as contemplated was the engineer train, and it is believed that results would be more satisfactory if it were made part of the regiment, forming a supply company as part of regimental headquarters. With this arrangement, engineer supply of the division and general supply of the engineer regiment will be better co-ordinated.

The strength of divisional engineers recommended by the board in 1913 for an infantry division was 6 per cent of infantry strength; but with the divisional reorganization during the emergency it was nearly double this figure, or about 6 per cent of the strength of the whole division. Experience does not indicate that the number of divisional engineers was excessive, and should the divisional organization authorized by the national defense act be substantially retained, the addition of a third battalion of three companies to the engineer regiment would seem to be justified.

Duties

The pre-war conception as to the duties of divisional engineers in the field was very well substantiated by the experience of the late war, with one or two exceptions, one of which was the duty of map-making and reproduction. This work in Europe, where the topography is so well recorded already, consisted in the addition of cultural changes and the reproduction of new issues of maps on so large a scale as to require for the latter work a special organization of engineers.

Aeroplane photography secured much of the data required for the preparation of the new maps, and, in my opinion, in future military operations, even in poorly mapped countries, the basic means of securing information for the production of maps will be this agency; the maps themselves being produced by a central plant well in rear. There is, of course, much information requisite to a good military map that can not be secured by aeroplane photography, and resort to the usual former topographical methods will be necessary. Furthermore, much topographical work will be required where the usual methods will be obligatory, and for these reasons topographical work will still be a duty of divisional engineers and one for which they must be prepared by having a suitably trained personnel and adequate equipment. I do not believe, however, that map reproduction within di-

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visions will be of sufficient extent or importance to warrant the training of any personnel of the division engineers in lithography, or to justify the retention of the rather cumbersome lithographic equipment.

The war as conducted in Europe did not demonstrate that searchlights can be used to advantage in field operations; but that their use was practically confined to anti-aircraft defense of important centers. It would accordingly seem that for future military operations no provision need be made for the use of searchlights by divisional engineers, or engineers of higher units. In fact, it may be argued that the operation of searchlights is a function of the artillery assigned to anti-aircraft defense, rather than a function of engineers, as the status is similar to the use of searchlights in coast defense by the coast artillery.

On the other hand, the need of electric lighting plants for division headquarters and such other localities where they are necessary, the use of electrified obstacles, and the supervision of power plants and lines in territory under military control, as demonstrated by the war, requires that the divisional engineers possess an adequate personnel with a practical knowledge of electricity.

Field fortification was an important duty of divisional engineers during the war and will continue to be such. While it was contemplated that infantry should be capable of constructing their defensive works, the general experience of the war seems to have been that the engineers, in co-operation with infantry and machine-gun officers, should lay out the defensive works and initiate and push forward the construction of the remaining works. Divisional engineers must, accordingly, be prepared to lay out defensive works and to initiate and push forward to completion the most important elements of such works. After the main features have been established, elaboration of the works and their maintenance may be placed in the hands of the infantry, with enough engineer supervision to insure continuity, and the work of the engineers transferred to the construction of the remaining elements of the defenses, for the construction of which they are better qualified than the infantry.

Affiliated with field fortification is the subject of camouflage. This is an activity which should be included in the training of all combat arms, but it should be specially thorough in the case of engineers, in order that they may be prepared to insure effective work by other arms. During the war detachments were assigned to sectors of the front from the engineer camouflage regiment, who made inspections and recommendations in order to improve the camouflage work of corps and divisional troops, and in some cases directed the same. This system worked satisfactorily, but it is believed that it would be preferable in future operations to have those who are responsible for effective camouflage work by division or corps troops members of the division or corps; and it is believed that this will be the duty of divisional and corps engineers. One officer in each divisional or corps engineer regiment with a small number of selected enlisted men should be designated to look after this work exclusively.

Road and bridge work will constitute one of the most important and extensive duties of divisional engineers in military operations. In a rapid advance to a limited objective such work as a rule need only be sufficient to insure the passage of foot troops over streams and the lighter transport over the roads; but with the stabilization of lines it will be necessary to provide means for the movement of the heavy artillery and supply trains without interruption. In the various offensives undertaken by the United States Army in France, work of road repair and construction was often greatly hampered by inadequate traffic control on the roads on which work was under way. It has been suggested, in order to obviate this difficulty, that engineers in charge of road repair be given authority to regulate traffic over such roads, so that in an advance they would act as military police for traffic control purposes in front of a fixed line, turning such roads over to the military police as soon as repairs are completed. Paragraph 103, Field Service Regulations, gives the engineers such authority in the case of military bridges, and it is believed that the same authority over roads under repair would be desirable.

Our ponton equipage needs revision to adapt it to the heavier loads which will be met with in future military operations, and also to provide for the use of tractor draft; but the present equipage can still be used to advantage in military operations, and should be retained until worn out. I do not believe that any more equipage of the present type should be built, however, provided a new equipage can be made available in a reasonably short time.

In the training of engineer troops in the future more time should be devoted to the construction of heavy fixed bridges, standard types of which should be adopted. Spar bridges, which have been so assiduously practiced in the past, should not be entirely eliminated from the training of our divisional engineers, as they can still serve valuable purposes under many conditions; but the limitations as to their use should be clearly defined.

In connection with road work, the experience in Europe, not only during offensive operations, but also on the march into Germany and in occupied territory, made it apparent that divisional engineers should be provided with one or more caterpillar tractors for the purpose of removing ditched trucks that are obstructing roads, and to assist trucks up steep slippery hills when necessary.

Demolitions and the handling of high explosive, in wire cutting, removal of enemy traps and mines, and the destruction of "duds" was a duty that gen-

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erally fell to the engineers during the war, and is one for which they must continue to be equipped and trained.

General construction duties devolved upon divisional engineers to a large extent in the A. E. F. in training and rest areas, and also in certain sectors of the front. In the army of occupation a great deal of general construction work, consisting of mess halls and kitchens, amusement halls, baths, delousers, stables, horse-dipping vats, corrals, etc., was carried on, as well as a great variety of smaller jobs that came up from time to time. The character of this type of construction indicates the need in an engineer unit of carpenters, blacksmiths, plumbers, concrete men, electricians, and allied trades, as well as a good proportion of "handy men."

In the army of occupation it became necessary for divisional engineers to take over to a greater or less extent work of road repair and maintenance, including direction and payment of German civilians engaged on this work. Direction was usually through the regular German road officials, with additional supervision by engineers, and means of transportation for road materials was furnished by the engineers, as the Germans were practically without transportation.

Supervision over public utilities, such as gas, electric light, and water supply systems, also became necessary, owing to the increased load put upon these utilities by reason of the army of occupation. Supervisors of public utilities in each town where they existed and where troops were stationed were appointed from the engineers, and any extensions of service handled through them, so as to prevent any overloading of plant.

Infantry Duties

Our Field Service Regulations, par. 126, indicate that engineers are to be used in the attacking line only in exceptional cases, and this is generally understood by division commanders. The engineers were used both in attack and defense during the war in a number of cases, and it is my opinion that they will be so used frequently in future military operations, and for this reason their infantry training should be of a high order. It is also believed that they should be armed with the automatic rifle in the same proportion as the infantry, so that they can make use of the same tactical dispositions. Any tendency to sacrifice thorough infantry training to engineer training should be suppressed; for with competent engineer officers, engineer work in the field can be carried on with a disciplined and soldierly organization, even though it is somewhat lacking in engineer training. In time of peace in our regular army time is available to give the enlisted men both military and engineer training; but at outbreak of war, when a large number of new troops must be raised, as in the case of our national army, I believe it preferable to devote the larger part of the available time to making the men trained and disciplined soldiers. Men entering the regular army in peace times usually require engineer training to make them fit for engineer work, but the material available in the national army required much less instruction to carry on engineer work in the field.

On the whole, I believe that our methods of training in time of peace, and the qualifications which are considered necessary for the personnel of a divisional engineer unit, as we conceived them prior to the war, are both sound and leave little to be desired.

Corps Engineers

The corps as organized in the A. E. F. corresponds to the field army of our Field Service Regulations. By tables of organization, it consisted of six divisions, four of which were combat divisions, and certain auxiliary or corps troops, whose aggregate strength was nearly that of a division. Included in the corps troops was a regiment of engineers, and also a regiment of pioneer infantry, from which additional details for engineer work could be secured, if necessary. The corps, particularly in position warfare, constituted what was practically a permanent sector personnel, which remained in position as divisions came and went, and was thus intended to insure continuity of policy in the corps sector.

The corps engineer troops usually consisted of a sapper regiment and train, which had been the engineer troops of a replacement division and had been transferred intact to duty as corps troops. Special engineer regiments, for duty as corps engineer troops, had been organized in the United States, but, except in one or two cases, they were not used as such, being diverted to other duty. The corps troops as a whole were at a disadvantage, in not possessing the same unity of organization as a division, due to the fact that they were gathered together from a number of different sources and had never served together until assigned to duty as corps troops, and then were scattered over so large an area that it was not practicable to secure the same cohesion as in a division. This lack of unity was shown by the fact that some of the units of the corps troops were not aware of the functions of the corps engineer troops, and were uncertain as to the proper means of arranging for the execution of their engineer work or for the procurement of engineer supplies.

The 4th Corps engineer troops—301st Regiment and Train—joined the 4th Corps on the day preceding the St. Mihiel offensive, and during that operation were engaged on the reconstruction of the Flirey-Essey road over the old trench systems north of Flirey. They continued on road repair work in the corps sector for about a month after the offensive, when the work of road repair on which they were being used was practically all taken over by the 2nd Army engineer troops. In this work they were assist-

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ed at first by one and, later, by two battalions of the corps pioneer infantry regiment, and these troops continued on road work practically till the armistice. During this period the corps engineers also constructed two corps ammunition dumps and did some work on a third for the corps munitions officer. The two dumps completed were located in woods, and each involved a loop of one-way plank road several hundred feet in length, providing an entrance and an exit on a main road and a roadway suitable for ammunition trucks. These dumps were also provided with powder and fuze houses, and the approaches were camouflaged where required. Light railway connections were extended to them by the light railway engineer regiment.

As soon as it could be relieved from road work, the corps engineer regiment took up the work of preparing the second defensive position, which had been approximately fixed by army and corps orders; and the preparation of which in the corps sector had been assigned to the corps engineer. The work of wiring this position from the left of the corps sector to a point where it connected with an old French position near the right of the sector, was practically completed at the time of the armistice.

After the beginning of the Meuse-Argonne offensive the combat divisions in the 4th Corps were changed quite rapidly; in fact, one division took over a sector of the front line and was withdrawn in a week. This made progress on the consolidation of the first position slow and unsatisfactory, as there was hardly time for a division to get oriented before it was withdrawn, let alone doing any effective work on the consolidation of the first line. Some changes in the first lines had been ordered since they were first established, but in a number of places where no change had taken place the wiring was incomplete and progress of consolidation was quite unsatisfactory. Under these conditions it seemed necessary to place a part of the corps engineers on first position consolidation work, and the regiment was disposed with this end in view; but as the divisions then occupying the front line were not moved, actual work did not become necessary

In the offensive of the 2nd Army, ordered for November 10, 1918, it was planned to establish a one-way motor truck circulation route for the use of ammunition and supply trains, with an "out" and an "in" route over the trench systems, and several cross connecting routes in rear of the German lines, to be used in succession as the advance progressed. The preparation of this route within our own lines had been undertaken as far to the front as possible as soon as it was decided on, and the corps engineer regiment, assisted by 2 battalions of the pioneer infantry regiment was designated to prepare it for truck traffic following up the advance of the divisions. One battalion of engineers and a battalion of pioneer infantry were accordingly placed in position well to the front by zero hour on the 10th of November near both the "out" and "in" routes, prepared to undertake this work as soon as the advance permitted. Sufficient distance was not gained, however, prior to the armistice to make any work by these corps troops necessary, but from the amount of high explosives afterwards removed from culverts along these roads, plenty of work would have been needed.

On October 10th corps headquarters moved from Menil-la-Tour to Boucq, where, under direction of the corps engineer, a number of portable barracks had been erected and camouflaged for office use by a company of the 5th Engineers, then in corps reserve. After about two weeks at this locality it was decided to move to Wainville, and a company of the corps engineer regiment was designated to remove the barracks, etc., and re-erect them at the latter place.

The direction of the corps engineer and pioneer infantry regiments of the 4th Corps on the march into Germany was, by corps orders, assigned to the corps engineer; but no engineer operations of any consequence were required on the march. On reaching Trier the duty of guarding railroads from that point to the Rhine was assigned to the 4th Corps and turned over to the corps engineer. The pioneer infantry regiment was distributed along the railroad from Trier to Coblenz, taking over from the divisions as they advanced. The corps engineer regiment took over the railroad east of the Moselle and after the Rhine was reached and the sector east of the Moselle taken over by the French, the regiment was concentrated at Brohl on the Rhine, it being considered desirable to have the regiment here, in case a crossing of the river became necessary. The chief engineer of the 3rd Army, on arrival at Coblenz, arranged through a German contractor for the construction of a bridge of German ponton equipage across the Moselle about 40 kilometers above Coblenz, where the valley road crosses the river by a ferry. After construction it was turned over to the corps engineer, 4th Corps, for maintenance, and one company of the corps engineer regiment was stationed at the bridge for this purpose, the companies being changed from time to time in order to give as many as possible experience in this work. This bridge was maintained continuously, except for short interruptions on account of high water, ice, and the carrying out of about half of the structure by a ferry-boat that had gone adrift on a fairly high stage of water.

Soon after the units of the army of occupation reached their destinations numerous requests for general construction work began to be received, and a considerable amount of work of this kind was done for corps troops by details from the corps engineer regiment, though in a number of cases it was done by the troops themselves after they received the necessary materials. The corps regiment also rendered assistance at times to divisional engineers of the corps in

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William Murray Black

Major General, U. S. Army; Member American Society of Civil Engineers
Chief of Engineers, March 7, 1916-October 31, 1919

[By direction of the President, and on his own application after more than 46 years of service, General William Murray Black, Chief of Engineers, U. S. Army, was placed on the retired list October 31, 1919]

WILLIAM MURRAY BLACK was born at Lancaster, Pa., November 8, 1855, the son of James and Eliza Murray Black. His father, James Black, was a prominent lawyer of Lancaster County.

He graduated from Lancaster High School at the age of 14, and from Franklin and Marshall College at 17. Forty years later his alma mater conferred on him the honorary degree of Doctor of Science.

He entered the U. S. Military Academy at West Point in 1873 and graduated at the head of his class in 1877. While at West Point he was Adjutant of the Corps of Cadets, then, as now, a recognition of soldierly distinction. Among his classmates were Cols. W. L. Fisk and S. W. Roessler of the Corps of Engineers, and Gens. Thos. A. Barry and Edwin F. Glenn.

General Black's entire service has been with the Corps of Engineers. The following is a very brief statement of the principal events in his long, varied and distinguished career of public duty:

1877—Assistant instructor at the Military Academy.

1877-1880—On duty with the Battalion of Engineers and Engineer School of Application at Willets Point, N. Y.

1880—Promoted to 1st Lieutenant, Corps of Engineers.

1880-1882—Assistant on engineering work to Col. W. P. Craighill, Maj. W. E. Merrill, and Capt. Wm. Ludlow.

1882-1886—Instructor in Practical Military Engineering at the Military Academy.

1886—Promoted to Captain, Corps of Engineers.

1886-1891—Assistant and District Engineer, St. Augustine, Fla., on river and harbor and fortification work.

1891-1895—Commanding Co. C, Engrs., and Instructor at Engineer School of Application, Willets Point, N. Y. Engaged in submarine mining development. Author of "Public Works of the United States."

1895-1897—On duty in Office of Chief of Engineers, in charge of fortification and personnel matters.

1897-1898—Engineer Commissioner of the District of Columbia. Assisted in development of highways and planned the elimination of railroad grade crossings in the district.

1898—Promoted to Major, Corps of Engineers.

1898—Lieut. Col. of Engineers in Spanish-American War. Chief Engineer, 3d Army Corps and 5th Army Corps. Took part in Porto Rican expedition.

1899-1901—Chief Engineer, Dept. of Havana, Chief Engineer, Division of Cuba, under Maj. Gen. Leonard Wood. Re-organized the Dept. of Public Works of Cuba. In this capacity Colonel Black "cleaned up" the city of Havana, including its water supply, sewerage and paving, and improved the highways of the island.

1901-1903—Commanding the Engineer School, Willets Point, N. Y. Transferred this school and re-established it at Washington Barracks, D. C. Pioneer in the establishment of "trade schools" for vocational training in the army.

1903-1904—On duty in Panama with the Isthmian Canal Commission.

1905—Promoted to Lieutenant Colonel, Corps of Engineers.

1904-1906—District engineer at Portland, Me.

1906-1909—Director of Public Works in Cuba during the American Intervention. During this period Colonel Black continued and extended the work he had inaugurated at the time of the Spanish War.

1908—Promoted to Colonel, Corps of Engineers.

1909—District Engineer, 1st District, New York City, Dept. Engineer, Dept. of the East, Division Engineer of the Northeastern Division. During this period he was chiefly engaged with the improvement of New York harbor and the Hudson River. Chairman of the Board of Engineer Officers appointed to raise the wreck of the *Maine* in Havana harbor.

1916-1919—Brigadier General, Major General and Chief of Engineers, U. S. Army. General Black commanded the Corps of Engineers and directed the Engineer activities of the American army throughout the great war. He also performed during this period a multitude of public duties of many kinds, and was awarded the distinguished service medal in recognition of his accomplishments.

1919—Having completed the demobilization of the engineer forces after the war, General Black retired on October 31, 1919.

The dominating motive, the outstanding characteristic of General Black's long and intensely active career, has been his compelling sense of duty. This has been the guide and support that has enabled him to go forward unwavering through every combination of adverse circumstances, and every period of disappointment and discouragement.

Richly endowed by nature with a keen analytical mind, a vivid imagination, exceptional reasoning powers, a faculty for organization, an iron constitution, indefatigable energy and enthusiasm, and great strength of character and decisiveness, General Black possesses in a marked degree most of the qualities that make the constructive engineer and the leader of men. He has been a powerful influence in every project with which he has been connected.

Though engaged during a large part of his career in engineering problems connected with the public works, General Black was above all a *soldier*, and never for an instant lost his keen interest in all affairs military. He believed that a thorough knowledge of the art of war is indispensable to the effective application of engineering science to armed conflict, and he constantly strove to impress this idea upon the Corps and the engineering profession. Perhaps his greatest efforts were those he devoted to the improvement in education and training for the younger officers of the Corps. It was his constant purpose to provide them with the broad and solid foundation upon which they might build their careers as military engineers of the highest type. The glorious record of the Engineers in the World War is the justification of his judgment and the crowning reward of his labors.

General Black leaves the army not to retire, which his restless energy forbids, but to enter other fields of activity and usefulness.

Conspicuous in the long list of public men who have served their country with intelligence, enthusiasm and devotion, stands for all time the name of WILLIAM MURRAY BLACK.

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Engineer Units in the National Guard

By

Col. H. A. Finch

Engineers, U. S. Army

FOR the past three months the writer has been watching the condition of the National Guard throughout the country but there have been few encouraging features to dwell upon and the strain on the observer's first-line trenches of optimism has been heavy enough to justify calling up the reserves.

Judging from surface indications the situation is certainly not such as to elicit loud cheers because the facts are that only a few more than half of the States have signified their intention of attempting to organize their allotment of troops for the year 1919-20, and out of 126,000 men contemplated for the enrollment during the present fiscal year only 35,000 were actually enrolled up to October 15, 1919. At that time only one Engineer organization was in existence in the Guard—a battalion which was organized in Arkansas too late to be accepted for service overseas.

So much for the pessimistic features of the situation. Reflection on this subject suffices to bring out certain hopeful thoughts, but more than reflection is required to solve the problem of the Guard's reorganization. Co-operation is what is needed or both the Regular Army and the National Guard will suffer.

There is a point here that frequently appears to be missed, i. e., since a militia is expressly provided for in our Constitution, the National Guard, in some form, is here to stay unless an amendment—a very remote possibility—puts an end to its existence. However much some of us may regret this apparent dispersion of strength, whatever, in our opinion, may be the weakness of the dual military system thereby imposed upon our country, no good can come from an attitude either of aloofness or of opposition on the part of regular army officers in their relations with the national guard. The weakness of the combination is centered more in in the form than in the substance, since American stock is the same throughout. But the opportunity for jealousy and misunderstanding to get in their work is the real defect of the system, and here our duty as officers is clear, i. e., since strength comes only from unity we should work to promote unity by every means within our power.

It is certain that not only the national guard but the regular army as well is at present in the doldrums. A countrywide apathy toward military service in any form is very evident, but what could be a more natural reaction, considering what the men in our country, eligible for military duty, have recently passed through? The same condition on a small scale was observed following the Spanish-American War.

Having met the demands of patriotism in the most critical time of war it would indeed be surprising if our young men showed eagerness to rush into peace time military service without first having had a period for relaxation and for a readjustment of their personal affairs.

The Militia Bureau recognizes this present widespread indifference as the main cause for the slow recruiting of the National Guard but it also recognizes other causes which may be listed in the order of their importance as follows:

(1) Delay on the part of Congress in acting on military legislation, thereby failing to establish definitely a military policy for our country.

(2) A decided Micawber-like tendency on the part of some officials to wait for conditions to become better without making any effort to improve these conditions in the meantime.

(3) A dislike for strike or riot duty which at this juncture appears to be the guardsman's inevitable portion.

(4) The hostility, either latent or active, of the labor unions toward military service.

Most national guardsmen, having seen from two to three years of active service, had to go to work at once to re-establish themselves. This they are doing, and a reasonable period having elapsed, there are many signs now visible of a revival of interest in the guard among eligible men. When the fate of the League of Nations is settled and our foreign obligations are thereupon determined, Congress may be expected to pass on army legislation and decide upon a definite policy for the military. Labor upheavals may be expected to subside gradually and with them will disappear the effects of the unions' hostility toward the guard. If in the meantime we can secure the liberal co-operation of the regular army, from the general staff down, then may we expect the realization of an efficient national guard; otherwise the reg-

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ular army officers concerned with this task will continue to face a situation from which can come neither satisfaction to themselves nor credit to the regular service.

The newspapers to-day show that a certain proportion of former national guard officers are bitter toward the officers of the regular army, as a result of the attitude of superiority and intolerance sometimes assumed toward the guard by men of the regular establishment. This is most regrettable but the writer is far from believing that more than a very small number of regular officers offended in that respect. Impatience and intolerance destroy congeniality and efficient team work wherever they are found, and the unfortunate fact remains that these qualities in even one regular army regimental commander have the effect of causing 50 or more national guard or national army officers to become disgusted with the system which the colonel misrepresents.

There is no denying that there are certain inherent defects in the national guard system, especially in the opportunity it affords a certain group of its personnel to play politics, utilizing the national guard organization as a form of political machine. This type of man deserves the contempt that he receives whether in the national guard or elsewhere, but on actual association with officers serving with state troops it is gratifying to note how seldom this species is encountered and how often one finds business men of a high type who are giving up their time and pleasure from patriotic motives unmixed with any desire for gain to themselves.

The writer commanded from June until December, 1918, a regiment composed of former national guard officers and men. He was impressed with the fine spirit and the high average ability of the rank and file, and he also was given much food for thought in the statement of one of the officers who was "thankful that the Lord has sent them two regular army colonels in succession who were real human beings."

Criticism can of course be brought and has been brought against the military system which permits the existence of our national guard, but the officers of the regular army will be among the first to state that the national guard divisions fought exceedingly well in the recent war. The writer holds to the belief that all of our divisions fought bravely and, in most cases, well; bravely, because our men are born that way, and well or better, depending upon the training they had received and the spirit inculcated in them by their officers. But service on the Mexican border and prior training in armories and during encampments prepared the men of the national guard for a quicker departure overseas than would otherwise have been the case. In August, 1917, the national guard furnished for national defense 12,115 officers and 367,000 enlisted men—by no means thoroughly trained, of course, but with the foundation for their training prepared. To that extent, therefore, the system justified itself.

All of the above is by way of impressing upon officers of the Corps of Engineers the necessity for patience, tolerance, and the utmost co-operation on our part in dealing with national guardsmen whether in the service schools or in the field, or on duty as inspector-instructors.

The plans for the engineers in the national guard are comprehensive enough as prepared by Colonel F. B. Wilby, Corps of Engineers, during his recent tour of duty in the Militia Bureau. The scheme contemplates the following eventual organization for the National Guard Army on the assumption that it will consist of four corps comprising sixteen infantry divisions and one cavalry division:

	Minimum strength
27 pioneer regiments (2 battalions of 3 companies each) at 1,000 each	27,000
1 for each infantry division 16	
2 for each corps 8	
3 for the army 3	
Total 27	
1 mounted battalion for the cavalry division (3 companies)	300
5 ponton trains (3 heavy div. and ½ supply div. each) at 100 each	500
1 for each corps 4	
1 for the army 1	
Total 5	
The following additional army troops—	
1 camouflage battalion (2 companies)	300
1 flash-ranging battalion (2 companies)	300
1 sound-ranging battalion (7 companies)	400
1 searchlight battalion (3 companies)	425
1 surveying and printing battalion (3 companies)	425
1 surveying company	...
1 printing train company	...
1 base printing plant company	...
Total	29,650

The strengths given above are approximate minimum peace strength equal to about one-half the war strength of the organizations listed.

The following extract is taken from a memorandum by Colonel Wilby:

The above organizations will include all those recommended for divisional, corps, or army troops, in report dated April 7, 1919, submitted by Board on Organization of Engineers, convened by the Chief Engineer, A. E. F.,—except one water tank train, 18 service battalions, and a headquarters detachment for Chief Engineer of Army. It does *not* include any of the following special engineering organizations required on the lines of communication:

Construction regiments,
Forestry regiments,
Road regiments,
Light railroad regiments,
Railroad construction regiments,
Shop battalions,
Engineer depot detachments.

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It is believed that none of these specialized engineer units for work on the line of communication would require peace time military training, but could be rapidly organized as needed in time of war.

To provide for the contemplated organizations the various states have been allotted the task of forming engineer units as shown in the table below. The table indicates both the allotment for the present fiscal year and the ultimate allotment which is supposed to be enrolled by June 30, 1924.

	1919-20 Allotment.	Ultimate allotment.
1 New York	1 regt. and train.	2 regiments.
		1 battalion (mtd.)
2 Pennsylvania	1 battalion	
	1 train	2 regiments.
3 Massachusetts	1 battalion	
	1 train	2 regiments.
New Jersey	1 battalion	1 battalion.
		1 hdqrs. company.
4 North Carolina	1 company	1 battalion.
	1 train	1 hdqrs. company.
Georgia	1 company	1 battalion.
		1 hdqrs. company.
South Carolina	1 company	1 battalion.
5 Ohio	1 battalion	
	1 train	1 regiment.
Indiana	1 battalion	1 battalion.
		1 hdqrs. company.
6 Illinois	1 battalion	
	1 train	2 regiments.
Wisconsin	1 company	1 regiment.
Michigan	2 companies	1 regiment.
7 Iowa	1 battalion	1 regiment.
Kansas	1 train	1 battalion.
		1 hdqrs. company.
Missouri	1 battalion	1 regiment
		1 battalion.
Colorado	1 company	1 battalion.
	1 train	1 hdqrs. company.
8 Arkansas	1 battalion	1 battalion.
Texas	1 company	1 battalion.
		1 hdqrs. company.
Oklahoma	1 company	1 battalion.
9 Oregon	1 company	1 battalion.
		1 hdqrs. company.
Idaho	1 company	1 battalion.
California	1 battalion	1 battalion.
Maryland	None	1 battalion.
Alabama	None	1 battalion.
Mississippi	None	1 battalion.
	None	1 hdqrs. company.
West Virginia	None	1 battalion.
Tennessee	None	1 regiment.
Minnesota	None	1 regiment.
Porto Rico	None	1 company.
Totals	1 regiment	15 regiments.
	10 battalions	18 battalions.
	11 companies	9 hdqrs. companies.
	8 trains	1 battalion (mtd.)
		1 company (Porto Rico.

The 18 battalions and the 9 headquarters companies provided for in the ultimate allotment are equivalent to 9 complete regiments, assuming that the headquarters company of the future regiment of engineers will include the train. The total of 24 regiments is enough to provide for the 16 divisions and the 4 corps, but it will be noted that no provision is made for the 3 pioneer regiments for the army nor for the 5 ponton trains and 5 special battalions recommended for the national guard. These units are to be allotted when the task of organizing the 24 pioneer regiments for the corps and divisions is farther advanced.

To provide engineer training and instruction for these units there will be required 9 engineer officers and 22 engineer sergeants for inspector and sergeant-instructors, for the first allotment (1919-20), and additional officers and sergeants at the rate of 1 officer and 2 sergeants for each new regiment formed.

These will be assigned to duty as follows to the groups of states having engineer units in their initial allotment. The assignment of territory will be shifted when necessary to take care of states forming new engineer units later.

Group No. 1—
Number of officers 1
Number of sergeants 2
Group No. 2—
Number of officers 1
Number of sergeants 1
Group No. 3—
Number of officers 1
Number of sergeants 2
Group No. 4—
Number of officers 1
Number of sergeants 3
Group No. 5—
Number of officers 1
Number of sergeants 2
Group No. 6—
Number of officers 1
Number of sergeants 3
Group No. 7—
Number of officers 1
Number of sergeants 3
Group No. 8—
Number of officers 1
Number of sergeants 3
Group No. 9—
Number of officers 1
Number of sergeants 3
Total, 9 officers; 22 sergeants.

So much for the plans.

The Corps of Engineers must be prepared to assume the obligation of training the engineer units of the national guard. It is understood that at this juncture the demands to be met by the corps are very heavy, including as they do the training of some 200 or more of the junior officers within our own ranks. Granting the importance of this task, it is clear that the detail of only nine officers for national guard duty

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would cause no great derangement of the training program within the corps, and the experience gained by these officers would more than compensate for any temporary inconvenience caused by their detail.

The officers required for such service must under the law be drawn from the regular establishment. These men will hold positions of trust and responsibility not exceeded by those of any officers within the corps below the rank of lieutenant colonel, on duty with troops. They will gain greatly from the broadening effect of living and working with the American business man and soldier.

Duty with the national guard is very popular in other branches of the army, and wherever the Militia Bureau has a voice in the selection of inspector-instructors only the best officers are chosen.

It is clear that our country will gain from the national guard only in proportion to the time and talent devoted to its advancement; the regular army will likewise gain and in even greater measure, but only if the service assigns to this task officers who have a correct attitude toward their duties and an aptitude for working with men. In other words, we shall get back from the guard only what we put in it.

The responsibility of the Corps for the engineer service in the national guard is direct and can not be avoided. Some of the nine officers are needed *now* to start the work of assisting in the guard's reorganization. If we do not take up promptly our share of this task the Corps of Engineers will soon, for the first time in its history, be trailing the procession.

Discussion

Col. F. B. Wilby
Engineers, U. S. A.

Col. Finch's article should be of interest to every engineer officer as it presents clearly a subject concerning which the average engineer officer has only the haziest idea. Most of us are content to dismiss the subject with the remark that "the national guard system is wrong, and will soon disappear, and therefore why bother our minds with it?" Such an attitude is most deplorable for several reasons.

1st. We have all sworn to support and uphold the laws of the United States, and as long as the laws of the United States include the national guard as part of the national defense it is clearly the duty of every officer of the regular army to do his utmost to make the national guard as efficient and dependable as it is possible to make it with the resources available. As part of those resources, Congress has appropriated this year something like $16,000,000 for the support of the national guard. It is a poor soldier who, upon receiving an order from his commanding officer, fails to carry it out to the best of his ability simply because in his opinion the order should not have been given. Yet, isn't this exactly the attitude of the regular army officer who, having received a $16,000,000 order from Uncle Sam to support the national guard, spends his time and effort in decrying the national guard system and proclaiming the fact that Uncle Sam shouldn't have given him such an order?

2nd. Is the national guard system to disappear as soon as many regular army officers believe? Colonel Finch has called attention in his article to a provision of the constitution which may stand in the way of such a consummation, and until we have something better to take its place, it is certainly better than nothing,—possibly not very economical for results obtained, or as efficient as might be desired,—but certainly worthy of our best efforts to make it as efficient as possible.

3rd. With all its faults, the national guard system has one great advantage which must be perpetuated in any system which takes its place; i. e., the localization of units. The worst national guard unit has more esprit or pride in its organization, due to this localization, than can be found in many far more efficient regular army units. Of course the esprit due only to efficiency and resulting from demonstrated ability is the most valuable in the long run, but the spirit of pride engendered in units whose personnel is drawn from one locality, whether town, county, or state, is a most valuable foundation upon which to build efficiency, and should be preserved in any forces raised for national defense, whether under the national guard system, universal training system, or any other.

The figures given by Colonel Finch showing the engineer organizations contemplated in the national guard are of course only tentative, and simply show approximately what the national guard engineers will be if organized under existing law—the National Defense Act of 1916. This act is undoubtedly liable to be changed before the plans given can be carried into execution. However, until it is changed, it is clearly the duty of the Corps of Engineers to see that such national guard engineer units as are organized under that law receive the fullest possible co-operation and assistance. One form for that assistance is in the detail of capable and experienced engineer officers and noncommissioned officers as instructors.

Col. W. A. Mitchell
Engineers, U. S. A.

This article covers the subject quite thoroughly. I was in the Militia Bureau when the war started, and it was quite evident to me that the engineers had not shown a great deal of interest in the national guard. The results were not to our benefit; we were

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forced to hurriedly form some engineer regiments, one of which was formed bodily by changing the name from infantry to engineers, and telling them that they were so. However, although they were not so immediately, they were quite earnest in their efforts and ultimately became very efficient as engineers.

As the national guard bids fair to remain a national force until we have compulsory service, and as no one can tell when we shall have that, it appears that the engineers should promptly take up their duties with the national guard as they have done in other works. If the Militia Bureau needs 9 officers and 22 sergeants, I feel sure that many of us are willing to add a little more work to the little more that we have already added in order that the Militia Bureau can have its wishes.

Col. Lansing H. Beach Appointed Chief of Engineers

The nomination of Colonel Lansing H. Beach, Corps of Engineers, to be Major General and Chief of Engineers, was sent by the President to the Senate, January 14, 1920.

Colonel Beach was born in Iowa, June 18, 1860. He graduated from the United States Military Academy number three in the class of 1882, and was assigned to the Corps of Engineers. He was appointed Additional Second Lieutenant, June 13, 1882, Second Lieutenant, June 30, 1882, First Lieutenant, January 10, 1884, Captain, October 4, 1894, Major, February 20, 1903, Lieutenant Colonel, February 28, 1908, and Colonel, February 27, 1913. He served with the Battalion of Engineers at Willets Point and West Point, N. Y., from 1882 to November, 1884, when he was assigned to river and harbor improvement work in Texas. From September, 1885, to November, 1888, he was a member of a commission to run and mark a portion of the boundary line between the state of Texas and the Indian Territory. For two years he was disbursing officer of this commission. At the same time, from December, 1885, to August, 1889, he was engaged upon works pertaining to the Ohio River and its tributaries.

He served four years at the United States Military Academy as Assistant Professor of Civil and Military Engineering, and in August, 1893, was assigned to river and harbor improvement work at Galveston, Texas.

He served at Washington as assistant to the Engineer Commissioner of the District of Columbia from November, 1894, until May, 1898, and as Engineer Commissioner of the District until November, 1901.

He was stationed at Detroit, Michigan, in charge of river and harbor work and the Eleventh Lighthouse District from November, 1901, to August, 1905, when he was detailed as Instructor of Engineering at the Army Staff College and Infantry and Cavalry School at Fort Leavenworth, Kansas. He was assistant commandant of these schools from November, 1906, to August, 1907, when he was assigned to fortification and river and harbor work at Jacksonville, Florida, in August, 1908, he was appointed Division Engineer, Gulf Division, New Orleans, La., and in August, 1912, was transferred to Baltimore, Md., in charge of fortification and river and harbor works. He was appointed Division Engineer, Central Division, with station at Cincinnati, Ohio, in August, 1915, where he has since served.

Colonel Beach has served as member of various Engineer commissions, including the Mississippi River Commission, and is a member of the American Society of Civil Engineers.

Proposed Huningue-Strasburg Canal

It is proposed to construct a canal running from Huningue to Strasburg, and to make a port on the river at the latter city. The canal will be 120 m. broad and 6 m. deep, and would be constructed so as to facilitate the erection of ten hydro-electric power stations with a total of about 700,000 hp., and costing one milliard francs.—*Eng. and Cont.*

Effects of Sea Water on Reinforced Concrete

German manufacturers, as a result of experiments extending over 20 years, make the following recommendations:

In order to obtain suitably strong structures in sea water, it is necessary to use cement which is as rich as possible in silicates, but poor in kaolin and iron oxide. Such cements, when at the same time they are rich in lime, can be considerably increased in value by adding certain quantities of trass. The decisive factor, however, for the permanence of concrete structures in the sea is the use of mixtures which are as dense as possible and impervious to sea water, while at the same time sufficient external hardening should be given to the substances before they are placed in the sea by exposing them to heat and to moist air. Concrete, the mortar of which contains more than 66⅔ per cent of sand, will generally not show the necessary density to enable it to stand attacks by sea water for any length of time.

Barge Canal Terminal, New York City

The largest of the terminals of the New York State Barge Canal is that recently completed at New York City. It includes piers Nos. 5 and 6, East River, near the foot of Broad Street. The dimensions of the piers are, respectively, 70 by 570 feet and 50 by 572 feet. They are of timber with reinforced concrete decks. The slips between these piers have a width of approximately 100 feet at the bulkheads and 200 feet at the entrance, and a minimum depth of 14 feet.

The piers are equipped with jib cranes of a semi-portable type and boom cranes specially designed, all operated by electric power.—*Eng. News-Rec.*

American Falls Dam, Idaho

A writer in *Eng. News-Record* states that the new dam of the Reclamation Service at American Falls will flood an area of 70,000 acres of land and create a storage of 3,000,000 acre feet, being the largest storage reservoir yet constructed.

Proposed Detroit River Bridge

The volume of traffic across the Detroit River necessitates a new bridge from Detroit to Windsor, Canada. The investigations for this bridge are in charge of Mr. Gustav Lindenthal and Mr. Charles Evans Fowler. It will be of the cantilever or suspension type with a clear span of 1,800 to 2,400 feet.—*Eng. World.*

Proposed Trans-Pacific Cable

In addition to the new proposed government trans-Pacific cable, private enterprise backed by the Western Union Co. proposes to lay a cable from Seattle to points in the Orient, by way of the Aleutian Islands. The proposed route will be only half the length of routes farther south, which it is said will double the speed of transmission.—*Eng. World.*

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Soldiers First!

By

Col. J. C. H. Lee

Engineers, U. S. A., formerly Chief of Staff
89th Division

COLONEL SPALDING'S article on the divisional engineer officer, published in PROFESSIONAL MEMOIRS, September-October, 1919, puts the question so clearly before engineer officers that it is to be hoped everyone will read and re-read it and think over the comments.

The sound truth of the statement, that the engineer regiment is the divisional engineer, is splendid. Also there should be no doubt that the engineer regiment must train with and become an integral part of the division. Some may still disagree with this. However, they remain quiet on the subject.

Two matters, however, seem to have brought forth a considerable opposition, to-wit: first, splitting up the engineer regiment temporarily from time to time and assigning it according to the needs of the situation; and second, recognizing the authority of the brigade commander in his own theatre.

Oftimes, and I think in these comments, the various writers may be trying to express much the same idea. Each no doubt is perfectly sure in his own mind, but has difficulty in conveying his ideas to others.

There is apparently, however, a wide difference of opinion as to the responsibility for command of engineer troops in a combat division. A conservative group, as we may style them, seem to entertain the view that the division engineer must retain command of all his troops all of the time as a matter of principle. The other group believes in allotting the engineers as the situation may require, giving temporarily to each brigadier, who needs their services, his proper share according to the opinion of the division commander after consulting with the division engineer, and leaving under the direct control of the division engineer only such part of the regiment as the particular situation may justify.

Several of the officers making comments on this article have indicated their alignment on the conservative side. There were many engineer officers who followed the conservative principle during the late war. Some corps engineers even went so far as to give direct orders to the divisional engineers operating in their corps, apparently considering that the corps engineer commanded all the engineers serving under the corps commander. On two occasions that I know of, where this attitude was promptly resented by a division commander, the corps engineer's action was repudiated and he was required to make his suggestions, or convey his corps commander's orders, to the division commander, except in very great emergency which must justify the departure from routine.

I cite these incidents as they form a good analogy to the situation within the division, where the division commander has allotted certain engineer units to his brigades for use in a given situation and where the division engineer, before these units had been put back under his immediate orders, might try to control them.

No doubt the earnest desire on the part of the average engineer, to get engineering results, is a strong reason for his reluctance to give over the temporary command of any of his men to a layman, a line commander. If we meet the issue fairly, however, we see a tendency to strive for 100 per cent perfection in mere structural details when the attainment of such perfection is not the mission of the combat engineers.

In analyzing this question it is well to examine our premises, lest we neglect to consider certain fundamental principles on which depend the proper participation of the engineers as well as all other troops in the campaign, and success or failure of that campaign.

We are now considering the division engineers, the regiments trained for and used as the engineers of a combat division. The first fundamental consideration is that the mission of the division is to win battles. It must produce results in action. Its organization, its training, its habit of thought and performance must be based on this principle of producing its maximum effort in battle. The divisional engineers are only one part of this fighting organization. It is their mission to fit accurately, gracefully and cohesively into the fighting machine and deliver the maximum of assistance to the division in action or preparation therefor. The organization, training, and control of the engineers must accordingly be based on this principle. Any habit of thought or mental attitude which will increase efficiency in performing this mission should be fostered. On the other hand, any custom or method of control which apparently hinders or jeopardizes

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the proper performance of this fighting mission should be scrutinized with suspicion, carefully analyzed and, if found unsound, ruthlessly eliminated.

The second fundamental principle we should consider is that of unity of command. In one theater of operation there can properly be but one commander if maximum efficiency is to be realized in fact. All the military means in that theater must be placed absolutely at the disposal of this *supreme* commander. He is held solely responsible for results and therefore must *command* without qualification or restriction, let or hindrance. From his next higher commander he receives his mission and his means. It is for him to produce results. This is organization, responsibility and command in their proper relation as proven by all military experience.

The third fundamental principle is that the fighting foot soldier in every war is the chief factor in success or failure. He suffers the greatest losses. He decides the issues of battle and campaign. In modern battles, supported by the powerful auxiliary arms, it is nevertheless he who must advance and clinch the victory, hold the gains, or lose them. He therefore is the guide. All other arms are auxiliary. The mission of these auxiliaries is to furnish the foot soldier with the maximum of real support. It is their only reason for being, their only excuse for not sharing equally his losses and hardships.

In order that the support of the many auxiliary branches may be given efficiently to the foot soldier there must be that condition of co-ordination and mutual confidence often so vaguely striven for and called *liaison*. However, this condition after all means only mutual knowedge, confidence, friendship and helpfulness between the infantryman and the other arms. If he knows and trusts them and they know and trust him, there will be liaison. He can then and only then really profit by their support.

Experience in the late war has no doubt had a tendency to lead us to false conclusions about the proper control of the auxiliary arms. I think this is due to the fact that many captains and majors of infantry and cavalry, after a decade or so of relative military inactivity, had fooled themselves into believing that they knew pretty nearly everything about the line soldier's job. These men were suddenly thrown into a situation where they commanded infantry regiments or brigades. The tremendous expansion, the routine work and the routine training of their troops required their best thought and effort. Many of these officers found themselves in action not only commanding their own regiments with the many new infantry weapons but having also at their disposal additional machine guns, field artillery, engineers, tanks, possibly gas and flame troops, and airplanes for reconnaissance. Not many minds can formulate new plans and accustom themselves to new conditions under the stress of battle. That many of our officers did learn in action and did handle these combined arms advantageously stands out to their great individual credit. That many failed to use these auxiliary arms advantageously was due to the fact that they never had the practice, they had never thought it out, they had never done it before. The division commanders usually were more fortunate in having as immediate assistants a fairly efficient staff assigned to them by law and who could at least advise individually along the lines of their respective experience. Brigade and regimental commanders, however, were fortunate if they had acquired staffs capable of merely supplying their troops and of writing out and distributing the plans and orders which the commanders themselves had to think out and dictate. Of course many brigade and regimental commanders failed to use properly the means placed at their disposal and made the engineers, for example, feel that their troops should never be placed under the orders of a line brigadier or colonel. Herein lies the danger of the deduction.

The division is the largest unit which has in its permanent organization the combined arms. This does not mean, however, that the combination of the various arms ceases in units smaller than a division. Far from it. In action either offensive or defensive—and we must consider success in action as the primary requisite—the infantrymen must be supported by the combined arms down to the smallest possible unit. Modern war has emphasized this, realizing the impracticability of attaching engineers and artillery to an infantry platoon, but giving them engineer tools and giving them increased fire power with the modern trench mortars and 1-pounder guns. However, where the situation justifies it, we give the assaulting infantry battalions the actual physical support of accompanying field pieces and the assistance of skilled engineers for passing obstacles. Probably the lowest infantry unit in the division to which are ordinarily assigned auxiliary troops, as such, is the battalion. This battalion may be defending a center of resistance, such as a fortified village or it may be moving forward in attack formation. It will probably have additional machine guns, possibly one company, and a platoon or even a battery of field artillery used either as anti-tank or close defense guns on the defensive, or as accompanying guns in the attack. It would have perhaps a platoon of engineers to work with the infantry in passing obstacles or, if on the defensive, in making obstacles, performing demolitions and assisting in the general preparations of the defensive organization. There may be also signal troops, gas and flame troops, and tanks, if in attack. However, in that center of resistance or in that attacking force there can be but one commander and he must command unequivocally all of the means put at his

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disposal: infantry, machine guns, artillery, engineers —all. "Co-operation" is not the ideal—it is "absolute command," to guarantee unity of purpose and unity of effort.

If an infantry major is going to control properly these auxiliary arms in action, he must have had practice; he must have thought out similar problems during quiet times when his brain could work; he must have learned the capabilities of the various arms; and he should not only have learned how best to use them, but preferably how best to deal with the individual commanders. If he has known the engineer by months of association, depending on him, it will be to his great advantage in action to understand him, and to count on him. His officers and his men will know the engineer officer and his men. The same is true with the other arms. All of which does not mean that this platoon of engineers or this battery of artillery has always been serving under or indeed in close contact with the infantry battalion, of course not. The engineers have been trained as part of the engineer regiment in their proper duties as engineers even as the artillery has been trained in its brigade. However, in their training, and in their maneuvers, wherever this infantry battalion was to receive artillery support and engineer support, these particular artillery and engineer units would if possible be those assigned. Moreover, in the daily routine, this engineer unit would if possible be the one assigned to help the infantry battalion in its target range construction, improvement of its camp drainage, etc. In other words the infantry major will *know* his means thoroughly. They will be a real and integral part of his fighting machine and the team will have the best chances of success.

If an infantry major, such as we have described above, learns how to command his battalion and the proper proportion of auxiliary arms, he will probably make an excellent colonel or brigade commander. He will know what to do with his engineers and his artillery. Is it not therefore a fundamental duty on our part to see that the field officers of the line acquire the experience of handling the auxiliary arms, particularly the engineers, in the proper way? If we don't help them to learn how, we can not justly complain thereafter if things go wrong. The artillery has been trying to show the infantry officers how best to use the guns. Similarly, we must show them how best to handle the combat engineers.

It may not be economical engineering, particularly at first, to let the line commander control our detachments temporarily. However, we are not only observing the true principles of organization and respecting proper command within a "theater,"—but we are helping that commander train himself to think in terms of engineers. We are increasing the chances for success in battle—we are travelling true to our course, carrying out our mission as the engineers of a combat division.

If we are going to convince the line how engineers should be handled we must first convince ourselves that we are right. There is a wide divergence now. It behooves us to thresh out the question in the light of our best experience, not forgetting the fundamental principles that underlie our profession. As members of the Corps of Engineers we are soldiers first. Our function in war is to produce those results which will assist in the greatest possible way in the attainment and maintenance of military success. We are soldiers first and engineers second. Those who thus believe I term the progressive party, and the other group, which I have named "conservative," rightly merit being called engineers first and soldiers second. This condition cannot continue. We must become one party, but not by unsatisfactory compromise. The conservatives must join the ranks of the progressives. If the Corps of Engineers is to justify its existence as an inherently essential element in the Army of the United States it must take for its motto "Soldiers First!"

Dust Explosions

Dust explosions occur in grain elevators, feed grinding plants, flour and starch mills, sugar refineries, wood working plants, paper mills, etc.

They are due to ignition of the dust in the air from an external source under certain conditions of temperature and humidity. Fineness of the dust particles, high temperature, and low humidity, increase the probability of explosion and the destructive effect.

The principle causes of ignition are lighted matches, heat developed by friction, electrical sparks and static electrical discharges.

The flame of explosion is propagated at a rate of more than 6,000 feet per second and it is impracticable to construct buildings which will withstand the pressures thus developed.—*Canadian Engr.*

Inter-river Drainage District

The inter-river drainage district of Butler Co., Mo., between the Black and St. Francis Rivers, is one of the largest projects for reclamation of lands subject to overflow. It includes an area of 127,500 acres.

The project involves about 54 miles of levees along both rivers, varying in height from 10 to 14 feet, and requiring over 4 million yards of embankment. Detention reservoirs were considered as a possible solution, but rejected as less economical than the levee system. There will also be provided some 208 miles of drainage channels for the interior of the area, varying in size from 12 feet bottom width and 6 to 8 feet depth, up to 55 feet bottom width and 10 feet depth.

The plans for this work were prepared by the Morgan Engineering Co. of Memphis.

Contracts for the levee work have been let to the Callahan Construction Co. of St. Louis.—*Mun. & County Eng.*

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The Military Engineer

Dedicated to the National Defense

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EDITORIAL

Construction Work of the Engineers in France

IN this issue appears an account of the work of the Engineers of the U. S. Army in the theatre of the World War. It is a simple record in plain fact and actual figures, of one of the greatest and most varied construction tasks ever undertaken, and successfully accomplished by human energy. It describes briefly the achievements of the Corps of Engineers, without underrating the work of others who did their part, without attempting to decry their efficiency, impugn their motives, besmirch their good name or destroy their usefulness, although efforts to destroy the good name of the Corps of Engineers have recently appeared in certain contemporary publications.

The men who did this work, the officers of the Corps of Engineers, and the men from every branch of the American engineering profession who responded to the call, strove under many difficulties. They were not at home, working under conditions in some respects more favorable than those of peace, but abroad in a strange land, facing new and unknown conditions, amongst a foreign people, speaking an unfamiliar language, having different customs, a different mental attitude, and often a lack of sympathy and the will to co-operate, due to the lack of understanding. The material resources of the United States were not at hand and readily available, but 3,000 miles away, across an ocean infested with hostile submarines. Our engineers did not control the transportation facilities of France—the railroads which were essential to their task. They did not have at their backs the organized efficiency and patriotism of the skilled contractors of America.

It was, moreover, not a simple task of building construction which these men faced, but a complex and intricate project, involving every variety of structure and installation. In the beginning they lacked almost every thing necessary to the prosecution of their work, personnel, supplies, equipment, transportation, though happily they possessed an organization well adapted to the difficult situation and capable of expansion.

Almost everything they lacked, but not *everything.* For these men possessed a practical knowledge of the fundamental economics of warfare, which demand prompt results, stripped of all niceties and refinements, sufficient unto their purpose and no more than sufficient. But above all, our engineers had the will to conquer, the genius of achievement, the "never say die" spirit that always has surmounted and ever will surmount all material obstacles. Herein lay the certain guarantee of success.

The heavy task was accomplished, rapidly, efficiently and thoroughly done in face of all difficulties, and it constitutes a proud monument of achievement in the field of engineering and construction.

The record is a worthy one, and adds lustre to the reputation of the Corps of Engineers and the American engineering profession. And every American citizen whose soul is not dead within him, should thrill with a mighty pride in the magnificent work of the American Army Engineer in France.

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A New Era

WITH this issue PROFESSIONAL MEMOIRS in a new form and under a new name enters a new era, on the occasion of its twelfth birthday. It must be an era of greater usefulness than that which has passed. We have a more important mission to perform, a larger clientele to whom we must appeal.

The scope of our efforts will be greatly increased. In this issue several new departments make their appearance and certain old ones have been abandoned. It is intended to add other departments in the near future. The news section, which now appears for the first time, is far from being complete or perfect. Still, we feel encouraged by a good beginning. This department has great possibilities of usefulness in keeping each of us in touch with what the others are doing.

Our change of name is in accordance with our change of policy. A "memoir" is a solemn chronicle of a task well done. But a magazine such as ours, to fulfill the mission we have set before us, should not be a mere archive of technical data and methods. It must be a living thing, pulsating with human emotion and interest.

To be instructive a magazine should be entertaining. The journal of a scientific institute, the "proceedings" of a technical society, do not serve the same purpose as a current periodical. They are in effect archives of technical knowledge, and our journal is not such. Our "body politic" consists chiefly of live human interests and passions, men who are doing things, and not "book-worms," or animated encyclopedias of impractical ideas. We aim to dispense and distribute enthusiasm as well as knowledge. Enthusiasm and knowledge combined win many battles where either alone would fail.

The aim of this journal is to promote the practical efficiency, the solidarity and the enthusiasm of the engineering profession, in the service of the country. It is not a mere recital of technical methods but a bond of union, sympathy and understanding between all engineers in civil or military life who are desirous that the profession shall be always prepared to render the most efficient possible service to the nation in case of need.

Accordingly THE MILITARY ENGINEER solicits from all its subscribers, from all engineers and from all military men, articles and news items which will help it to accomplish its mission. For since we have no staff of paid writers we are dependent for existence on the voluntary contributions of those who believe in our mission.

What is the class of articles that will best meet our needs? First, they must generally be current, up-to-date. Second, they must, in general, appeal to a relatively large number of our subscribers. Third, they must be of value for instruction. Fourth, to be read they must be readable. This generally requires a relatively short article. In each issue there should be a few articles of moderate length and a greater number of short articles or notes.

It is seldom wise to attempt in any article for a current publication to *tell all,* for that is generally tiresome. If the article be, for example, an account of the construction of a dam, it should not aim to be a complete guide with plans and instructions for others to follow in the future. For as such it will never be used. Neither should it be a history of the work. In some articles that have been submitted there has been included what was almost a journal of operations, which cannot possibly be of an interest to our readers proportionate to the space it occupies. Professional memoirs and technical instructions which are in effect text books, have their uses, but not in a current periodical. We need accounts of new and unusual things, new schemes, new difficulties encountered or new ways of overcoming old troubles. Some details are interesting and important. Others are merely tiresome to a reader. The latter should of course be omitted. Important statistics should be summarized when practicable.

The belief that monumental treatises were required has often served to deprive us of valuable contributions. An author having a valuable idea sometimes feels that he must expand it into a long-winded article. The effort required to do this is so great that often we lost a valuable idea that might have been suitably written up in a few hours or even a few minutes time. Some accounts are of most value when, for our purposes, complete and thorough. But the majority are most useful when presented in sketchy and picturesque style.

In any case it is *quality* rather than *quantity* that we need. The most valuable commodities usually come in the smallest packages.

In order to cover a wide field and to maintain an uncompromising standard of excellence in the material presented to our readers we should have plenty of contributions to select from in order that we may, so saying, skim the cream for each issue. The fact that an article is not published does not mean that it is not good, even excellent. It may simply mean that we are receiving many excellent contributions, all of which manifestly cannot be published. Also it is necessary that we present a "balanced ration," and the best of articles judged *per se* may not fill our needs at any given time. Not every shot of even the most expert marksman is a bullseye. And we want nothing but bullseyes.

If you have a valuable idea don't fail to let us have it simply because writing is not your forte. If your literary style is not in accord with our standards it is very easily re-dressed. It is much easier to adapt some-one else's work than to give birth to new ideas. We are glad to re-write the crudest article which contains valuable information—or have some one else do it. It is the substance rather than the appearance

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that counts. To see that good ideas are properly and attractively presented is the editor's job. You need not be a finished writer to be a helpful contributor.

However, waste of time may often be avoided if authors before writing articles complete will send to the editor titles and brief outlines of topics they are prepared to contribute. If articles of any nature or on any subject are not needed at the time, the labor of preparing them may thus be saved. Also if several contemplate an article on one subject the editor can designate one to prepare the article and the others may be called on for comments. Thus duplication of work is avoided.

When an article on a particular subject is requested of a particular individual it will be quite plain that the article is specially needed and will most probably be published.

Comments or discussions of articles will never be called for unless it is fully intended to publish them. Literary style and logical arrangement are of less importance in discussions than in capital articles. Therefore when your comment is invited, help the cause by sending it in promptly.

From time to time the editorial columns will indicate articles needed, and those who are in a position to contribute them are urged to volunteer.

It is desired that subscribers suggest subjects that would be of interest. Our journal can be a success only if it continually presents live matter of interest to us all. So tell us what you want.

Increase in Price of Subscription

DURING the ten years that have just passed the costs of all items which enter into the make-up of a magazine have greatly increased. In some cases they have doubled.

Due to legislative restrictions it has become necessary to discontinue the printing of the journal at Washington Barracks and to contract with a commercial press for the work, with a very decided increase in costs of issue.

This occurs at the very time when we are endeavoring to improve the quality and extend the scope of our work.

As a consequence of these changed conditions the publication of the magazine will cost henceforth from four to five times as much as heretofore. We are accordingly reluctantly compelled to make for the first time in our history a small increase in our subscription price, from $3.00 to $4.50 per year. This increase in price will by no means cover the increased cost of production. This can be met only by a large increase in the number of new subscribers and the increase in advertisements which will naturally follow.

It is the intention to secure these additional subscribers by issuing from now henceforth a magazine which no engineer who is interested in the national defense can afford to be without.

Civil and Military Engineering

IT will be the policy of THE MILITARY ENGINEER in the future, as in the past, to include in each issue articles on both civil and military engineering.

Division of articles into "military" and "civil" engineering does not mean that such articles are of interest solely from a military or from a civil point of view, as the case may be. Most of the operations of modern military engineering are adaptations of civil practice to military needs. Military experience broadens the viewpoint and develops the resourcefulness of the engineer; military necessity results in the development of new and ingenious methods. This military experience cannot fail to promote the development of civil engineering. All branches of engineering, civil, mechanical, mining, electrical, etc., find their application in military operations. No military engineer, therefore, can be indifferent to developments in civil practice, any one of which may be employed in the future conduct of war. And no civilian engineer, however highly specialized his work, can be indifferent to the possible application of his knowledge and experience to the service of his country in time of war.

The defense of our country is a duty which any engineer may be called upon to perform. It is a duty quite as important and always more urgent and critical than the development of civilization and the creation of wealth in time of peace.

The obligation of service to the flag involves the duty of preparing ourselves efficiently to perform that service. Accordingly every engineer who is also a patriotic citizen, is interested in all developments in the field of engineering which may find an application to warfare.

A National Military Policy

SOMETHING over a year ago the Armistice terminated the greatest military conflict that this world has ever seen. In the course of the struggle millions of men gave up their lives and billions of wealth were destroyed. As a direct consequence of the war dynasties passed away and new nations came into being. Normal economic processes were interrupted and the conditions of life which obtained before the War will never be restored. But in this interplay of cause and effect the controlling factor—the elemental force dominating it all was not destroyed. In spite of the ordeal through which it has passed, human nature still remains the same. Individuals will continue to disagree and nations will not always find their aspirations in accord. There is

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small hope that the World War will stand for all time as the last war of mankind. Even now the peace treaty, not yet fully consummated, exhibits a tendency to take its place with other historic scraps of paper.

Our own nation has not yet fought its last fight. That "splendid isolation" which has been our vaunted first line of defense against a foreign foe has been destroyed. The appearance off our coast of hostile submarines, the crossing of the Atlantic by air and our own performance of transporting to Europe within a space of six months' time one and one-half millions of men, are powerful demonstrations of the military situation which now confronts the nation.

In the rapid march of modern progress in transportation and communication, time and space in a military sense have been all but annihilated. Scant opportunity remains for the creation of a nation's defenses after diplomatic processes have failed to achieve results. More than ever before in history national preparedness is an issue and it can not be ignored, but the question now is not one of principle but one of means and methods. The great conflict has brought home to all the fact that professional armies, however well trained, however well equipped and however numerous, short of the total national resources, cannot meet the ultimate demands of modern warfare. Nations at war must be in fact nations-in-arms and their war power can be nothing less than their total strength in men, in matériel and in an invincible will to win—"men, munitions and morale." Obviously, however, no nation can afford to keep its total manpower under arms at all times, nor, on the other hand, can any nation afford to dispense entirely with some force which shall serve to hold the outer lines in the first assault and to cover the mobilization of its reserves. Some organization must be maintained by means of which the nation may generate its full fighting resources.

The World War was not fought in vain, but the United States will have failed to fully consolidate its success if it does not adopt a rational military policy in keeping with the genius of the American people which shall insure a continued existence of the fundamental principles of the nation. By reason of the participation of all its people in war activities the country as a whole is now informed and interested in our foreign policies and relationships. Through the various associations formed during the War and which are still in existence, educated public opinion has a means for expressing itself. Scattered throughout the land is a body of thinking men who have had actual experience and who can make themselves felt in national affairs. The events of the last two years in which they have taken a vital part have made preparedness a personal issue with each and every one of them.

This body has already through the American Legion announced its military policy as one of universal military obligation, with equal opportunity for all, to be secured by a national citizen army based on universal military training. It is opposed to compulsory military *service* in time of peace and to the establishment of any strong military caste. It favors a citizen army capable of rapid expansion, organized into suitable tactical units, trained, equipped and officered before rather than after the commencement of hostilities. This policy includes a small regular army with a general staff composed of citizen-soldier officers and regular army officers in suitable numbers.

This policy is true to the ideals enunciated by the founders of the republic. It is in harmony with the constitutional declaration of faith that "A well-regulated militia is necessary to the security of a free state"—for, to the founders of the nation, "a well-regulated militia" was a citizen-army, trained, armed, equipped and instantly ready to fight in defense of the nation. The "militia" as a *word* was in fact nothing more than a colonial colloquialism for the citizen-soldiery of the national forces. The Spirit of Valley Forge was its soul and the Minute Man of Concord was its embodiment. Through the compromises necessary to consolidate thirteen independent states into one sovereign power, and to give life and force to the national motto "E Pluribus Unum," through circumstance and conditions not then foreseen and through persistent failure to appreciate that, in war, offensive action is the most effective form of defense, the word "militia" has been subverted from its primal meaning of a national soldiery to that of a local constabulary.

In the one hundred and forty years of its existence the sovereign rights of the nation as against the local rights of its component states, have been fairly well determined in all spheres of national activity except in that one sovereign right and duty, paramount to all—the right of national existence and the duty to take measures to maintain that existence. That right and that duty, in the crisis through which we have just passed, were exercised by destroying the arbitrary distinctions between regulars, militia, volunteers and the selective service levies—they were all one, the *Army of the United States.* The contention of our foremost military experts in favor of one national army and only one is founded on experiences, and is now supported by the opinion of the well-informed and thoughtful average citizen; for the American Legion is none other than that citizen, no longer mute but with a voice to be heard. Its policy aims to provide a single unified national defensive force as opposed to a heterogeneous aggregation of regulars, national volunteers, state forces and conscripted contingents secured in varying numbers under some form of compulsory service. It proposes to form an army of the United States, one and indivisible. In this endeavor it is entitled to the support of all who have at heart the best interests of their country.

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The Military Engineer

THOUGH the fighting foot-soldier has ever been the backbone of armies, engineering has always played a major rôle in the conduct of war, and with the advances made in modern times in metallurgy, chemistry and the various other sciences and arts, it has become in some of its many applied forms a controlling factor in the progress of military operations.

There is a strong family likeness in all engineering work and in many respects construction behind the lines in the theatre of war does not differ greatly from that often conducted under emergency circumstances in time of peace, but the governing conditions under which the work is executed are radically different. The purposes in view are not the same and considerations enter in military work which rarely find their analogy in civil constructon. Besides his technical equipment as an engineer, his knowledge of strains and stresses, his familiarity with the characteristics and uses of structural materials, his experience in the management of labor and in the utilization of construction equipment and appliances, the military engineer must be thoroughly familiar with other subjects of which the civilian has little knowledge and for which he normally has little use.

The engineer in war must be not only a competent engineer and an efficient manager, but he must be thoroughly versed in the art of war. He must have a full appreciation of strategy and tactics; of the employment and effect of artillery and infantry fire, and must be able to devise measures which shall reduce or wholly nullify their destructive action. He must be prepared at all times to direct his construction talents in support of military operations against the enemy. A ready resourcefulness and an ability to substitute or improvise must be dominating elements in his professional equipment for his heavy duties.

The engineer who accompanies the combat troops into action is essentially a military man. In the face of the enemy, when the nation's honor or its very existence are at stake, military considerations are paramount and all operations of every nature must directly contribute to military success. This means that time is of the essence, which is the fundamental economic principle of military engineering.

His technical engineering attainments must be supplemented further by a knowledge of army regulations and governmental business methods, restrictions and requirements. He must know the duties and responsibilities of the various staff departments and the relations that they bear to one another and to the combatant forces in the field. The trained military engineer is thus at one and the same time a general practitioner and a specialist in the engineering field. He applies general engineering to the very special purposes of war under unusual and abnormal circumstances and conditions, as judged from a peacetime point of view. He does not, as is sometimes supposed, disregard economic considerations, but to achieve success he must realize that the economics of war are not those of peace.

While military engineering is a specialty, it is by no means an occult science whose mysteries only a gifted few may hope to solve. It knows no horizons—it recognizes no limits. Its field is coterminous with that of human endeavor, for there is no activity of man which does not find its application in war in some form or other. The civilian engineer, therefore, will encounter no insurmountable barrier to prevent his becoming an able military engineer, but it can not be done by the mere act of accepting a commission, or donning a uniform. There is no royal road to learning, nor is there an asphalt highway to knowledge of the military engineer's art. This can be acquired only by study and practice. The civilian, however competent he may be as an engineer, will find himself at a loss in the military machine unless he is also a trained soldier with a soldier's appreciation of military conditions. To take his place in a national citizen army the civilian engineer must train himself in time of peace to apply economically and efficiently his art in war.

If the country abides by precedent we shall always have in the permanent military establishment a force of engineers, but this body, on a peace basis, can never be more than a mere nucleus of that vastly larger number needed in a national crisis. Its object will be to keep alive the best traditions and practices of military engineering, to note developments in commercial and industrial life and to study their applications to the art of war. Not the least important of its functions will be to furnish a medium through which the great number of engineers from civil life may be instructed in the military phases of their profession and to provide a channel through which they may in an emergency be incorporated in the defensive forces, organized and assigned to those positions and duties in which they can render the maximum service.

The Engineer Officers' Reserve Corps, authorized by the National Defense Act of 1916, affords at present the most direct means of accomplishing these objects through military channels. A great many officers who served in engineering capacities in the National Army during the World War have applied for commissions. Others are known to be waiting on legislation and their future course will depend upon the action of Congress in respect to universal training and its effect on the reserve corps.

However, the Engineer Officers Reserve Corps is now reasonably able to respond to an emergency provided, of course, that it does not take on the dimensions of another World War. Due to the limited number of officers available for the multitudinous

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duties of the Corps of Engineers, it has been necessary to conduct the examination of records and requests for consideration with an altogether inadequate force. An attempt has been made in each instance to tender the commission with a rank appropriate to the actual capacity and service of the officer concerned. Since the records are voluminous, though in many cases incomplete, the work involved in determining the proper grade for officers who were not formally recommended, but whose experience demonstrates suitability is enormous, and unfortunately has produced an impression of delay or indifference. Notwithstanding these adverse circumstances, steady progress is being made in this work of reorganization.

Under the law commissions in one grade higher than those held by them during the war may be offered to former officers whose records warrant it, and every effort is being made by the Board of Review to accomplish this in all appropriate cases without additional correspondence.

On the first of December there were about 3,185 reserve officers classified as to their availability for immediate duty with combat engineer troops, or for duty with certain specialist engineer organizations. This total was distributed in grades approximately as follows: 15 colonels; 70 lieutenant colonels; 300 majors; 850 captains; 850 first lieutenants; 1,100 second lieutenants.

Every reserve officer is urged to keep his correct address on file in the Office of the Chief of Engineers to the end that communications may reach him without delay. Under plans now being made, it is anticipated that information of value will be sent to these officers from time to time in order to keep them in touch with military developments.

A Society of American Military Engineers

THE war left its mark on the engineering profession as a whole, for in some capacity or other, in the government service or in the industrial world, at home or abroad, all took part in it. On April 6, 1917, when the existence of a state of war with Germany was formally declared, the engineers available for immediate military service consisted of 256 officers and 2,228 soldiers. In November, nineteen months later, there were in the Engineering Department of the United States service 10,886 engineer officers and 292,300 soldiers. There were in addition in the Ordance Department, in the Construction Division, in the Chemical Warfare Service and in various other branches of the Government, a vast number concerning whom exact data are not now available. The engineers of the country bore well their part and when the final record is written no page will be more brilliant than that which chronicles their achievements. They are justly proud of their service and their contributions toward the winning of the war are too well known to need comment here. They are vivid in the memory of all and many of their accomplishments are perpetuated in the form of structures and devices which, though created for war, will continue to serve the purposes of peace for all time.

By far the greater number of these officers and men have long since returned to their former less spectacular if more beneficent labors. Some few of these thousands of engineers came out of the war perhaps with a just grievance and a mental resolve expressed by the slogan "Never again." Improper assignments were undoubtedly made—the square peg did not invariably get to the square hole. Promotions were slow in coming and were not always made with even-handed justice. Now and again some regular officer whose rank had outstripped his judgment, "dressed in a little brief authority" took undue advantage of his position, but with the passage of time the disappointments, the resentments, the bitter memories have faded and their once sharp outlines have been softened in the happier recollections of great achievements. Distance has cleared the vision and restored the sense of proportion, and the citizen soldier now judges the army, not by the markedly inefficient nor yet by the conspicuously able, not by the most arbitrary nor yet by the thoughtfully considerate. He has begun to apply the law of averages—he realizes that the regular army man is neither god nor devil, saint nor sinner, but combines the attributes of them all and the composite result is an individual on whom the country may place its reliance.

The thinking citizen everywhere has come to realize that in deflecting an unprepared nation from the paths of peace to those of war, mistakes will occur, that war itself is a dislocation of the normal processes of thought and normal lines of endeavor, that it breeds mistakes and that unpreparedness, such as was ours before the war, serves to multiply natural errors and omissions. He now appreciates that, in consideration of things as they really were before the war, results, by and large, were not so bad after all; he experiences in his inmost soul a keen sense of gratification that it was his privilege to have taken a man's part in upholding the standards of a free people.

Under the wholesome reaction that has set in, the citizen soldier has ceased to brood upon the trials and tribulations of a day that is passed, and in the light of his experience has turned to the solution of new problems which now confront the country. His previous resolution to avoid all military service is directed instead toward the maintenance of personal preparedness to do his part should the nation again require his services, toward the formation and adoption of a sound military policy for the nation, toward preventing a recurrence of national mistakes and toward

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so training coming generations as to spare them the painful and humiliating blunders of the past. "Never again" will his country face a great conflict in behalf of liberty and justice, unprepared, if he can prevent it.

But these thousands of officers and men are no longer in the service and there exists no distinct agency to unite them as engineers in their common purpose or to direct their efforts to a common goal. There are, to be sure, great numbers of engineering societies, each with its specific purpose, and all thoroughly imbued with the most patriotic spirit. These societies include within their membership those professional men who by virtue of experience and training are now qualified as military engineers or who may so qualify hereafter. But there is no society which concerns itself consistently with questions of military engineering and allied military activities.

There is, therefore, a pronounced need for a society or an association of American Military Engineers. The reasons for its existence are primarily of a professional and patriotic nature and secondarily, only, of a social or sentimental character. Its first purpose should be to conserve the teachings of the World War in the field of military engineering and to maintain unimpaired the assets represented by our late experience. Its policies and aims should be of a positive and constructive nature looking to the needs of the future rather than the glories of the past. Such a society will provide a common meeting ground for those who in a future national emergency must shoulder the engineering burdens of the country. It will furnish a medium for the interchange of ideas and for the dissemination of professional information of military character.

Steps have been taken to form such a society and it is hoped that those whom the supreme need of the nation once welded into an effective instrument for the vindication of its ideals and the preservation of its sovereignty will, now that the bonds of military compulsion have been dissolved, unite voluntarily to maintain the ties of a common experience and preserve the heritage of their service in the cause of freedom and democracy.

The Aeroplane in Surveying and Mapping

THE extent to which the aeroplane may be used in mapping and the methods of its employment have been subjects of much speculation amongst all who are interested in maps, and that means most engineers. Many have hoped that it offered a large measure of relief from the laborious methods we have heretofore of necessity employed, have hoped in fact that the butterfly would now take over the functions of the ant. In this issue appears an article by two well-known authorities on this important subject, which must be of great interest to all our readers.

Essayons

EVERY ENGINEER OFFICER in our service wears over his heart, as well as at sundry other points on his person, a button bearing the seal of the Corps of Engineers. This emblem of a distinctive service is the oldest in the army. Its origin and the circumstances of its adoption are lost in the unrecorded history of the early days of the nation though we know it came to us from France with that little band of self-sacrificing but practical idealists who accompanied Lafayette or followed in his train.

Amongst these were Louis le Begue du Portail, who was the first Chief of Engineers in our service appointed by act of Congress (though the third to occupy the post), and the gifted L'Enfant, to whose artistic genius and far-sighted faith in the young republic we owe the present beauties of the national capital.

In consideration of the scholarly attainments of these ancients, their mastery of speech and the leisurely politeness of the times, we may not doubt that the simple motto "Essayons" adequately represented their ambitions, but we may not doubt on the other hand that our literal translation "Let us try" lamentably fails to express their high-souled hopes as signally justified by their actual achievements.

For them "Essayons" was not a mere polite phrase, it conveyed no sense of weak irresolute endeavor, it carried no suggestion of possible failure. It stood for a living fighting force, a determination to win through at all costs. Its real spirit was "let us try, we will not fail; let us do, and it will be done."

Our motto, "Essayons," has served the Corps of Engineers through long years of earnest endeavor and consistent achievement. We cherish it for its associations, for the memories it evokes, for the examples it calls to mind of engineer officers of other days who have essayed and won.

But fashions have changed; the lumbering coach-and-four has given way to the luxurious auto-limousine; the stately minuet has been replaced by the romping jazz; politeness has succumbed to "pep." While the spirit may be the same the polished phrase of other days has been done to death by the demand to "make it snappy."

During the past five years the French have had slogans, the verbal manifestations of their unconquerable spirit, breathing sentiments and determinations far above the simple "Essayons" which served their forebears and ours. The spirit is the same but finds its expression in other terms. In August, 1914, Viviani said, "We are here without reproach, we go forward without fear." At Verdun there came through set teeth, "They shall not pass." There was no hesitation, there was here no "if possible," no idea of "let us try,"—and trust to luck.

It is related that during one of the first engage-

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ments of the American Expeditionary Forces, when the Germans were raiding our lines north of Toul, a French battery was sent in by the high command to support the regimental sector then being harassed. Around the American P. C. there was great excitement and confusion. The general locality was being "strafed," couriers rushed in and out, telephone messages gave garbled and exaggerated reports of the situation. The "buck-fever" of the tyro held sway for the moment.

The French battery came down the road, halted near a clump of woods while the French captain rode up to report at the American P. C.

The Frenchman stepped into the confused little office, stood quietly till he caught the eye of the commander, then saluted smartly and said "Nous sommes arrivés, mon Colonel." The youthful American colonel stammered: "Why yes, of course, we are glad to see you. A little bit hot around here." The Frenchman stood silent a moment, then said, "Positions?" The Americans collected their wits and showed him where they thought the guns could go. This determined, the Frenchman said, "Echelons?" They then showed him the places for picket lines, kitchens, etc. He then said, "Munitions?" and they told him he could draw ammunition supplies from the artillery munition dump. Each of these localities the Frenchman noted on his map. He then saluted, saying briefly, "Etendu" (understood), and left. Quietly, yet quickly, and in a manner that put calm and confidence into every American officer, this single French captain completed his work.

Now the only thing that the Frenchman said when he got "his job" was, "Understood." In English he might have said, "Very good sir." His short words, his alert attitude, inspired instant confidence. There was no doubt in his Commander's mind that the work would be done. He did not say, "I shall try," he did not raise in the mind of his commander a doubt as to his ability and full intention to do his task.

At one of our new division camps at the outbreak of the war the division commander called in his division engineer. "Now Colonel," he said pleasantly, "what is your regiment prepared to undertake?" "General," replied the young colonel, his lip trembling a little, "we will *do* anything you tell us to do."

In one of the branches of the engineer department there is a certain civilian employee, an old timer, who enjoys the enviable reputation of never admitting that there is anything he cannot do. He says that on a certain occasion his commanding officer asked him if he could perform a certain very difficult task. He was about to respond, "I shall try." Just then a large moving van rumbled past, and on its side, in enormous letters was the boast, "We move *anything.*" "Right there," says our friend, "I took for my motto 'I *do* anything.' They never ask me if I can do things now. They just tell me to go ahead." This man has apparently progressed beyond the "Essayons" stage.

The Corps of Engineers was created and is maintained for the primary and essential purpose of furnishing able military engineers for service in war. All of its activities and all of its work in peace time are the necessary means to this end. It is not enough that these officers should be men who will try, men who can be depended upon to do their best. They must be, and must be known to be, men who can and will "deliver the goods" in any circumstances. When the commander gives his engineer a task it is not enough that he should believe the engineer will *try*, or even that he will do it *if possible*. He must know absolutely that *it will be done*, and done promptly, efficiently and thoroughly; that if it proves impossible it will still be done, "because I told my engineer to do it."

We believe that the motto of any association of men should express its highest aspirations. Does not the literal translation, "Let us try," fall short of our ideal? Does it not even fall short of what *we have done* and *can do?* Do we need a higher ideal as the goal of our efforts?

Training for the Engineer Officers' Reserve Corps

THE National Defense Act of 1916, which established a Reserve Corps of officers of various arms of the service, prescribed that these officers should receive such training as necessary to fit them for the performance of their duties in case of war or other emergency.

The Engineer Officers' Reserve Corps was established and enrolled promptly upon the passage of the Act. Although our country was then at peace, the engineering profession responded to the call in numbers and with an enthusiasm that was most gratifying to those who have cherished a pride in the patriotism of the engineer. Many of the most eminent men in various branches of the profession applied at once for commissions. These applications continued to arrive in constantly increasing numbers after the declaration of war, until the Chief of Engineers was embarrassed with the wealth of talent placed at his disposal. The Engineer Department entered the war better equipped with available commissioned personnel than any other branch of the service.

The work done by the Engineer Reserve Officers during the war is now a matter of history and is a record of which the profession may well be proud.

When, in August, 1918, the various military forces were combined as the U. S. Army, the Reserve Corps as a distinct organization ceased to exist. Up to that time, 7,189 commissions had been issued in the Engineer Officers' Reserve Corps. In November, 1918, there were 11,174 engineer officers in the army, and during the period of the war nearly 14,000 origi-

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nal commissions as engineer officers were issued.

Now that the war is over, the Engineer Officers' Reserve Corps has been re-established. It is no new, untried organization. It has behind it a glorious history, and a record of patriotism, devotion to duty and splendid achievement. Most of the men now in the corps took part in the war, where they all rendered meritorious service. The number already commissioned exceeds 3,000 and is constantly growing. Many other engineers are awaiting legislative action, establishing a definite policy with reference to our reserve forces, before making their applications for commissions. The prospects of such legislative action are excellent. (See Synopsis of Army Re-organization Bill elsewhere in this issue.)

So much for the present situation. What is to be the future policy with reference to the training of this corps? Many of its members, as we have pointed out, have already been well trained in the school of actual war. But we are not content to rest on our laurels. We live in a world of progress and we must "carry on." Moreover, new men, with no previous training in military engineering, will join in large numbers.

The War Department fully appreciates its responsibility in the matter. It must furnish the incentive, the leadership and the guidance necessary to reap the fullest benefits of the time and effort that will be given by the patriotic citizens who will constitute the reserve forces on which we must rely in the event of war. The Training Branch of the General Staff is now perfecting a policy and devising ways and means for the proper training of the Reserve Corps. These plans are not yet fully matured. As a first step, however, they contemplate the issue of instruction literature by the Training Sections of the various services at the War Department, in co-operation with the Service Schools at Fort Leavenworth, Camp Humphreys, etc. In this manner much valuable instruction may be given.

For engineer officers of the reserve corps no instruction in engineering is contemplated, since these officers are well versed in this subject, as they proved during the war. What is needed is instruction in military matters and the tactical application of engineering science.

To meet this need of the Engineer Reserve Corps for military training, which will enable them to apply their professional knowledge and experience to the best advantage of the National Defense, is one of the chief functions of the Society of American Military Engineers and of this periodical.

Our columns will contain articles and digests on military and engineering subjects which will be of special value to the reserve officer. Plans are under way for the establishment of a department of matters of particular interest to the reserve corps, which will be published in such manner that they may be clipped and filed for reference. It is contemplated to issue instruction courses similar in form and substance to the "Engineer Field Notes" of the American Expeditionary Forces, but of still wider scope.

To carry out these comprehensive plans is no small undertaking. It will require continuous and persistent effort in the face of difficulties. The contributions to our columns represent the voluntary effort of officers and others, all of whom have regular duties which require a full day's work every 24 hours. We shall need the support and assistance of all our subscribers and, in particular, we need the support and assistance of the officers of the Engineer Reserve Corps themselves. With this support we shall "carry on" to success and usefulness in promoting the efficiency of the Engineer Officers' Reserve Corps in the interest of national security and independence.

In this issue is a synopsis of a Bill for Army Reorganization, which will be presented to the Senate in the near future.

It is characterized by Secretary Baker as the most statesmanlike military legislation ever introduced in Congress, an opinion in which the army will concur.

It is gratifying to note that the lessons of the war and the advice of military men have not been wasted upon Congress.

Promotion by seniority from a single list, with elimination of the unfit, is approved by the vast majority of army officers, even including those who have hitherto favored promotion by selection in some form. It will be incumbent upon the army itself to justify the wisdom of Congress by an effective application of the law.

This provision will do more to eliminate hurtful politics and mutual jealousies and distrust, and to promote good feeling, efficiency and hearty co-operation amongst individuals and between different branches of the service, than any other which could have been devised. Most of the discontent, the jealousy, bitterness and recrimination, which have been known in the army, are due to the utterly unreasonable inequality of promotion, which the present bill would forever remove. The army would work as a unit, shoulder to shoulder, all moving forward with a common purpose and mutual interests.

A regular standing army of moderate size, and an effective reserve, created by Universal Training, are in accord with the lessons of experience and the advice of all military experts. They would give us for the first time in our history a sane, economic, fully effective military policy, as a sure guarantee of national independence.

Perusal of the provisions of this bill puts new hope into the flagging soul of the Army. To the apathy towards all things military which has followed the war, the efficiency of the Army, the Nation's only sure guarantee of law, order and independent existence, is being rapidly sacrified. The best of its personnel is swiftly melting away, under the cruel economic pressure forced upon them by the Nation's indifference towards the maintenance of its defenses. The morale of those who remain is rapidly approaching the vanishing point. Strong, resourceful, self-reliant men, the only men who can carry out the will of Congress in establishing an effective defense, are not content to live in poverty and uncertainty, deprived of everything which makes life worth the living. Men of this type are leaving the services by thousands, those in civil life cannot be attracted to the services under present circumstances.

To correct these deplorable conditions, to re-establish our shattered defenses before they are utterly destroyed, two important but simple measures are necessary: the enactment into law of this bill providing an adequate military policy, and the provision of a decent living wage for the nation's defenders. These measures, if not too long delayed, will save what remains of the wreck and insure its ultimate rehabilitation. But during every day of delay the Ship of State continues to pound on the rocks and suffer injuries which threaten its ruin. Shall our National Defense be sacrificed to a penny-wise economy? Is it a useless extravagance which should be eliminated? We believe that the American people, however great their apparent apathy, in the reaction from the war, will never again approve a makeshift, haphazard and niggardly policy of National Defense

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"Through Military Channels"

By

Col. Ernest Graves

Engineers, U. S. A., formerly Section Engineer
Advance Section, S. O. S., A. E. F.

THE recent war was a most illuminating experience. The acid test of actual contact with a strong and resourceful foe dissolved many finely drawn pronouncements of the school room and many of the illusions evolved during a long term of peace. There is, however, one pernicious feature in the practice of the Army of the United States which appears to have gone unscathed, and is the more noticeable since the war did so much to improve army methods generally. In the matter of army correspondence procedure, that is to say the routing and handling of written matter, there appears to have been a retrogression rather than an advance.

In the groove (or rut) known as "military channels," a written communication must always pass from a subordinate through his various superiors to its final destination. As a matter of theory, the reason usually given for this requirement is that thus the superior is enabled to be familiar with what is going on. As a matter of fact, the only reason for following such a method is to maintain loyalty between subordinates and superiors. Theoretically, if a subordinate is not permitted to communicate except through his superior, no action can be taken without the recommendation of the superior. The two reasons given above are fundamentally wrong. The passing of a mass of written detail through the office of a superior does not keep him informed of what is going on. It has a tendency to do just the opposite; that is, to befog the vital issues or conceal them in a mass of unintelligible detail. Likewise, the routing of official communications can not keep loyalty where it belongs, because when a subordinate really wishes to overstep certain superiors, he simply addresses his communication "Dear Bill" or even "Dear General." The correspondence is then "privileged," and "Dear Bill" is so touched by being thus affectionately addressed that he has not the heart to do anything but answer in the same way. In addition, he is generally very glad to get information that he can rely on and that is not camouflaged under the courteous language of strict military etiquette.

In our operations in France, all the various organizations of supply, construction, and transport became so large that business simply could not be done under the old, out-of-date rules of correspondence. Nevertheless, people who were continually trying to get things done were always hampered by these rules and attempts to enforce them. The people who had common sense simply disregarded rules. Those who did not, suffered, or caused others to suffer, on account of the delays of correspondence.

One of the most conspicuous examples of the unworkability of the time-dishonored system of communication in the army was the relation in France between General Headquarters and the Advance Section of the Services of Supply. The Headquarters of the Advance Section, S. O. S., was at Neufchateau; G.H.Q. was at Chaumont, lying in the Advance Section, S. O. S.; Headquarters of the S. O. S. was at Tours. So, according to the Army system, when G. H. Q. wanted a sprinkler cart to sprinkle the dust down in front of the office of the Commander-in-Chief, word to that effect was sent to Tours, where it was relayed up to Headquarters, Advance Section, S. O. S., where in turn it was referred to the Section Engineer, Advance Section, who thereupon sent it to his local representative in Chaumont. By the time the sprinkler heard the news, it had rained and no sprinkler was necessary. This, of course, sounds extreme, but is an actual instance and serves to show the ponderosity of accepted methods governing army correspondence and the transmission of orders.

Whenever a general staff officer in one of the large headquarters received anything urgent, he did not dare entrust it to correspondence. Generally, he cut all channels and telephoned to the person who needed the information. One instance occurred in which a phone message put an officer on the lookout for necessary data, and he waited eight days for the letter with the data to pass through one headquarters. In another instance an officer was heard demanding of a messenger an explanation of the reasons why it had required seven days for a communication to pass from his hands to those of his chief clerk, who was in the next room.

In many instances the normal peace-time rules of routing correspondence were changed, but they were not sufficiently revised to permit business to go on without unnecessary and often disastrous delays. The fellow who was wrapped up in his job and was simply breaking his neck to produce results, found a large percentage of his time and ingenuity devoted to get-

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ting through and around the rules of procedure which would wreck his job if he did not surmount them.

In addition to reform in prescribed military channels, there is vital need of revision in the manner of handling letters and indorsements. Necessary reform involves training of staff officers as well as general education in the army in the use of letter-writing. Since the typewriter came into common use, the waste of paper and ink and time has been enormous, and the proper performance of work has been really seriously injured without the seriousness of it being realized.

Our new staff organization came as a result of a vital need and it has come to stay. However, as yet, our officers have not generally become expert staff officers in the matter of correspondence, and it is very necessary that this feature of their training should not be neglected. The fellow who simply sits at a desk and is satisfied to pass papers along, should be eliminated. He should be taught that wherever possible papers should either be returned by him or put into the waste-basket. If he does not know enough to eliminate a large percentage of the useless correspondence that travels, he does not know his "job."

The fundamental reason for the passing round of letters that are either aimless or that request information, or require minor decisions, is the disinclination of an officer to accept the responsibility of giving a definite answer, no matter how unimportant the information or the decision required. This human weakness should be combatted in every way possible and certainly our Army officers ought to have it educated and trained out of them.

The average staff around the various headquarters during this war was much too large, and the members kept themselves busy by writing to each other, and by requiring the fellows in the field, who were trying to get work done, to render voluminous and useless reports that the staff could not understand. Usually, by the time the reports arrived, they were too late to permit of any correction in the method of work or in the kind of work being done. As histories, they are useless because the man in the field soon learned that they were often not even read, much less understood and he very properly devoted his energy to getting his work done rather than to composing eloquent eulogies on it.

All of the foregoing destructive criticism is of little value without some kind of constructive scheme of correction which is practical. Effective correction is very difficult to suggest. However, the following principles should be laid down in a general order and all officers should be urged to thus educate and train those under them. The principal reason that subordinate officers do not assume their proper responsibility is that superiors do not encourage or permit them to do so.

(*a*) Useless letter writing should be stopped by all commanding officers, who should instruct those under them never to send a letter without closely scrutinizing it to determine if it is really necessary for higher authority to be thus addressed in writing. Letters should never be written where the matter can be settled by personal conference.

(*b*) Staff officers are placed in their positions for the purpose of properly acting on papers received by them and they should never pass a letter on because they do not know what else to do with it. When necessary to forward a communication it is their chief function to know the exact place where the subject-matter of the letter can be attended to and to send it there by the shortest route. When useless letters are received they will be returned with censure. If offenses of this kind are repeated, disciplinary action will be taken.

(*c*) Where the subject-matter of a letter is such that the opinion or judgment of superior officers should be expressed, the communication should be forwarded through these superiors. No letter requiring a decision will ever be forwarded without a recommendation by each officer who signs the original or an indorsement. An officer will never forward anything upon which he can act himself. Where the subject-matter of a letter is such that a superior is not interested, the letter should go direct to the person most concerned. If a superior would be interested indirectly as a matter of information, a copy should be sent to him.

(*d*) The foregoing method of procedure must not be used to keep information away from a superior or in any way to promote disloyalty. A properly supervised organization can keep loyalty and information in proper channels without slowing up necessary business with cumbersome and clogging red-tape.

Of course, the above instructions must be followed up by a real and active supervision to stop viciously useless letter writing and to produce an actual improvement in military business methods. Every officer in the Army must shoulder his own responsibility, make his own recommendations, and be on the alert to keep himself from "passing the buck." He must likewise not permit his subordinates to pass the buck to him. In other words, let the Army, in this day of education, launch a campaign to teach its officers to shoulder each one his own responsibility and to assume all the responsibility that he can acquire, even if he occasionally gets into trouble by so doing. Keeping ourselves out of trouble is not, after all, our principal function.

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The Key Bridge Cofferdams

By

John T. Talman
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THE Key Bridge (named after Francis Scott Key), in process of construction at Washington, D. C., is to extend across the Potomac River from Georgetown, D. C., to Rosslyn, Va. This new structure, being built by the United States Government to replace the old Aqueduct Bridge, is to be a concrete-arch bridge composed of seven spans varying in length from 85 to 208 feet. The total length of the bridge, including approaches, will be about 2,700 feet, and the length of the masonry structure proper about 1,450 feet.

The width of the deck from out-to-out will be 70 ft. 6 in., which allows for a double-track electric line, two 16-ft. roadways and two 8-ft. sidewalks.

The bridge will also be provided with two conduits located under the sidewalks in which cables, gas and water mains, etc., may be laid. The height of the deck of the bridge at mid-stream will be about 85 feet above mean low water, which will give an under clearance of 72 feet at the center span.

The plan shows alignment of the bridge and location of the four river piers. These piers are designed as abutment piers and are being founded upon solid rock. Prior to construction careful examinations were made of the foundations at the site of each pier and abutment.

This examination consisted of a series of soundings and probings taken on, and parallel to, the center line of the proposed structure from shore to shore. After the spans were decided upon, a floating template, the size of the proposed cofferdams, was placed at each pier position and three sets of soundings and probings were made around it. Borings were also made at each end of each pier position and a core removed to a depth of 20 feet into the rock.

The depth of water at these pier locations varies from 24 to 35 feet at mean low water, the average tide being about 2.9 feet. Floods in this river are not frequent, are of short duration and seldom raise the water level more than 6 feet above M. L. W.

The method of constructing these piers was given most careful study and it was finally decided to build them in open cofferdams. These cofferdams are timber frames surrounded by steel sheeting sealed to the rock bottom. The timber frames were erected on the Virginia shore upon launching-ways. They are 103 feet long, 45 feet wide and 24 feet deep, and composed of three longitudinal trusses 101 feet long and 24 feet deep, separated by series of 12 by 12 timbers, and two end-trusses 45 feet long and 24 feet deep, all connections being through-bolted. The reason for trussing these frames was to give them greater rigidity and prevent any chance of distortion in handling them from the ways to their location in the river.

These frames are supported upon nine shoes about 12 feet long, 3 feet wide and 2 feet high, each furnished with two sets of cast-iron rollers connected by steel axles. The rollers turn in grooves cut in the bottom of the shoes and drop off as the frame leaves the ways. They are later recovered and used again under the next frame. The rollers run in 7-inch channels spiked to the timber-ways. The shoes also function when the frame is in place by holding the lower timbers off the uneven bottom, thereby making it easier to level-up the frame.

These frames, after being launched, were lifted clear of the bottom by means of a scow at each end, and towed to their proper locations.

After being lowered into position and blocked up level by a diver, their height was increased 10 feet by superposing additional frames.

The sheeting of these coffers consists of ordinary 12-inch 31½-pound I-beams interlocked into two 7-inch channels, separated by wood filler blocks 5⅛-inch by 5⅛-inch in section, securely bolted together.

This sheeting was placed by a derrick-boat with swinging pile-driver leads. The sheets required very little hammering to force into place, as the small amount of mud that overlaid the rock had been removed by dredging prior to the placing of the frame. The only driving that was necessary was enough to overcome the friction of the interlock; many sheets dropping to place of their own weight.

A diver watched the sheets at the bottom to see that they hugged the frame and about every fifth sheet was secured to the frame at the top. About fifty sheets were placed in a single day of eight hours. At the corners 12-inch I-beams, bent 90 degrees, were used. The closures were formed by using wide channels bolted together and filled with concrete after being driven. Practically all the steel employed as

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sheeting will be used later in the construction of the deck of the bridge.

The sealing of these dams was done by divers, and consisted in placing a sand-bag wall around the outside of the dam, about 4 feet from the steel. The top of this wall was brought up about 2 feet above the bottom of the steel sheets. The rock bottom of the trench formed by the bag wall and the walls of the dam was cleared of mud, sand, etc., by the use of an air jack or siphon.

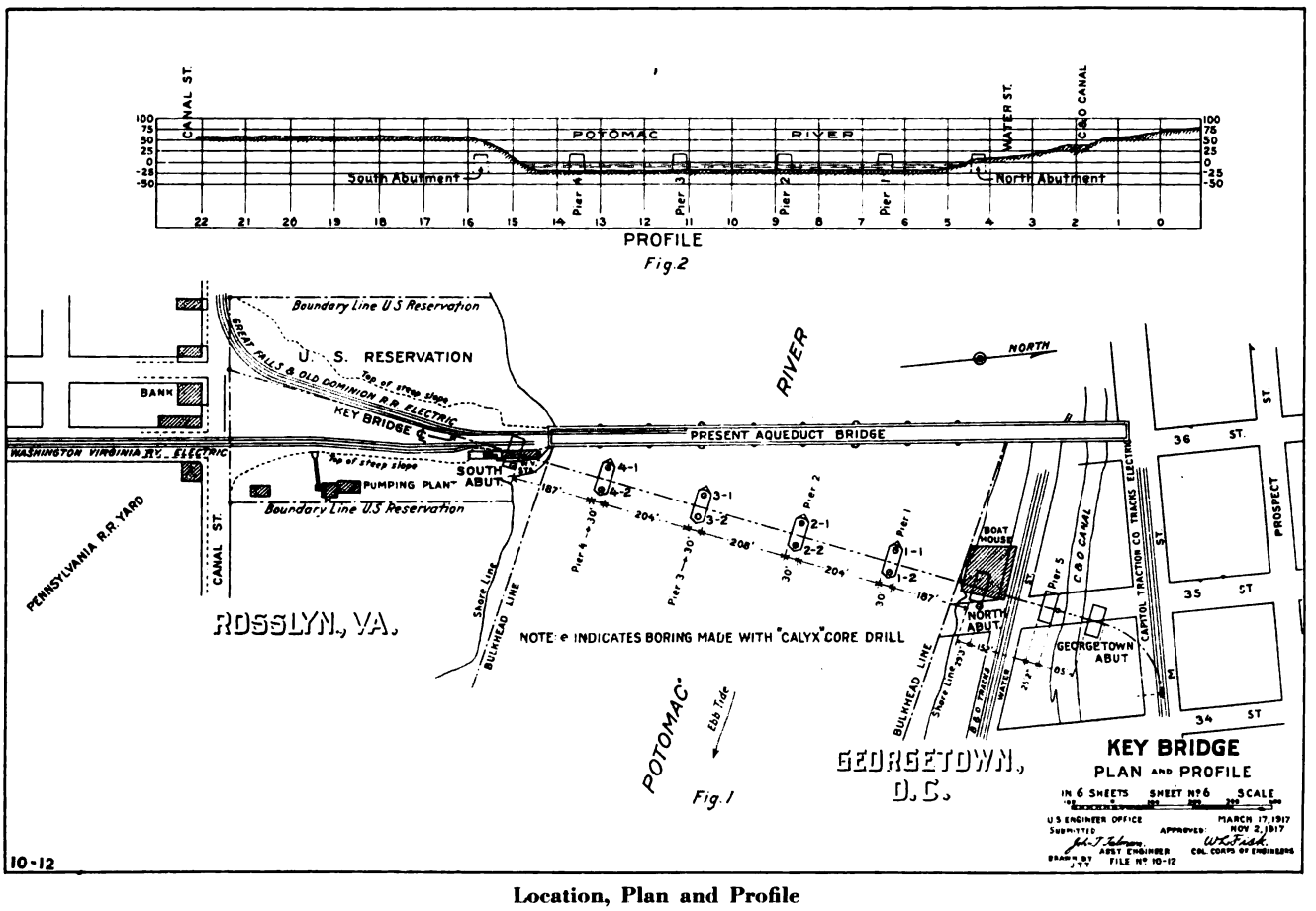
An air-jack is a long piece of 6-inch malleable pipe with a small air-pipe leading down outside to the bottom of the larger pipe and turned up into it. The jack is floated at its upper end just above the water and the air or operating end is moved from place to place by the diver. Compressed air is forced down the air-pipe into the base of the jack-pipe and lifts water, sand, mud, and even large cobbles to the discharge end. It is in effect a siphon.

As soon as the trench had been thoroughly cleaned, wedge-shaped forms, about 12 inches deep, were placed all around the dam, the forms being suspended by wires with their tops at the same level as the top of the bag wall. The trench was then filled with concrete placed through a trémie on a scow, the movements of the trémie being regulated by the diver. As soon as this concrete had set-up sufficiently, the wedge-shaped forms were removed and this groove was packed with a row of sand-bags. Upon these sand-bags rolling mats were placed. These were composed of canvas in long rolls, filled with straw, old burlap, manure and such other materials as could be secured at the time. The mats were about 12 inches in diameter with a flap 3 or 4 feet long. These rolling mats were placed as close to the steel as possible with the flap extending out over the concrete seal and weighted down with sand-bags.

The object of this pliable wedge was to take up the give in the timber frame caused by the pressure developed during dewatering. This inward movement would cause a crack to develop between the steel sheeting and the concrete seal.

As soon as the seal was perfected the pumps were started and cinders were dropped in small quantities down the outside of the sheeting. These cinders were drawn into any small leak that developed either in the sheeting or in the seal. The seal was then tested out for some time before any mud was banked around the dam, and on the dam just dewatered a head of about 15 feet was secured without any banking.

When the pumps had produced sufficient head on the dam, the diver made an examination of the seal and, at the same time, an examination was made by the use of a current-meter inside the dam to detect the location of leaks. These leaks are usually caused by sand or gravel deposits in rock seams, and may

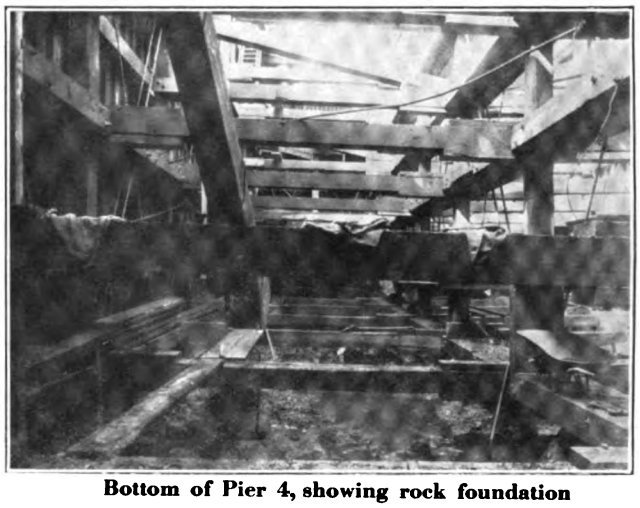


Location, Plan and Profile

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Cofferdam-frame on ways ready for launching

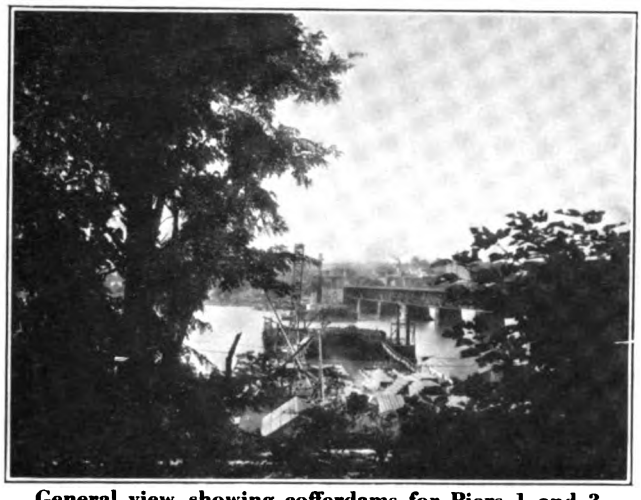


Bottom of Pier 4, showing rock foundation

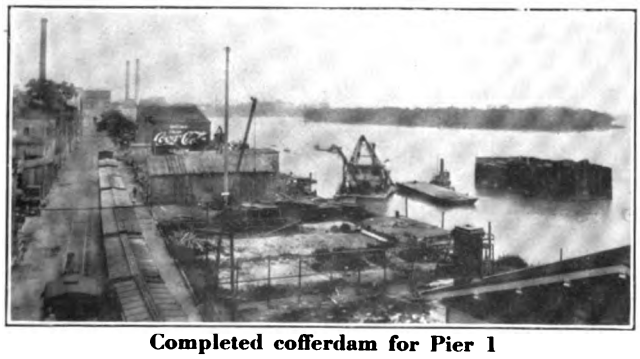
extend far out from the dam. The hardest leaks to detect are bottom leaks. So far they have given no trouble in these dams, but there is kept on hand a compressed-air grouting machine ready to meet such a condition should it arise.

After the test of the seal, a mud bank from 6 to 10 feet high was placed around the dams.

The pumps used were two pulsometers and one Emerson steam pump. The Emerson pump has a capacity of 2,000 gallons per minute, one pulsometer 2,200 gallons and the second 750 per minute. The steam for these pumps is supplied from two 125-horse-power portable boilers, mounted upon a scow.



General view, showing cofferdams for Piers 1 and 3 and Pier 4 almost completed



Completed cofferdam for Pier 1

Three dams have already been placed and pumped out. The shortest time required to dewater a dam was in the case of No. 3, which was eleven days from the time the pumps were started. No. 1 dam required four weeks and No. 4 required 6 weeks.

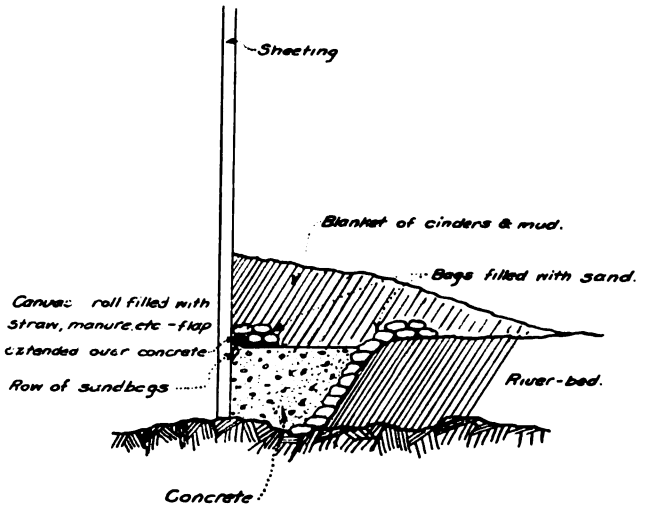
Immediately after the dams had been dewatered, forms were placed 2 feet inside the lower wales, the rock thoroughly cleaned off and an inner concrete sealing ring placed. This ring extends from the rock to the under side of the lower wale and canvas was placed wherever possible against the steel sheeting to prevent the concrete from bonding with the steel and making the pulling of of the sheeting difficult.

Wherever lateral leaks existed, the water was carried through the inner seal by wood boxes or conduits, the concrete being poured around them, and when the concrete had set the conduits were plugged.

When the inner seal was completed the sealing forms were removed and the entire bottom of the dam was thoroughly cleared of mud and loose or disintegrated rock, and the surface scoured. The foundation was then ready for the base course of the pier which was poured up to the lower waling timbers. Above this point forms were set up and the pier was poured in the form of blocks 12 feet high between the timbers. When these blocks had set, the pressures on the lower section of the dams were taken by strutting against them and the lower inner timbers were removed. The space between the blocks was then filled with concrete and this process was continued to the top of the dam.

It has been found that the steel sheeting in these dams pulls remarkably well and is in excellent shape after using. Dam No. 4 was pulled and the steel redriven around Dam No. 3 without the loss of a single sheet and the frame re-erected for Dam No. 2, there being but few broken timbers requiring renewal.

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Method of sealing cofferdam
Width of concrete, about 3 feet. Height is great enough to care for inequalities in height of bottom of sheeting.

These cofferdams have, to date, shown absolutely no indication of failure in any respect, although very roughly handled. This work, like all cofferdam work, required an infinite amount of patience.

At the time of writing pier No. 1 is completed above the water and the cofferdam sheeting is about half pulled; cofferdam frame No. 2 is in the river, but not yet placed; cofferdam No. 3 is dewatered and part of the inner seal is in place, and pier No. 4 is completed nearly to the deck and the cofferdam all removed.

This work is being done by day labor and Government owned plant.

[No special difficulties appear to have been encountered in this work, but it is a good example of standard practice in bridge-pier construction. No pains were spared to secure tight coffers and the results evidently justified the effort.—ED.]

New Infantry Howitzer for Army

The Infantry-Cavalry Equipment Board has, after careful study, determined the requirements for an Infantry accompanying gun. The requirements have been approved by the Chief of Staff and have been sent to the Chief of Ordnance for development. In order to avoid confusion the gun will be known hereafter as the Infantry howitzer and it will take the place of the 3-inch Stokes mortar and the 37-mm. gun, being arranged for both high angle and direct fire. It is believed the caliber will be about 2.75 inches and the range approximately 3,500 meters.—*A. & N. Journal.*

Light Mortars as a Cavalry Weapon

Stokes mortars and a moderate amount of ammunition (12 shells per load) may be carried on pack animals. Accordingly these weapons will be exceedingly useful for the exploits of mobile forces of cavalry, which are by no means obsolete for all time because they found little application in the World War.

An enemy intrenched can hold off cavalry armed only with rifle and machine gun. Perhaps they cannot even be reached by direct fire of artillery. But the Stokes mortar can seek them out.

The following equipment to accompany a squadron is proposed by an officer of the Indian army:

1 pack animal, gun and mounting.
2 pack animals, 24 rounds of ammunition.
3 pack animals, 36 rounds of ammunition.

Wireless Telephone in War

Prior to the European War no application of wireless telephony to military operations had been made. The most urgent demand for it is in aeroplane communication. Its disadvantages for this purpose are the weight and complexity of the apparatus and the lack of secrecy, but these are more than compensated by the speed of communication and the fact that the aviator need not be familiar with the difficult telegraph code.

The aeroplane wireless telephony set was developed by the Western Electric Co. under direction of the Signal Corps. The development proceeded rapidly. Several experimental sets were issued, great improvements effected and success was regarded as assured, but at the time of the armistice quantity production was not yet in process. Training of aviators for "voice command," using the experimental sets, was in progress, and excellent results had been obtained.

An interesting history of this development is given by Col. N. H. Slaughton (formerly Signal Corps) in *Journal of the Franklin Inst.*, Jan. 1920.

Gas Masks in Mining and Manufacture

The gas mask, a product of the World War, seems destined to a great field of usefulness in commercial life. In mining and mine rescue work a light, properly designed gas mask can take the place of the cumbersome oxygen helmet. In many industries it may be used to protect workers from noxious gases and fumes, thereby greatly increasing their output. Recognizing these possibilities of usefulness, the U. S. Bureau of Mines has established a gas mask department at its Pittsburgh Experiment Station, where masks will be developed for industrial purposes.

Placing Bridge Girders without False-Work

Mr. S. W. Connor, in the *Canadian Engr.*, (Jan. 8) describes an interesting method of placing bridge girders across a deep ravine, without falsework. The girders were of the latticed type, 108-foot span. The entire span of two girders with lateral members, was assembled and riveted on the bank. A pair of triangular trusses, 60 feet long with cross bracing, called a "pilot," was then bolted to the forward ends of the girders proper. The first pair of girders, with pilot attached was then rolled out from the first pier, the pilot reaching the second pier before the center of gravity of the whole had passed the first. Subsequent girders were then rolled along the tops of those already set, and jacked down into place. The reinforced concrete was then placed. The method was apparently entirely successful.

Concrete Blocks for Road Cost

A British engineer states that sheet concrete roads are unsatisfactory because of the length of time required for the concrete to set, and the difficulty of repair. He recommended the use of concrete in the form of blocks (analogous to clay bricks) as the remedy for these difficulties.

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Engineer Construction in France

Continued from Page 8

By Lt. Col. J. A. Woodruff, C. E.; Discussion and Comment by Maj. Gen. W. C. Langfitt, Maj. Gen. M. M. Patrick, Brig. Gen. Edgar Jadwin, Col. J. B. Cavanaugh, Col. Ernest Graves, and an Extract from the Final Report of General Pershing.

in the intermediate section, each with 4,000-bed convalescent camps, including road, water, sewerage and lighting facilities, and other features necessary that the projects might function as full grown municipalities. Each of the twenty 1,000-bed units was entirely self-contained and provided for the functioning of a completely equipped hospital, in addition to the buildings for administration and quarters for the operating personnel. In each unit were 20 ward buildings, in addition to kitchens, dining rooms, store rooms, operating buildings, laboratory, morgue, baths and personnel quarters; a total of 58 buildings per unit.

Work on the Mars hospital project was commenced February 23, 1918, and was 60 per cent complete when stopped by the armistice on November 11th. At that time 700 buildings, covering a floor space of 33 acres, had been completed and 14,000 wounded and sick American officers and soldiers were housed in comparative comfort, and provided all the facilities of a great modern hospital. In the specially designed operating rooms the most delicate operations of modern surgery could be undertaken with as much confidence as in the best appointed hospitals in the United States. The provision of these facilities necessitated the construction of a water-supply system, involving a 10-inch pipe-line 5 miles long and a 100,000-gallon reinforced-concrete reservoir; 6 miles of standard-gauge railroad; thousands of feet of concrete sewer pipe, and a 15,000-volt transmission line 11 miles long; maximum labor employed, 4,152 men.

In its scope and general layout, the hospital project at Mesves was practically a duplication of the 20,000-bed base center at Mars. Access to the site was provided by the construction of 3 miles of standard-gauge railroad, and on April 23, 1918, the first train-load of material was unloaded. At the time the armistice was signed, more than 4,000 car-loads of construction material had been delivered and quarters had been provided for over 20,000 patients. An idea of the magnitude of some of the work involved may be obtained by considering the fact that the water-supply system necessitated the laying of 28 miles of pipe, about the same amount also being required in the sewer system. In November, when operations were curtailed, a total of 45 acres of concrete floors for barracks had been laid and no less than 23,000 windows, containing 270,000 panes of glass, in place. The maximum amount of labor was 5,184 men.

The story of the Mesves project is one of continuous struggle against a shortage of material, labor and transportation. In July, many of the United States troops and many of the motor trucks were withdrawn from the work. At this time, materials were arriving in trains, requiring the unloading of 115 cars daily, and wounded were arriving in considerable numbers. The maximum number of patients at Mesves, on November 11, was approximately 18,700.

Ports

At first the main ports for debarkation for American supplies were St. Nazaire, Bordeaux, and La Pallice, using existing berths allotted to the A. E. F. by the French government. Brest was also used, but chiefly for the debarkation of troops. These ports at a later period were supplemented by Marseilles and certain small ports. Supplies coming through England were discharged at Le Havre. French ports of shallow draft, such as Tonnay-Charente and Les Sables d'Olonne, were used for coal. At all French ports it was necessary to alter the railway facilities to American standard, which is explained later under the heading of railroads.

Additional berths needed were constructed by the D. C. & F. Up to November 16, 1918, 67 ship berths had been obtained from the French government, 12 had been constructed, and work had been projected and material and equipment obtained for the construction of a total of 40. The port program as finally adopted contemplated the use of 160 berths by June, 1919, 40 of which were to have been built, the balance secured from the French. At all times there was a sufficient number of berths in advance of the necessity of unloading of materials and troops. For September and October, 1918, the total number of month-berths actually used was 63, and the total number available 77. As against this there was an average of 7 vessels waiting berths in the harbors.

During the early days of the A. E. F. the port program was the subject of much discussion. As a result of this discussion, the only construction authorized during 1917 was the 10-berth dock at American Bassens, with a preponderance of opinion in favor of undertaking the construction of a dock at Montoir. A consolidation of this opinion began to take form in December, 1917, by the appointment of a board of engineers known as the "Bassens Board," primarily to make recommendations on the structural difficulties of the Bassens dock, but resulting in a general discussion of the port program.

Further progress was made in January, 1918, when the Montoir board was appointed to report on the practicability of construction of a dock at Montoir. The action of this board was not only to recommend the construction of a dock at Montoir, but also to recommend further development at Brest and the possibility of using the port of Marseilles, provided the navy could furnish the necessary protection.

In March, 1918, the Chief of Utilities appointed a

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board to report on all possibilities of port development. This board again recommended the construction of a dock at Montoir, also docks at Talmont and at Brest, and lighterage docks at St. Loubes and Donges, with necessary lighters to serve them.

Construction having been started on Montoir, there remained many details yet undecided. In July, 1918, the C. G., S. O. S., appointed Brig. Gen. Edgar Jadwin and Col. W. J. Wilgus as a board to make a definite detailed report and program to be undertaken immediately and carried through to completion by June, 1919. The report of this board not only made recommendations, but also estimates of material and labor needed and transportation by rail required for each project, and was the final and consolidated program for all port development in the A. E. F.

Construction was started on a 10 berth dock at American Bassens in October, 1917, and it was ready for berthing ships by the following March. This dock was 4,100 feet long and 82 feet wide. As originally constructed, it was built of piles and timber mainly obtained from the United States. It had ample switching facilities, including classification and departure yards, and was connected by rail with the 10 berths used by the American Army at French Bassens, the 20 berths being connected by a third track constructed parallel with the P. O. railroad in order that a shuttle service could be operated to the St. Sulpice storage project. In August it was decided to reinforce the dock for installation of American gantry cranes, and 3,200 additional 80-foot piling were driven. This dock, as finally constructed, contained 11,000 piles and timber amounting to 4,500,000 feet b. m. It was equipped with 40 American gantry cranes.



Ward Barracks, Base Hospital—106, Beau Desert

The port program at Brest included the construction of two berths on the Jetée de l'Est and four berths on the Jetée du Sud. The two berths on the Jetée de l'Est were the only ones completed. This dock included warehouses and direct track connection with the Etat railroad. Actual construction was started in July, 1918, and the dock was in use the following September.

Because of the necessity of obtaining accurate soundings and other data, construction on the Montoir dock was not started until July, 1918. The original plan called for double-track trestle approach, 4,000 feet in length, and a dock 3,230 feet long. At the time of the armistice the double-track approach had been completed and 40 per cent of the dock proper. Because of the armistice, it was decided to construct only three berths, and those were completed and in use January, 1919. The outstanding feature of the construction of this dock was that all timbers and most of the piles were obtained in France. Piles 80 to 100 feet in length were found and cut in the Vosges, hauled to the nearest railroad point, and shipped by rail to Montoir.

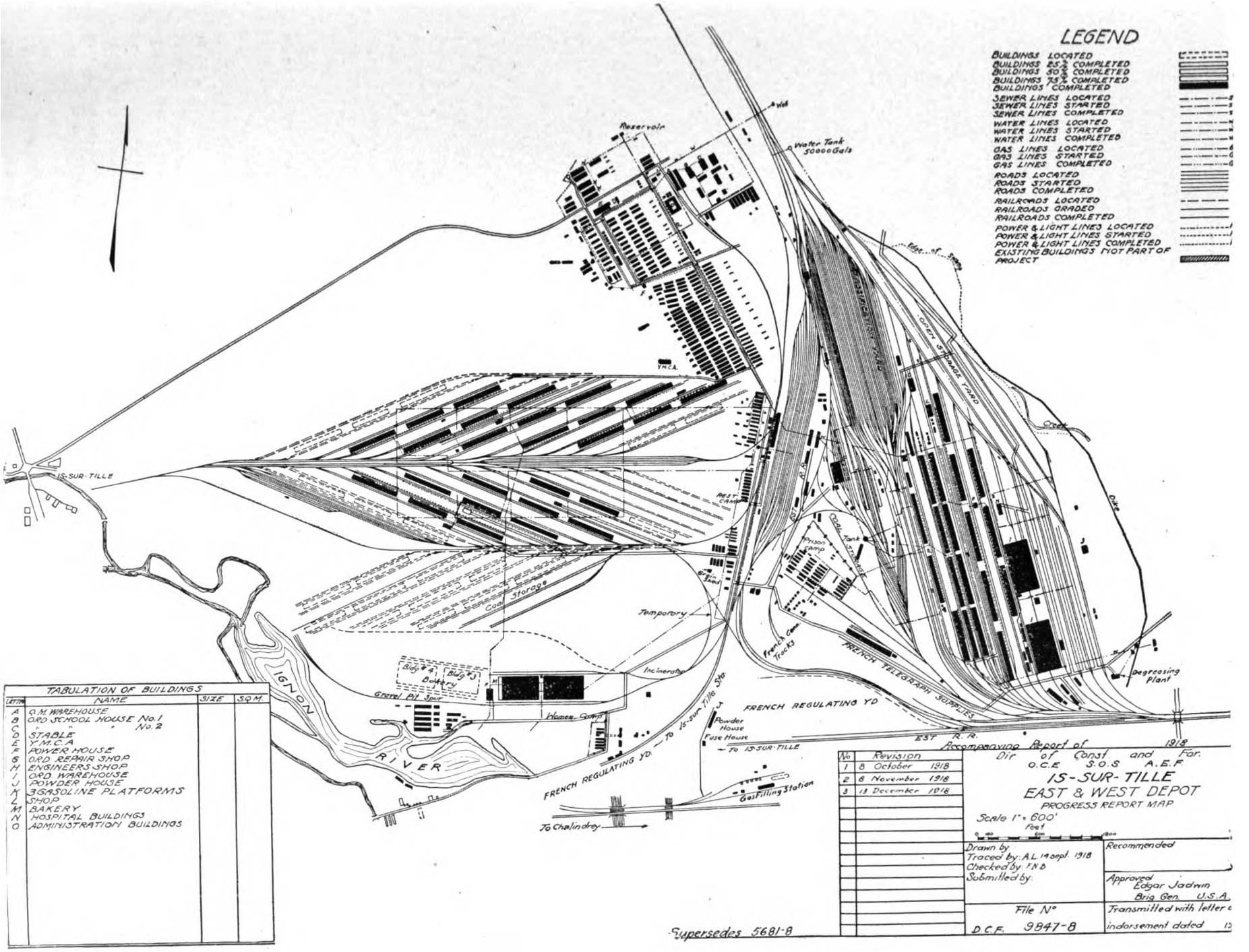
Preliminary work for the 10-berth dock and storage depot at Talmont was well advanced, equipment and material assembled, and railroad built into the dock site when all work was stopped by the signing of the armistice. This dock would have been completed by June 1, 1919. A labor force of 2,500 men was engaged on this work during October, 1918.

Of the lighterage docks recommended and authorized by the dock program, only one, St. Loubes, on the Dordogne River near Bordeaux, for 8 berths, was completed and in operation at the time of the armistice.

Other docks of similar design were under construction at St. Pardon, on the same river, and at Donges, near Montoir, and material had been delivered and other dock construction was ready to start on the Jetée du Sud at Brest and at two points on the Seine River near Rouen. Fifty-eight 300-ton lighters were constructed from French timber and twenty-six 500-ton lighters from American timber, besides seven derrick barges of from 30 to 100 ton lifting capacity and others in course of construction. A part of this work and a part of the construction of Bassens dock was done under contract by the Phœnix Construction Company and James Stewart & Co.

In addition to the above construction, detailed plans had been provided, equipment assembled and construction started for adapting many French

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TABULATION OF BUILDINGS			
LETTER	NAME	SIZE	SQ.M.
A	Q.M. WAREHOUSE		
B	ORD. SCHOOL HOUSE No. 1		
C	" " No. 2		
D	STABLE		
E	Y.M.C.A.		
F	POWER HOUSE		
G	ORD. REPAIR SHOP		
H	ENGINEERS SHOP		
I	ORD. WAREHOUSE		
J	POWDER HOUSE		
K	3 GASOLINE PLATFORMS		
L	SHED		
M	BAKERY		
N	HOSPITAL BUILDINGS		
O	ADMINISTRATION BUILDINGS		

No.	Revision
1	8 October 1918
2	6 November 1918
3	13 December 1918

Accompanying Report of Dir of Const and Tr. O.C.E. S.O.S. A.E.F.

IS-SUR-TILLE
EAST & WEST DEPOT
PROGRESS REPORT MAP

Scale 1" = 600' Feet

Drawn by
Traced by: A.L. 14 sept. 1918
Checked by: F.N.D.
Submitted by:

File N° D.C.F. 9847-8

Recommended

Approved Edgar Jadwin Brig. Gen. U.S.A.

Transmitted with letter d
indorsement dated 12

Supersedes 5681-8

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berths to American standards, notably at Marseilles, Toulon, Cette, Brest, and Le Havre, in accordance with the program mapped out in the Jadwin-Wilgus report dated August 19, 1918. The 17th Engineers handled most of the work near St. Nazaire, and the 18th Engineers that near Bordeaux.

Railroads

The main lines of communication for the A. E. F. utilized existing French double-track railroads, extending from the ports of Brest, St. Nazaire, La Pallice and Bordeaux eastward and converging in the center of France within the quadrangle formed by the cities of Tours, Chateauroux, Bourges, and Orleans, thence radiating easterly to Is-sur-Tille, Chaumont, Neufchateau and St. Dizier, which points were in close proximity to the rear of the American armies. These railroads were the Paris-Orleans Railway, the Paris, Lyons and Marseilles Railway, the Etat and the Est railways. These railways comprised both the first and second lines of communication, and were the lines of railway along which the main American facilities were constructed and upon which American trains with American train crews were operated. The P. L. M. Ry., from Marseilles and Toulon was also used, but with the exception of a few track changes at the ports included no American facilities and was operated by the French.

Starting at the ports and extending the entire length of the lines of communication, all construction work was done in a very densely populated foreign country, with all the consequent difficulties to be met and overcome.

The track layouts at the dock and port facilities were entirely the French standard, where tracks were parallel and all connection was by means of turntables operated by hand, making a very slow and cumbersome operation. In order to get the maximum capacity and use of American railway equipment it was necessary to change from the French standard to the American standard of switching. This change entailed a complete rearrangement of tracks with all the coincident troubles of street crossing, removal of buildings, overhead crossing, and the construction work carried on under traffic. At St. Nazaire, the first port used by the A. E. F., these changes entailed a rearranging and construction to the American standard of switching of a total of 23 miles of track, and at other French ports and docks in like proportion.

There was urgent necessity for getting the supplies away from the ship's side as fast as possible, and in order to do this it was necessary to build direct track connection under American control between the docks and the storage and classification yards. At St. Nazaire, a double-track connection was built, approximately 4 miles in length, involving considerable grading and one double-track bridge across the Etang de Mean. At Bordeaux a third track was built parallel to the P. O. road, a distance of 8 miles, to the storage yard at St. Sulpice.

In order to properly classify and store supplies pending shipment it was necessary to build extensive yards and storehouses as near to the ports as there was available ground. These were built at Montoir for St. Nazaire, at St. Luce for Nantes, at St. Sulpice for Bordeaux, and similar construction was started at Aigrefeuille for La Pallice, and Miramas for Marseilles.

The storage depot at Montoir was originally designed for a total trackage of 240 miles. The construction work proceeded as the facilities were needed, and at the time of the armistice 128 miles of track had been built and were in operation. These facilities included complete operating facilities, comprising 25 miles of track in receiving and departure yards, 5 miles in classification yards, 5 miles in engine terminal, 6 miles in ordnance storage yard, and the balance of track to serve general storage warehouses and the many connections necessary to serve minor facilities. Construction of the project at Montoir started on September 30, 1917, and was completed December 31, 1918. The maximum number of men engaged in the construction work was 3,083. The project at St. Sulpice was practically identical with that at Montoir.

The two large intermediate storage projects were located at Gièvres, and Montierchaume, near the city of Chateauroux. These projects were intended to accommodate the reserve supplies for the operation of the American Army.

At the storage project at Gièvres, supplies were received from all ports and held in storage until needed in the advance depots or elsewhere. This project as originally designed contemplated a total trackage of 280 miles, and at the time of the armistice there was laid and in operation 143 miles of track, which comprised the 36 miles in the receiving and departure yard, 9 miles in the classification yards, 7 miles in engine terminal, 13 miles in engineer depot for open storage, and the balance, 69 miles, to serve the 165 warehouses, refrigerating plant and other lesser facilities; Gièvres was the largest of the storage facilities. It covered an area 6 miles in length and 2 in depth. There were 30,000 men stationed in camps within the project, 20,000 for construction and 10,000 for operation purposes. Construction work was started at Gièvres by the 15th Engineers (Railway) in September, 1917, and the depot started functioning in November of the same year. The maximum number of men employed on construction was 5,877.

The intermediate storage yards at Montierchaume were designed on approximately the same plan and size as Gièvres. Construction work was started on

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a small scale in April, 1918, and was accelerated in June, and at the time of the armistice a total amount of 50 miles of track had been laid, including receiving, classification and departure yards, engine terminal and storage tracks.

Ammunition storage depots were constructed at Jonchery, Mehun, Issoudun and St. Loubes.

Advance storage and regulating stations were built at Is-sur-Tille and Liffol-le-Grand, and the French regulating station at St. Dizier was used. At Is-sur-Tille, 10 miles north of Dijon, the largest advance storage and regulating station was built, comprising a total of 95 miles of track. This was divided into receiving, classification and departure yards, storage and miscellaneous tracks, and included engine terminal facilities. Construction on this project commenced October, 1917, by the 16th Engineers, and the station began functioning in December of the same year, and was practically completed in June, 1918. The construction of this yard involved heavy grading, a large part of which was in solid rock. The maximum number of men engaged on this work during the course of construction was 3,984.

Liffol-le-Grand, near Neufchateau, was in reality a regulating station, with comparatively small amount of storage. It consisted of 26 miles of track in receiving, departure and classification yards, 7 miles of track in engine terminal facilities, 12 miles for storage purposes. Construction was started in April, 1918, but for military reasons the work was not rushed until the following July. The maximum number of men engaged on work was 2,576. The work was practically complete, and the yard functioning in October, 1918.

It was found that the engine terminal facilities along the French railways would not be of sufficient capacity to handle the heavy traffic necessary to adequately supply the A. E. F., and as these engine terminals were in congested centers, it was decided to build new ones solely for American operations. Under this program engine terminals were built at Montoir, Saumur, Gièvres, Cercy-la-Tour, Is-sur-Tille, Liffol-le-Grand, and along the line out of Bordeaux, at Nexon, Perigueux, and Montierchaume. All these engine terminals were constructed and in operation. Studies were made and in some cases construction was started on other engine terminals in order to further increase the American traffic, but these were suspended by the armistice.

The engine terminals were practically of the same design, including receiving and departure yards, engine house and repair shop and other necessary facilities. The trackage involved varied from 8 to 14 miles. The water supply along the French railroads used by the A. E. F. was improved and augmented in numerous places.

In addition to the railroad work as set forth above, it was necessary to construct sidings and spur lines at the various hospitals, aviation centers, camps, ordnance storage projects, oil and gasoline stations, and to the many forestry operations. A total of 1,055 miles of railroad was constructed. If this were laid in a continuous line it would reach from the Atlantic Ocean at St. Nazaire across France and Germany and to the Russian frontier.

Comprehensive plans were prepared by the transportation service for all track facilities, but the shortage of materials and labor and the rapid increase of the program of troop arrivals called for wise discrimination as to what was needed and what was not, in order to meet the actual situation. It was necessary to make decisions almost from day to day as to what tracks should be put down on the various projects extending from the ports to the front, in order to provide facilities urgently and immediately needed, as there were neither labor nor materials to construct all facilities shown on plans. The comprehensive plans contemplated four tracks along each line of storehouses and open storage space, two on each side of the storehouse. It was found in practice that at the intermediate depots all the traffic could be handled on one track on one side of each line of storehouses without unreasonable delay in loading and unloading of cars. Later, the same type of arrangement was also being used at the large base depots.

Experience and observation of the tracks which were used most and those that were not largely used led to the conclusion that on this class of work, under war conditions, to avoid loss of man-power and material without adequate return, considering the rapidly changing conditions, it was advisable to put in little more than the number of tracks that were needed to start operations, leaving space to add others as their necessity develops.

Storage Depots

The covered storage as estimated by the various services was originally 21 square feet per man in the A. E. F., but it was found by experience that for a 90-day reserve, 10 square feet per man was sufficient for supplies actually requiring cover, inclusive of ammunition. This was later reduced to 5 square feet when a reserve of 45 days was decided upon. These requirements were met as follows:

	Square feet	
Gièvres	3,850,000	
St. Sulpice	2,652,000	
Montoir	3,456,000	
Montierchaume	1,222,000	
Is-sur-Tille	1,380,000	
Other depots	3,608,000	
		Square feet
Total depot storage		16,168,000
Dock storage		3,213,000
Miscellaneous storage		3,858,000
Grand total		23,239,000

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Original warehouses were constructed of lumber with ruberoid roofing. Owing to the difficulty in obtaining lumber, a type was developed with wood frame and corrugated-iron roofing and sides, using round poles for posts. The warehouse was 50 by 490 feet, and 12 feet high at the eaves and required only 20,800 feet board-measure of lumber and 44,000 square feet of corrugated iron, and could be easily and quickly erected. At Gièvres, on one occasion, a warehouse of 50 by 294 feet was erected by 60 men in 8½ hours, only the roof and ends being covered—with corrugated iron.

It was found necessary to omit floors except in buildings where supplies subject to injury by moisture, such as sugar, salt, and flour, were stored. In these cases a floor was built, or the supplies were placed on loose dunnage.

Considerable attention was also given to the question of placing in open storage supplies that would not be damaged in the length of time that they would have to remain in the open. Experience has demonstrated that the following main classes of supplies can be placed in the open with paulin covers without material damage: hay, canned goods, small arms ammunition and projectiles.

The principal motor transport project was the main base plant and repair shop at Verneuil, near Nevers. It was designed to serve as the base repair center for the motor transport corps. The total number of vehicles repaired in this plant up to March 1, 1919, amounted to: light and heavy trucks, 4,592; automobiles, 1,700; ambulances, 324; motorcycles, 3,230, and bicycles, 1,724. Repair parts, amounting to 485,724, have been manufactured from raw material, and 6,635 broken and salvaged motor vehicle parts have been returned to service. In addition, repair and salvage work was done on horse-drawn vehicles and other miscellaneous equipment and material.

The project consisted of the main base plant, which included 14,400 square feet of office space, 120,000 square feet of stock storage, and 361,000 square feet of shops; the camp for personnel, amounting to a total floor space of 302,430 square feet; and the prisoner-of-war enclosures.

The principal air service project was the air service production center, No. 2, at Romorantin, near Gièvres. This project was designed to be the main assembly and salvage depot for the air service in France and was to receive and assemble all airplanes from the United States, to salvage a large part of the planes from the front, to repair and rebuild planes, to repair and maintain all motor transportation for the air service, and to serve as a depot for air service supplies. Later, a complete balloon depot and repair station and 1,000-bed base hospital were added. The location was chosen principally because it was accessible to the converging main lines of communication from the ports, and at the same time within easy flying distance of the distributing points near the front, while still near the extreme bombing radius for enemy planes.

The supply depot and airplane spare parts depot handled all air service supplies and all airplane and engine parts. An average of 30 cars per day were used in handling these supplies.

The original project was authorized December 27, 1917. A small detachment of Engineers started work on the railroad on January 21, 1918. The first air service personnel arrived January 19, and began erecting barracks January 21. The maximum number of men employed at one time was 2,684. When construction was stopped on November 15, 1918, 85 per cent of the entire authorized work had been completed. The construction consisted of 1,297,200 square feet of shops, 765,200 square feet of storehouses and hangars, 616,000 square feet of barracks, and 126,000 square feet of hospital space.

The plant as completed was capable of assembling about 30 planes per day and would have soon been able to handle double that number. The number of planes assembled was 1,177; liberty and foreign engines repaired, 1,670; salvaged, 212; planes repaired (all types), 776; planes of all types salvaged, 308.

Remount Depots and Veterinary Hospitals

In addition to the work of providing shelter for troops there was the problem of providing necessary shelters for animals required for the A. E. F.

This construction was initiated in August, 1917, when a request was made for the immediate erection of temporary shelters for the mounts of a cavalry regiment expected to arrive at an early date. As a result of this request arrangements were made with the French government to supply 500 demountable wooden stables, each with a capacity of 50 horses, and to use many small existing remount stations to which additional capacity was added when possible.

During May, 1918, a program of remount and veterinary hospital construction was instituted. A board selected sites in the base, intermediate and advance sections and visited the British area to study construction of buildings and accompanying facilities which had been developed during the four years of the war.

Remount depots with veterinary hospitals in close proximity were established at the principal base ports to care for animals arriving from the states or other overseas sources, until they could be forwarded to the intermediate or advance depots. Large depots with veterinary hospitals adjoining were established at Gièvres, Selles-sur-Cher, and Sougy, in the intermediate section. In the advance section a large depot and veterinary hospital was built at Lux, near Is-sur-Tille, and many smaller remount depots

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and hospitals between that point and the front lines.

The total facilities authorized by the staff comprise remount depots for 61,200 animals and veterinary hospitals for 39,100 animals. Of these, there was actually available on February 1, 1919, the following space for animals:

In remount depots constructed by the engineers.	27,700	
In remount depots obtained from the French...	12,000	
		39,700
In veterinary hospitals constructed by engineers.	16,500	
In veterinary hospitals obtained from the French	11,100	
		27,600
Total space in remount depots and veterinary hospitals		67,300

These facilities involved the construction of 2,210,000 square feet of stabling, provision for quarters for 650 officers and 17,000 enlisted men, and the various facilities required for the functioning of these projects.

At each separate remount depot and veterinary hospital there were required dressing rooms, operating rooms, dipping vats, sulphurizing chambers, forges, and blacksmiths' shops, and storehouses for equipment and forage.

Each large project required a standard-gauge railroad siding and spur with facilities for rapidly unloading animals, an ample water supply and good roads and drainage.

The type of horse shelter adopted for remount depots and veterinary hospitals after a study of the best French and British practice was a stable, 216 by 23 feet, with a space for 100 animals. Supports were of 6-inch round poles with a framework of 2 by 4's and covered with corrugated iron if available, otherwise with 1-inch sheeting and tar paper.

For shelter alone each animal required from 80 to 140 feet board-measure of lumber, depending whether or not corrugated iron was used for covering. The stables actually constructed consumed over five million feet board-measure of lumber.

In general, remount depots were built for 2,000 to 5,000 animals with a veterinary hospital near at hand for from 1,000 to 2,000 animals. The project at Sougy has a capacity for 5,000 animals in the remount depot and 2,000 in the veterinary hospital. It has quarters for 100 officers, 2,500 enlisted men, with necessary mess halls, bath houses, and includes a recreation building.

Water Supply and Sewerage.

In connection with the classes of work described above, much water supply and sewerage work was required. A large amount of labor was required in the listing of supplies to be purchased in American and European markets and in the preparation of priority schedules to permit this material to be ordered and shipped so as to be available in time for use.

A system of water analysis laboratories was established and the water supply in the S. O. S. placed under the same kind of care from bacteriological and sanitary point of view as is customary in the cities and states of the United States. Arrangements were made for the chlorination of various water supplies in the S. O. S. and the storage and forwarding of chlorinating apparatus for the armies. Arrangements were entered into with the cities of Tours, Vendome, St. Nazaire, Le Mans and Dijon for the chlorination of the whole city supply.

The water supply for the city of St. Nazaire and vicinity constituted the biggest single problem of the D. C. & F. The ordinary French uses amounted to about 1,000,000 gallons per day and was obtained from reservoirs of a capacity of 160,000,000 gallons which were filled during the rainy season. During unusually dry seasons it was necessary to resort to tank boats in order to furnish the city. The combined French and American uses were estimated at about 3,000,000 gallons per day and, as the country does not yield deep well water, it being underlaid with solid granite rock, and as the nearest surface free from salinity was at a distance of about 15 miles, it was decided to be more feasible to provide additional storage reservoirs of a capacity of 400 million gallons. It was necessary to construct one rapid sand filter of 3,000,000 gallons daily capacity and another of 1,000,000 gallons daily capacity in order to provide satisfactory water. To fill the reservoirs in the rainy season and to elevate the water to the various levels of the project, 15 pumps with a total capacity of 30 million gallons per day had to be installed; 48,000 feet of 24-inch to 12-inch pipe, 60,000 feet of 8-inch to 4-inch pipe, and elevated tanks of 200,000 gallons capacity were used in the supply and main distribution systems alone, not to mention miles of smaller pipe used for distribution as well as for interior plumbing and piping.

The water supply of the docks and camps at Brest and vicinity offered another large problem. The original French systems which supplied Port de Commerce, Foutras Barracks, Bougen Fortress and Pontanezen Barracks, were insufficient and it was necessary to immediately make provision for an additional 900,000 gallons per day. A pumping station on the Penfield River was installed with a daily capacity of 1,300,000 gallons and 28,000 feet of pipeline laid. In order to supply all portions of the projects and to provide adequate pressure, pumps of a total capacity of 2,000,000 gallons per day and elevated tanks of a total capacity of 100,000 gallons, were installed. Due to the increase in the size of the Pontanezen camp and constantly increasing needs at other ports of the project, this original augmentation of the French supply, almost before completed, became inadequate and further provision had to be made. It was estimated that 3,000,000 gallons per

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day would be necessary and with this to do away to a large extent with the use of the French system, particularly at Port de Commerce. The Penfield River was selected as the source. Two reservoirs, one of 23,000,000 gallons capacity and another of 2,000,000 gallons capacity, were built. Two pumping stations containing 6 pumps and with a total capacity of 4,700,000 gallons daily were constructed. Forty-one thousand feet of 14-inch to 10-inch pipe and 10,000 feet of 6-inch and 4-inch pipe were used on the main supply and distribution system.

While Brest and St. Nazaire presented the largest problems of water supply, practically all the other large projects constructed required water supply installations of considerable magnitude, a few of which may be mentioned as of interest. For the Saveney Hospital water supply, a concrete arch dam 40 feet high and containing over 6,000 cubic yards of concrete to provide a reservoir storage capacity of 10 million gallons was constructed, in addition to 2 filter plants, each of 330,000 gallons daily capacity. Some 25,000 feet of sewer lines and 50,000 feet of water mains were laid and a concrete standpipe of 50,000 gallons capacity was installed. For the Mars Hospital supply a 10-inch force main, 5 miles long, was laid. A reinforced concrete reservoir of 100,000 gallons, on towers 30 feet high, was constructed. Two pumping stations, each of 500,000 gallons daily capacity, were installed, and a filter plant of 500,000 gallons per day was erected. For the Mesves Hospital an installation practically duplicating that of Mars was made. At both Allerey and Beaune hospitals, some 57,000 feet of sewer pipe and 40,000 feet of water mains were laid. At Romorantin air service plant two filters, each of about 200,000 gallons daily capacity, were placed. A slow sand-filter was installed at both Langres and Chateauroux hospitals. The installations at the Montierchaume storage depot involved the laying of some 30,000 feet of 4-inch, 6-inch, and 8-inch pipe, the installation of pumping stations of a capacity of 100 horsepower, the drilling of wells of a total depth of 1,700 feet, and the construction of elevated tanks of a total capacity of 150,000 gallons. The general intermediate storage depot at Gièvres called for even a larger installation than that at Montierchaume. At Bassens, 1,500,000 gallons of water per day was obtained by drilling two artesian wells to a depth of 700 feet. A well of 1,520-foot depth was drilled at Beau Desert Hospital, and one of 1,020-foot depth at St. Sulpice.

Refrigeration

In addition to such cold storage space as could be obtained from the French, plants were constructed by the D. C. & F., upon plans prepared by experts engaged by the Q. M. C., for the storage of frozen meats from the United States, with a total refrigerated space for the storage of 14,900 tons, and ice-making facilities for 500 tons per day.

The plants at Gièvres and Bassens are the largest of those constructed, having an ultimate capacity for 7,500 and 6,000 tons frozen beef, respectively. These figures are based upon full utilization of refrigerated space with consequent elimination of alleyways. The original rated capacities of these plants, making liberal allowance for alleyways, were 5,200 and 4,000 tons, respectively. Plans were prepared and equipment obtained from the United States for a duplicate of the Bassens plant to be located in the advance section, as well as for a duplication of the cold storage building at the Gièvres plant; also plans for a 400-ton plant at Marseilles, these three projects being canceled after the armistice. A beef storage plant of 700 tons capacity was authorized at Bendorf, near Coblenz, February 6, 1919. This plant is included in the above capacity figures.

The beef storage building at the Bassens plant is cork insulated throughout, using 100,000 cubic feet cork obtained from a point near Bordeaux. The floor is of reinforced concrete over corkboard on a 4-foot sand fill. The cold storage rooms contain 134,800 linear feet of 2-inch standard pipe. The engine room is modern in every respect; the refrigerating machines are driven by cross-compound condensing Corliss engines. The boiler capacity is 900 horsepower. The reinforced concrete reservoir has capacity for 130,000 gallons water. Due to the use of cork for insulation, and improved design, the amount of lumber used was reduced to 931,000 feet board-measure. This plant was constructed and in operation in 4½ months after commencement of work.

Bakeries

A mechanical bakery at Is-sur-Tille was constructed from plans furnished by the Q. M. C. with a capacity of 800,000 pounds daily. This plant is capable of emergency production of 1,000,000 pounds daily. Mechanical bakeries were constructed from plans furnished by the D. C. & F. at Brest and Bordeaux, with a capacity of 150,000 pounds daily and at St. Nazaire of 120,000 daily. Plans were completed for a mechanical bakery at Liffol-le-Grand with a capacity of 400,000 pounds daily. Plans were furnished for the construction of field bakeries totaling in capacity approximately 600,000 pounds daily. Of this amount, construction capable of producing 500,000 pounds daily was completed.

Two steel truss buildings, 240 by 380 feet, with a corrugated iron roof and sides, were erected for the mechanical bakery at Is-sur-Tille. The floors were concrete throughout. All machinery in the plant was electric-driven, power being furnished from a modern steam turbo-generating plant of 900 K.W.

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capacity, the power-house being a separate building, 55 by 125 feet. Ovens were built on standard British practice in groups of seven, so arranged as to lessen chance of plant being totally disabled.

Electrical Installation

Steam generating stations involving approximately 3,000 K.W. of power were designated and in process of construction when the armistice was signed. The larger of these were a 200-K.W. plant for the bakery and storage project at Is-sur-Tille; a 1,000-K.W. standby plant for the Bassens project; a 750-K. W. plant for the air service production center at Romorantin.

Three thousand K.W., in rotary convertor substations, were designed and under construction. These were at Neuvy Pailloux to serve the tank factory; at Marseilles, La Pallice and St. Nazaire, to serve the gantry cranes. A 2,500-K.W. substation was constructed at Mehun from plans furnished by the Ordnance Department to serve the ordnance shops. A 2,500-K.W. substation design by the Transportation Department was constructed at Bassens to serve the projects at that point. Of this station 1,500 K.W. was in rotary convertors and the remainder in transformers for miscellaneous light and power.

One hundred and twenty-five miles of transmission line had been constructed or was under way, the plans and specifications for which were furnished by the D. C. & F. Low-tension distribution systems and interior wiring of all hospitals, storage yards, warehouses, docks, shops, schools, and camps in the S.O.S. were installed on the basis of plans and specifications furnished by the D. C. & F.

Oil and Gasoline Storage

The D. C. & F. was charged with the construction of the oil and gasoline seacoast storage stations, intermediate storage station fabrication shops for small tanks at Gièvres, and the construction of the small gasoline distributing stations throughout France. The following seacoast gasoline storage stations have been constructed and placed in operation:

La Pallice, four 25,000-barrel tanks; St. Loubes, one 25,000-barrel tank. Two 25,000-barrel storage tanks were erected at Blaye, but this plant was never placed in operation.

Intermediate storage station, four 10,000-barrel-tanks were constructed and placed in operation at Gièvres.

At the Gièvres shop for the fabrication of small tanks there were constructed and tested 69 300-barrel tanks and 150 150-barrel tanks. Of this number 29 300-barrel tanks and 119 150-barrel tanks were shipped out to small gasoline distributing stations at various field locations. To facilitate the installation of the small gasoline distributing stations, the necessary pipe, valves, fittings, and pumps were assembled and marked for field erection and shipped out at the same time as the small tanks. The construction work on the seacoast and intermediate gasoline storage stations and the 150 and 300 barrel tanks was largely done by contract with the James Stewart Company under the supervision of engineer officers. Thirty-seven complete installations of small gasoline distributing stations were shipped out, 17 of which were placed in operation and other 20 were either canceled or construction suspended. These stations were constructed by engineer troops.

With the storage and distributing stations already erected, sufficient gasoline can be stored to provide for any emergency, and the small distributing stations not yet erected could be relocated without much expenditure of labor, and without any further demand for material.

Roads

The D. C. & F. in the year 1918 had charge of all road work in the S. O. S. except that in the advance section, which was performed under the section engineer officer for the division of light railways and roads. During this period 90 miles of new road were constructed within projects such as the larger hospital units, general storage projects, ordnance and aviation projects. The major part of the road equipment available was needed at the front, and for this reason and for the lack of labor due to priority of other work, the maintenance and repair work was limited to approximately 300 miles. The repair work was performed mainly in congested centers, such as the immediate vicinity of Bordeaux, the docks at Bassens, and the streets of St. Nazaire adjacent to the docks and leading to the camps.

The national highways and other French roads along our line of communications and serving the many camps, training centers, and other activities of the A. E. F. were under extremely heavy traffic during the summer and fall of 1918, and comparatively little repair work was undertaken because no labor was available either from French or American sources. The wet weather in the western and southern part of France and the freezing weather in the eastern and northern parts during the month of December put the roads in bad condition and the C. in C. directed that month that extensive repairs be undertaken along the entire lines of communication, not only in justice to the French in repairing their roads damaged by the American traffic but also to permit continued use of the roads by the American Army. This resulted in the issuing on January 2, 1919, of an order placing all road work in the S. O. S. and Luxemburg under the direction of the D. C. & F. and that in the occupied areas of Germany under the C. G., 3rd Army, giving the D. C. & F. a co-ordinating supervision.

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The D. C. & F. used his existing organization for this work and through the section engineer officers of the various sections, immediately started the leasing and acquiring of quarries, a system of distribution of stone by rail haul and motor transportation, distributed labor upon roads most requiring repair, put into service all available road equipment and tools, both from French and American sources. The section engineer officers were instructed to adopt the cantonier system, which was a system of constant patrol and of carefully placing well-tamped patches and resurfacing wherever the surface of the road developed weak spots. Special attention was also given to opening up all drains and ditches and the removal of accumulated mud, both from the surface of the road and ditches. The French government cooperated by issuing instructions to their departmental engineers to furnish all stone and equipment available and in a few places stone was furnished by the French, transported in American cars and trucks and placed upon the roads by combined forces of Americans and French. The results obtained from the use of this system were very satisfactory and some roads that were almost impassable in January were put in reasonably good condition. This system reduces the cost of new roads and keeps all roads in better condition by constant patrols and repair.

The maximum force engaged in road work has approximated 110,000 men who were scattered in small working parties over nearly 16,000 kilometers of road and placed about 90,000 tons of stone per week. This stone was obtained from quarries operated by the French government and French contractors; also from quarries opened up and operated by the D. C. & F., any many small local quarries where the rock was taken out and broken up by hand. The quarries operated by American labor were 90 in number; the total number operated by the French, 50. The stone was hauled by rail from the quarries to the nearest station and then distributed by motor truck. From the small quarries the distribution was made by means of motor trucks and horse-drawn wagons direct.

The following table shows the work done from January 1 to June 1, 1919, at which time the road program was practically completed in all sections.

Section	Roads worked—km.	Rock distributed—metric tons	Man-days—8-hour day	Truck-ton days—8-hour day	Road rollers
B. S. No. 1...	500	91,000	261,500	38,900	22
B. S. No. 2...	1,700	154,000	295 450	51,830	27
B. S. No. 5...	75	197,500	156,220	16,330	9
B. S. No. 7...	575	25,200	80,530	12,580	8
Int. Sec. W...	4,200	291,000	658,850	78,510	39
Int. Sec. E...	550	95,000	115,230	24,310	17
Advance	5.400	512,500	2,671,600	171,250	135
Total in France	13,000	1,367,500	4,239,380	393,710	257
Luxembourg ..	350	19,700	17,000	4,000	...
Occupied ter...	2,500	307,500	487,250	80,320	40
Total.....	15,850	1,694,700	4,743,630	478,030	297

In the advance section 650 kilometers of road were reconstructed within the battle areas devastated previous to the arrival of the American Army. There was also constructed 34,000 square yards of stone-paved street and 21,000 square yards of concrete road. In addition to restoring and maintaining the road surfaces more than 500,000 tons of crushed rock were distributed and left along the roads for future repair work by the French authorities.

Forestry

The lack of ocean transport made it necessary to obtain practically all of the lumber and other forest products required by the A. E. F. from the French and other European sources. Shipments of such bulky material from the United States was restricted to a small quantity of piling and dock timbers used chiefly in the Bassens dock. Furthermore, the shortage of forest products in France and the heavy requirements of the French and British armies made it necessary for the A. E. F. to be self-sustaining in the supply of these essential materials, which were called for in enormous and steadily increasing quantities. The current monthly requirements of the army at the time of the armistice totaled 50,000,000 feet board-measure of lumber and timbers, 250,000 railroad ties, 6,500 pieces of piling and cribbing, 1,500,000 poles and entanglement stakes, and something over 100,000 cords of fuel wood.

Limited quantities of lumber were obtained from France, Switzerland and Norway. Approximately 590,000 railroad ties used in the first installations were advanced by the French government and some additional ties were obtained under contracts placed in Spain and Portugal. Fully 75 per cent of the lumber and ties, over 90 per cent of the poles and piling, and a large part of the fuel wood required by the army were produced in France by the forestry section.

Lumber production was begun in December, 1917, by the 10th Engineers (Forestry), which operated two American and four French mills that month and cut 321,000 feet of lumber, 205 piles, 12,000 ties, 20,000 poles, and 1,200 cords of fuel wood. During the winter and spring of 1918, the Forestry troops were augmented by the ten battalions of the 20th Engineers (Forestry), and by three battalions comprising the 41st, 42d, and 43d Engineers. Nine battalions of engineer service troops were also assigned to forestry work. Thirty-four mills were operated in March, 1918, and 59 mills in June. At the time of the armistice, 90 operations, including 81 sawmills, were in progress, employing nearly 12,000 technical engineer troops and 8,500 service troops.

The earliest operations of the forestry section were undertaken (1) in the Landes pineries of base section No. 2, where there was an early demand for piling, warehouse lumber, and railroad ties; (2) in the Loire River valley near the line of communica-

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tion and the large depots and construction projects in central France, and (3) in the soft wood forests of the Vosges and Jura mountains and the hardwood areas immediately behind the American Sector of the Front. The forest resources of these regions were fully explored and new operations placed as far as possible with reference to the main points of consumption and the varied demands of the army for different classes of forest products. Construction lumber had to be obtained mainly from the soft-wood forests of the south and of the eastern mountains. These regions also furnished the bulk of the piling. The hardwood forests of central and western France were drawn upon heavily for railroad ties, road planks, dock, barge, and bridge timbers, and fuel wood. In the summer of 1918, it was necessary to push out into the southern Jura region and the central plateau of France, in order to obtain the quantities of timber needed.

The forestry operations at the time of the armistice were grouped in the 14 operating districts, each under a battalion commander and organized as far as practicable to function as a self-contained unit. In addition, 8 operating units with portable sawmills were attached to the first and second armies, working near engineer camps and supplying them with the forest products most urgently needed from time to time.

At the completion of its work June 25, 1919, the forestry section had produced approximately 206 million feet of lumber, 3 million standard-gauge ties, 1 million small ties, 39,000 piles and 1,800,000 poles and entanglement stakes, for the A. E. F. In addition to these amounts, approximately 10,000,000 feet of lumber and 440,000 standard ties were cut by two forestry battalions which were loaned to the French and British armies. All told, the forestry section up to the same date supplied 400,000 cords of fuel-wood to the army. In addition, 30 of its officers were loaned to the quartermaster corps to direct the production of large quantities of fuel-wood by quartermaster troops.

To maintain this enormous production, it was necessary to scout practically all of France south of the northern provinces for suitable timber and to negotiate its purchase through French channels. This work was extended into the Pyrenees, the French Alps, and the central plateau, in order not only to keep the forestry troops in France continuously supplied with timber, but also to obtain the large quantities needed for the operations of 24,000 additional troops approved by the War Department for forestry work in September. By the date of the armistice, 630 million feet of timber and 700,000 cords of fuel-wood had been acquired; and half as much had been located and cruised and was in process of acquisition.

On account of the delay in the arrival of American equipment, 8 stationary French saw-mills were leased or requisitioned in the fall and winter of 1917 and 12 portable French mills were acquired. This equipment aided greatly in meeting the acute shortage of lumber. The French plants were largely remodeled by the forestry troops and their production doubled or trebled. Their capacity was still so limited, however, that they were discarded as rapidly as American mills could be obtained.

Three types of American saw-mills were employed:

(1) A heavy-powered, permanent steam plant, rated to cut 20,000 feet board-measure in ten hours.

(2) A moderately powered, portable type of steam saw-mill, rated to cut 10,000 feet board-measure in ten hours.

(3) A very light, portable "bolter mill" run either by steam or by gas tractor, rated to cut 5,000 board-feet in ten hours and especially suited to light products, like railroad ties.

Twenty of the large mills were installed at points where the supply of timber permitted their operation for eight months or longer. The other mills were well adapted to the many small wood-lots in France which it was necessary to utilize. In the face of a critical shortage of lumber, every possible effort was made to speed up production. Practically all saw-mills were operated day and night shifts and some of them three 8-hour shifts. More than double the rated capacity of the plants was obtained currently in most of the forestry operations. Upwards of 150,000 feet of lumber were cut in twenty hours at several of the large mills whose rated capacity for the same period was 40,000 feet. Cuts as high as 66,000 feet of railroad ties were made in 20 hours on the little bolter mills. All of the large and many of the small mills were steamed successfully by means of "dutch" ovens for burning sawdust, designated and installed on the ground by forestry millwrights. An enormous quantity of fuel-wood was saved by this means.

Standard or motor gauge railroad installations, up to 3 miles in length, were necessary at two-thirds of the mills to give them direct rail connections and provide adequate facilities for loading cars. Light railroads of 3-foot, meter, or 60-centimeter gauge, with steam or gas locomotives or horse-drawn trams, were used for logging at many operations. A difficult area in the Vosges Mountains was logged by means of a 4,000-foot meter-gauge incline, with an average grade of 35 per cent, down which carloads of logs were lowered by donkey engine and cable. Much of the logging was done by horses with log wagons, spool carts, or high wheels. The excellent French roads were used extensively for bringing in logs by motor trucks and by tractors drawing a low-speed trailer of log-wagons. One hundred-foot piles were hauled by this means for distances up to 15 kilometers.

One of the noteworthy accomplishments of the forestry section was the cutting and logging of 15,000 piles from 65 to 100 feet in length, under great difficulties, which assured the completion of the major dock

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projects at the A. E. F. base ports. Approximately 15,000,000 feet of long heavy timbers, requiring special selection and manufacture, were also furnished for dock, barge, and bridge construction. By an active field organization, it was possible to keep the current rail and cargo deliveries of lumber, ties and piling up to 70 per cent of current production in spite of the shortage of transportation facilities in France.

While the changing program and the difficulties incident to the submarine warfare, an insufficient amount of ocean tonnage, cars, man-power and material, were all great, still the division of construction and forestry met all of its essential responsibilities and was equal to the situation in each of the various activities of the A. E. F. dependent on it for their success. This was due on the one hand to the organization, to the character of the men in the service, their splendid loyalty, enormous amount of work which they performed, and their rapid adaptability to the changing conditions, and on the other hand to the backing received from the Chief Engineer, the C. G. S. O. S., and the C. in C.

As an illustration of the work done, if all the railroads constructed were laid in a continuous straight-line track it would reach from the Atlantic Ocean at St. Nazaire, across France and Germany to the Russian frontier. Similarly, if all the building construction were consolidated into one building having the width of our standard barrack and hospitals it would reach from St. Nazaire, across France and to the Elbe River. The Forestry troops produced 75 per cent of the lumber and ties used on this construction, and in addition 375 miles of corded fuelwood, and 144 miles of piling.

An appreciation of the work of the division of construction and forestry is contained in the following letter from the Commander-in-Chief:

28 March, 1919.

Brigadier General EDGAR JADWIN,
Director, Construction and Forestry,
Through Chief Engineer, A. E. F.

My Dear General:

Now that hostilities have ceased it gives me great pleasure to thank you, and through you the officers and soldiers of your organization, for the splendid work you have accomplished.

The Division of Construction and Forestry required the services and unselfish efforts of experts in many lines of skilled endeavor. It is a source of deep pride and satisfaction that numbers of this type of men responded readily, and through their invaluable assistance you attained the highest goal of achievement.

The supply and shelter of troops was one of the most responsible tasks that befell any organization. Although operating in a foreign country, under conditions and circumstances vastly dissimilar to those accustomed to, you met successfully each and every demand.

You, and the officers and men of your organization, labored in almost every department in France, often in isolated detachments, working under arduous conditions of service and making countless sacrifices. Yet they withstood all hardships and difficulties, surmounted all obstacles and kept tenaciously at their important tasks. Such tireless energy, actuated as it was by a high sense of duty, deserves the commendation of all.

The vast projects wisely planned and boldly executed by you and your efficient personnel, the thoroughness and celerity with which you labored, the splendid co-operation maintained throughout, especially among the highly trained men of affairs who gave their best to the common cause, the keen foresight displayed in preparing for emergencies and the many sacrifices made are worthy of the highest American traditions.

In the name of the American Expeditionary Forces, I thank them one and all and send them the appreciation of their comrades and their Commander-in-Chief.

Sincerely yours,

JOHN J. PERSHING.

Discussion and Comment

Maj. Gen. W. C. Langfitt
Chief Engineer, American Expeditionary Forces

Colonel Woodruff's article describes in detail the operations of the Division of Construction and Forestry, one of the main divisions of the Office of the Chief Engineer, A. E. F. There seems but little room for comment by the Chief Engineer, except to express here publicly his very great appreciation of the loyal work of the Division of Construction and Forestry and of the great results achieved.

The organization in its final form was necessarily a growth. General McKinstry, I think, first suggested the idea of districts somewhat along the lines of our river and harbor districts, but did not remain long enough in charge to develop the scheme. General Patrick worked along the same lines and the organization was finally developed and perfected by General Jadwin. It, of course, met with my hearty approval and I know of no other suggestion which could have brought about such satisfactory results.

The types of construction and, in fact, all plans were evolved always keeping in mind two main essential governing features. First, the views of the department for whom the construction or work was being undertaken. Second, to keep ahead, so far as possible, of the demands of the various departments.

The first demanded much diplomatic interchange of ideas with the various supply departments, the Transportation Department and, in design of hospitals, with the Medical Department. The second required simplicity and standardization. Standardized buildings were therefore designed, so as: (1) to be built with a minimum of material: (2), to require minimum preparation for erection work: (3), to consume minimum time in erection, with minimum economical force.

As a result of this foresight and care, the Division of Construction and Forestry met all requirements most satisfactorily. Full recognition was had, at all times that we were building only for the duration of the war, resulting in suitability with the ut-

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most economy. Permanent work, so to speak, was never undertaken, except where, by the nature of things, temporary cheaper expedients could not be adopted.

That civilian labor was never satisfactory should be emphasized. The lack of technical troops, as indicated by Colonel Woodruff, was most seriously felt. The services of such troops will be needed before those of all others in any campaign in which it is possible to conceive that the United States may become engaged. Wisdom would therefore dictate that these troops should, in time of peace, form a larger proportion of the peace organization and provision for necessary prompt expansion be adopted. All labor in the theatre of operations should be militarized, and it may even be questioned if the same policy should not be adopted for all war workers, wherever employed. Therefore, in all legislation looking to preparedness, provision must be made for obtaining quickly such labor in amounts as circumstances demand.

A few words seem desirable in regard to the road question. In the first organization, roads formed a branch of the Transportation Department. All road work from base ports to the Zone of the Armies was under a Director of Roads, under the Director General of Transportation. Later, roads, together with light railways, were separated from the Transportation Department and combined under the writer, as the Department of Light Railways and Roads. After careful consideration, it appeared to me that, except in the Advance Section, perhaps, the roads in the S. O. S. should be under the Department of Construction and Forestry and, accordingly, the necessary instructions were issued. The only reason the roads of the Advance Section were left with the Department of Light Railways and Roads was that, at the time, it appeared that road work so far to the front and joining up with the road work of the Army Zone should be under an officer or department with headquarters nearer to the front than were those of the Department of Construction and Forestry. I therefore had headquarters of Light Railways and Roads, although one of the large subdivisions of the Office of the Chief Engineer, A. E. F., placed in the Advance Section, in order that the Light Railways, only used at the front, might be under closer supervision, and where emergencies could be more quickly met. The exact line of demarcation between road work under S. O. S. and under Armies was never finally decided; but, in general, I am of the opinion that the S. O. S. should do all road work in rear of that which Army troops must necessarily perform. The line would thus be variable and advance or retreat as exigencies of the campaign dictated.

There are several other questions of like nature which were not definitely answered, but no troubles arose therefrom, as everyone in the A. E. F. was there to do his bit, and it was rarely that questions of precedence, or exact status, were raised. A man, officer or soldier, given a piece of work to do, did it and asked questions afterward, or forgot it.

Our experience in France brought out the fact that all construction in the theatre of operations should be under one head, and that head, beyond question, should be the Engineers—fitted by education and training especially for such work. The previous training of our officers in construction, mainly in river and harbor work and fortifications, was of the utmost value to them in dealing with the large problems arising in France demanding prompt decisions and rapid results. From this previous experience the satisfactory organization of the work was promptly developed, and no time was lost in experiments. That army engineers should be trained in such work is so apparent that to state it seems almost supererogatory. Further, that all construction of the Army, in peace as well as war, should devolve on them as one of their duties seems equally apparent. The present situation, with an engineer construction branch in the quartermaster corps, is anomalous and should be corrected. Aside from the value of such work in time of peace as a training school where young engineers under older and more experienced men can be trained in construction methods, handling contracts, contractors and men, there are other controlling reasons for such assignment of army construction. These may be briefly enumerated as follows:

(*a*) The Engineer Department is already organized for carrying on work of all kinds and magnitude. A separate organization for the purpose is an evident duplication.

(*b*) An economy in overhead charges would evidently follow.

(*c*) Greater economy and efficiency in the actual prosecution of the work should certainly follow. That is what trained engineers are for and the record of the Corps of Engineers bears out their claim to efficiency.

(*d*) Elimination of competition between various branches of the army in purchases of supplies and labor in peace and war, as was conclusively shown to be necessary in France.

This whole subject might be discussed much more extensively, but it is thought that here only an outline of what was definitely shown in France at best can be given.

In conclusion, Colonel Woodruff deserves much credit for his very complete article.

Maj. Gen. M. M. Patrick
Director of Division of Construction and Forestry
American Expeditionary Forces

Colonel Woodruff has set forth very clearly and concisely the immense amount and the varied character of the work done by the Engineers in France.

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It is a plain, unvarnished tale of unswerving devotion to duty and of magnificent achievement under conditions that were more trying than can be realized by any who were not in the midst of them.

The writer was in charge of this work for about 8 months, from September, 1917, to May, 1918, the commencement of it all, a period when we were little acquainted with French minds and methods and when they knew nothing of us, of our energies, our visions, our capabilities. There was never a time while we were in France that there was not a sad lack of both men and material sufficient to do all of the work which was really necessary, but this lack was more real and more apparent during these first few months. It was then that we had to argue at length with the French, to convince them that they must sacrifice some of their well beloved forests, stake them upon the outcome of the war, for if the war were lost it would make little difference to them whether their forests were standing or not.

It was then that the Chief Surgeon recommended that the Chief Engineer, Lines of Communication, be ordered to supply lumber for flooring tents in order to prevent pneumonia, only to be told that it would be a far easier task for the Chief Surgeon to discover or invent an infallible cure for this disease.

It was during this winter of 1917-18 that the engineer regiments, which Colonel Woodruff rightly calls the backbone of the construction force, the others that were added to them, all in fact, officers and men who were part of the organization, showed their worth by the way in which they worked in snow and rain, in mud and mire, giving every bit of brain and brawn they possessed (which was much) to carrying on the tasks which devolved upon them.

There were further complications due to the fact that there were some who seemed to fail to realize the war conditions under which this work was being carried on. They apparently wanted all construction work done along the lines to which they were accustomed in the United States with unlimited resources and under peace conditions. It had to be hammered into them that this was not a time for striving after perfection, it was a question rather of providing something, no matter how rude, that could be made to answer the purpose, that they were expected to get results, and to get them with the means available.

Colonel Woodruff is slightly in error in stating that all railroad construction work was turned over to the Transportation Department the middle of September, 1917. Construction work of all kinds was under the Chief Engineer, Lines of Communication, until the 31st of October, 1917. On that date there was a division of work, that at the ports and some of the railroad construction work being turned over to the Transportation Department, the rest remaining under the Chief Engineer.

As had been pointed out quite clearly and emphatically before this division of work and responsibility took place, it was an unfortunate arrangement, and one which did not make for economy or efficiency. There was the inevitable duplication of overhead, and, then, with sadly insufficient numbers of men and quantities of material, there was the conflict between the two departments, each probably thinking its work the more important and each consequently striving to get such men and materials as were available in order that its own work might progress, even though the work of the other suffered. There was no possibility of establishing correctly the relative priority of all of the different projects.

It took just about four months for this state of affairs to be realized, and then all construction work was put back where it had been originally. But part of this four months was time lost, just when time was most precious.

One of the outstanding lessons of this experience in war is that all of this engineering work should be under one head. In such a war there will never be men enough nor material enough. They must be shifted from place to place as the needs demand. The priority of the many projects must be established, but with the knowledge this may be changed many times by the changing conditions of the struggle and a concentrated power must exist to make such changes and to utilize the entire resources of the army to the very best advantage. This is utterly impossible when the work is divided, part put under one, part under another organization.

Other striking facts were the efficacy of the methods developed under the Engineer Department of the Army and the value of the training on civil works which our officers had acquired. Essentially simple, the Engineer Department methods were adaptable and the organization was capable of great expansion. Decentralization, making each man in charge of work carry his own burden, but with the certainty of vigorous backing when this was needed, was one of the factors in the successful conduct of this great task.

The fact that engineer officers had been doing civil work was responsible for their having come in contact with men of just the kind with which they had now to work. It had accustomed them to large enterprises and had given them vision.

On the other hand, too much can not be said for the men from civil life, many of whom, at great sacrifice, came forward and gave themselves, their brains, their knowledge, their trained intelligences, to aid in winning this war. They were truly loyal and unsparing of themselves. It was always certain that each one of them would do his best. The great difficulty was to determine each man's capability and to put him at work where he would be most effective. Many times this was not possible, but nevertheless these men,

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one and all, did earnest and effective work under whatever conditions.

Brig. Gen. Edgar Jadwin

Director of Division of Construction and Forestry American Expeditionary Forces

The work of the Division of Construction and Forestry is ably described by Colonel Woodruff, both as regards the difficulties encountered, the results accomplished and method by which these results were obtained. I can not let the opportunity pass without a word as to whom the credit belongs for these splendid results.

Looking at it in retrospect, my predominant thought is that everbody connected with the work at any time showed a most commendable, patriotic and intelligent devotion to duty. This applies both to officers and men from the regular army and to those in the army only for the war, and applies also whether the organization be regarded chronologically or from top to bottom.

With the changing force which at times was as great as 160,000, it is manifestly impossible to cite all the names, much less to specify fully the specific items for which each man should be commended. I can not, however, let the opportunity pass without including at least the names of the heads of the central office organization and of the construction work in the field, namely,

CENTRAL OFFICE ORGANIZATION DURING MY INCUMBENCY.

Col. J. A. Woodruff	Deputy Director.
Col. E. A. Gibbs	General Construction.
Col. J. H. Graham	Railroads and Docks.
Col. E. H. Marks (later Lt. Col. W. B. Greeley)	Forestry.
Maj. Geo. Sykes (later Maj. H. W. Gregory)	Administration.

The construction work in the field was carried on through the following section Engineer officers:

Base Section No. 1—	
Hq. St. Nazaire	Col. J. S. Sewell.
	Lt. Col. W. G. Atwood.
	Lt. Col F. B. Maltby.
Base Section No. 2—	
Hq. Bordeaux	Col. J. B. Cavanaugh.
	Col. Hugh L. Cooper.
	Col. Ernest Graves.
	Col. J. R. Holman.
Base Section No. 3—	
Hq. London	Col. R. G. Powell.
Base Section No. 4—	
Hq. Le Havre	Col. W. A. Johnson.
	Maj. Geo. S. Brinkley.
Base Section No. 5—	
Hq. Brest	Lt. Col. E. V. R. Payne.
	Col. Mark Brooke.
Base Section No. 6—	
Hq. Marseilles	Col. R. C. Moore.
	Maj. A. B. Cutter.
Base Section No. 7—	
Hq. La Rochelle	Col. J. R. Holman.
	Lt. Col. J. W. Williams.
	Maj. C. C. Cragin.
Intermediate Section, East—	
Hq. Nevers	Col. E. N. Johnston.
	Col. Harry Burgess.
	Col. Geo. H. Webb.
	Lt. Col. J. L. Buchanan.
Intermediate Section, West—	
Hq. Gièvres	Col. Ernest Graves.
	Col. S. B. Williamson.
	Lt. Col. E. L. Daley.
Advance Section—	
Hq. Neufchateau	Brig. Gen. J. F. McIndoe.
	Col. T. H. Jackson.
	Col. Ernest Graves.

The forestry work in the field was carried on through district commanders, each of whom also commanded a battalion of 20th Engineers (Forestry), with attached service companies which operated from two to eight sawmills.

Most of the mills were in the advance section and base section No. 2.

The districts in the advance section were combined under Lt. Col. C. B. Chapman (later Maj. F. F. Spencer), section forestry officer, and those in base section No. 2 under Lt. Col. Raymond E. Benedict, section forestry officer. These officers acted directly under the central office for production and shipments outside their own section, but filled local requisitions on the orders of the section engineer in whose section they were located.

Col. J. B. Cavanaugh

Engineers

Colonel Woodruff's presentation of the accomplishments in construction in the A. E. F. needs no additions to show clearly the debt which the Expedition and the country owes to the engineering profession, and which General Pershing acknowledges in his letters of appreciation quoted.

While, as indicated by Colonel Woodruff, the most important and ever-present handicap of the construction program was lack of material and personnel certain difficulties and defects of organization were met by practically all officers in charge of construction which, by careful consideration and the application of remedies dictated by experience gained, might be removed in large part so as to make future operations of this character less difficult.

While the construction materials and engineering equipment available were distributed and used to the best possible advantage, I am convinced that the commanders of all engineering organizations first overseas were thoroughly impressed with the importance of having complete equipment accompany the organization, and those commanding officers who in spite of strenuous objections found their organizations

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separated from their equipment on embarkation from the United States, saw their fears and objections wholly justified by subsequent loss of efficiency through failure to secure the wherewithal to work.

However wise the general policy of equipping organizations from supplies shipped to depots may be, engineer organizations sent in advance to prepare the way for large movements should not be forced to depend for their equipment upon the shipment of supplies to depots which have not yet been established.

As to the character of equipment and supplies provided for the A. E. F., a study of the supplies in engineer depots in France leads to the conclusion that the items of equipment furnished for construction work and the classes of construction materials were more varied and extensive than were actually needed, and that the primary importance of the saw and hammer of the jack-leg carpenter was underestimated.

While at least the original equipment of engineer organizations may be simplified to include only an ample supply of instruments and tools for rough work, this equipment should be kept with the organization as long as the infantry keeps its rifle.

The greatest lack in equipment experienced on the work with which I was directly connected, aside from the part of the regimental equipment left behind at New York, was of the simple tools necessary to keep labor troops and combat troops, assigned for work, usefully employed.

With construction materials the greatest difficulty aside from their scarcity was lack of immediate availability due to failure to pack all the nails, bolts and other items necessary for erection so thoroughly tied to the shipments that any important part would be complete in itself. Rails should be accompanied by bolts and spikes; roofing and other building materials by nails, special cements, and other materials for erection, and structures in every shipment should be complete, since classification and assembly in the field is far more difficult than at the shipping point.

A consideration of the engineering and construction personnel drawn from civil life, which actually did the work, and to which the success of the construction program is so largely due, leads to the conclusion that the qualifications found most useful were adaptability and enthusiasm coupled with recent experience in handling men or upon actual construction.

The real engineering problems were few, while the amount of work to be actually accomplished was immense. Therefore, workers rather than advisers were necessary, and the field for consulting engineers of the highest grade was small. The axiom that in war the vast majority of men are employed below their full capabilities was well illustrated by the duties of engineers in France.

While in general the spirit shown by engineers of training and experience was of the finest, many of them felt that they were called upon to perform duties not in accord with their training and capabilities, and not all of them were able to recognize that this was inevitable since positions calling for the exercise of their highest qualifications did not exist, or required not only a knowledge of engineering but also familiarity with military and government procedure.

Faulty assignment of officers with respect to special qualifications was one of the inevitable results of lack of preparedness, but this fact was generally recognized and due to the great adaptability of the engineering profession; as a whole, the amount of dissatisfaction and discontent resulting was surprisingly small.

Many of the service battalions and labor organizations were officered by men entirely competent to take charge of large independent works, where the only practical use of their organizations due to the character of enlisted personnel or to the military situation was to utilize them practically as labor forces under the supervision of others at times no more competent than themselves.

Where independent work was not available, the best results were secured with those organizations of labor troops and service battalions where the officers were qualified more for handling men on construction work than as enginers accustomed to the supervision of construction work in direct charge of others. For labor troops construction superintendents and foremen make the most desirable officers.

Criticism, unless constructive, is unwarranted, and in view of the splendid accomplishment in construction in the A. E. F. is offered with reluctance. It is my opinion that the plans, particularly for transportation facilities, tended too much towards the desirable or ideal and could have been simplified with reduction in labor and material far outweighing the resulting loss of efficiency. This opinion is supported by satisfactory functioning of incomplete facilities and the small use of some of those provided, and further by the fact that the later tendency in all plans was towards greater simplicity.

Broadly speaking, the organization and administration of construction work in the A. E. F. was that used in the United States by the Engineer Department in the execution of public works, a competent engineer officer experienced on construction work in general charge, with other trained engineer officers in local charge of the different localities, and a decentralization of authority to the widest extent practicable under the military conditions existing in France.

The most responsible positions in original organization were filled largely by engineer officers of the regular army, but as the organization was expanded and tried out and engineer officers from civil life acquired the necessary military experience they replaced to a large and increasing extent the regular officers, thus not only securing well-earned recognition but

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also releasing the regular officers who were urgently needed for other duty more strictly military in character.

It is thought that my own personal experience in charge of construction work was not different from that of other engineer officers similarly placed, and this experience brought home the realization that the training secured on public works in time of peace was the most valuable part of my equipment for construction work in time of war.

Experience in handling contracts, in supervising the work of large organizations, in dealing with local authorities of the United States, all found its use in connection with the problems in France.

The important elements for the most successful conduct of engineer operations in time of war, as indicated by experience in the A. E. F., may therefore be summarized as follows:

(*a*) Training and broad experience in construction work for military engineers, such as that now obtained on public works in time of peace.

(*b*) Such a listing and classification of engineers in civil life as will permit assignment in line with special qualification and provision for training in military matters to fit them for the discharge of all the duties of an engineer in time of war.

(*c*) Control of engineering equipment and supplies by the department responsible for engineering and construction work in the field.

(*d*) Simplification of engineering supplies and equipment and special adaptation of both to field requirements.

(*e*) Simplification of type plans and a determination of minimum requirements which shall take into consideration not only what is desirable but what is reasonably practicable of accomplishment.

Col. Ernest Graves
Engineers

Colonel Woodruff has given us a complete, unimpassioned and accurate account of the engineer construction done by the American Army in Europe. The figures are so enormous that it is difficult to get a birds-eye view of the magnitude of the greatest engineering feat of all time.

The pictorial maps herewith show that the barracks constructed, if placed in line end to end, would reach from Bordeaux, France, to Turin, Italy. Wood cut and corded in line would extend from Bayonne to Nice, thence to Strasbourg and thence to Brest. Enough standard-gauge railroad was laid to make a double-track line from Bayonne to Berne, Switzerland.

During the early, formative days of the A. E. F. there was much uncertainty and embarrassment in fixing the responsibility for the execution of the many and varied construction projects involved in our participation in the mighty struggle. Every branch of the service had construction projects to be promptly executed and all faced the same difficulties of lack of personnel and material. These various services were not equipped and especially they were not trained to do this work. All had other functions. There was a need for a single department with a single head to execute these vast projects. All the other departments turned hopefully to the Engineers. And this was right and proper, for the engineers alone of all branches of the service, civil or military, were trained and able to do the job. Their record in peace and war entitled them to the confidence of the other services, nor did they fail them in this trying time.

But in the beginning the engineers, like everybody else, had neither personnel nor material to work with. They had only their enthusiasm and confidence in themselves, based upon years of success in overcoming all kinds of difficulties.

On the first boat which carried Americans to France were some quartermasters having blueprints of type camps. These they turnd over in joyful confidence, not misplaced, to the engineers. When the quartermaster in France received from the States the plans for a large ice plant these likewise were handed to us. A firm of civilian contractors undertook to erect shops and warehouses for the Ordnance Department in France. After contemplating the apparently insurmountable difficulties for a time, they placed the responsibility upon the broad, though over-burdened, shoulders of the Engineer Department.

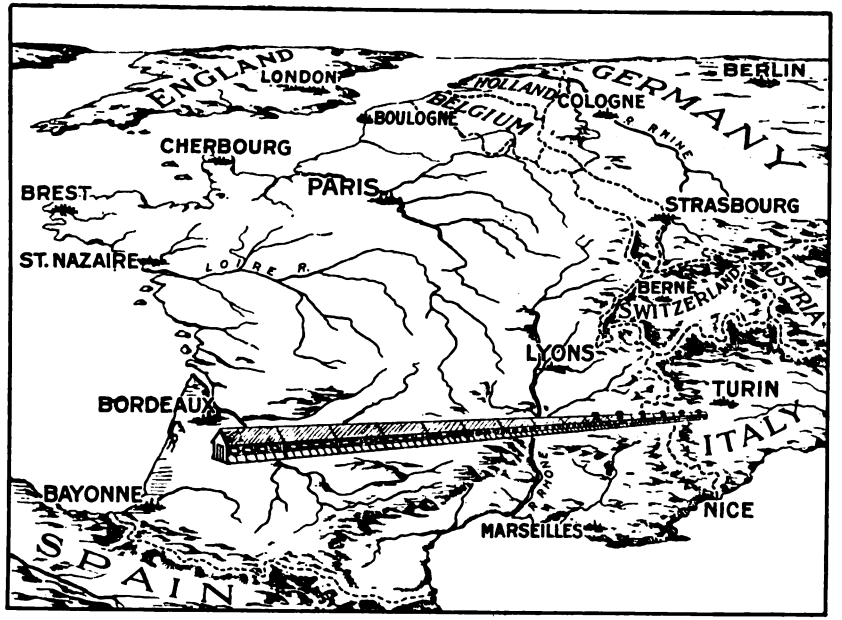
The Air Service, in like confidence, turned over their construction projects. And eventually all such tasks found their way to the department where they properly belonged and where they should have been, and should always be, from the beginning.

Construction of whatever nature and under whatever conditions (the worse the conditions the greater the stimulus) is the natural function of the engineers. We are organized and trained for such work, we ask only "lead us to it." That the army and the nation should look to the Corps for results in this line is natural, proper and just. The confidence of the other branches of the service that the engineers will do the impossible in their own line, a confidence which we have earned and repeatedly justified, is our special pride. It is the reason for our existence as a corps, the justification for our maintenance by the government. We wish the other services to rely upon us. We have not failed and we shall not fail them.

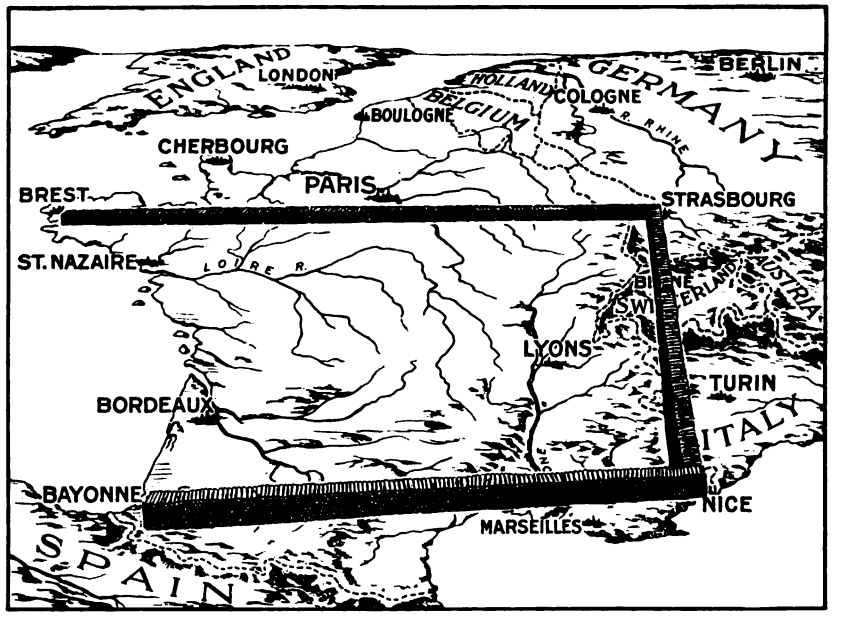
The methods of the engineers, developed by long experience, in handling men, funds, supplies, materials, machinery, property, etc., make it possible for them to perform large tasks under difficult conditions with the minimum of delay and lost effort. At every place where I was stationed in France, and that was all over the country, I was constantly being asked by officers of all branches to do little things which they could not get anybody else to do. Every engineer officer who has been on construction has had similar experiences.

For example, at Bordeaux I regularly furnished

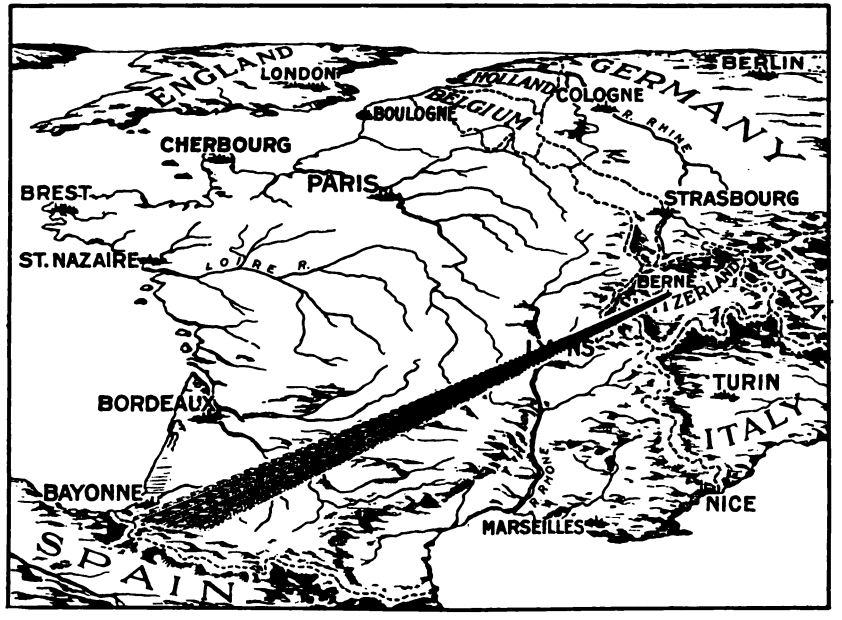
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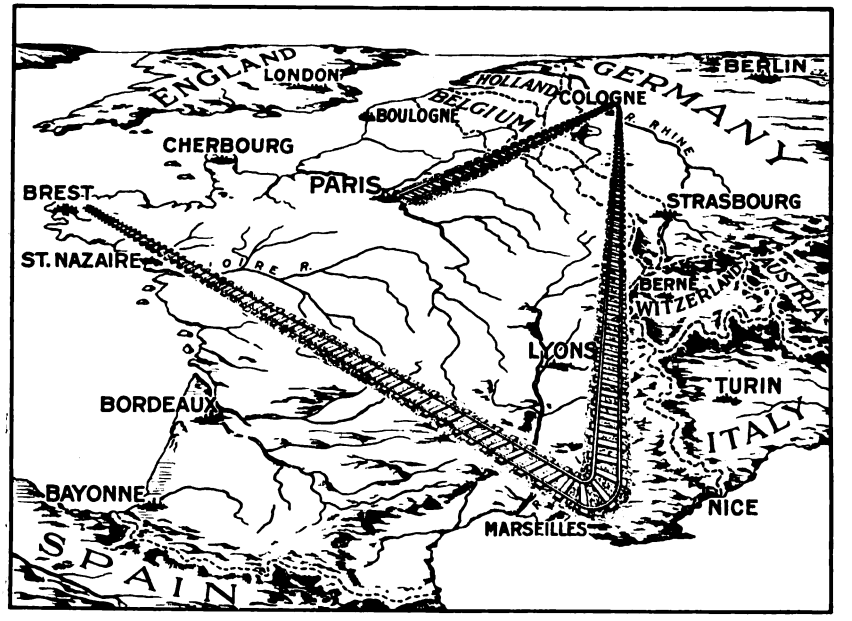
Barracks and Hospitals. The A. E. F. built 258 miles of barracks and 146 miles of hospital wards—enough to make a single building from Bordeaux to Turin



Fuel Wood. The A. E. F. produced 1,332 miles of fuel wood, corded 1 meter high by 1 meter wide—enough to reach from Brest to Strasbourg, to Nice, to Bayonne



Standard Gauge Railway. The A. E. F. laid 967 miles of standard gauge railway track—enough to construct a double-track line from Bayonne to Berne



Light Railways. On November 11, 1918, the A. E. F. was operating 1,400 miles of light railway lines—enough to make a single-track line from Brest to Marseilles, thence to Cologne to Paris

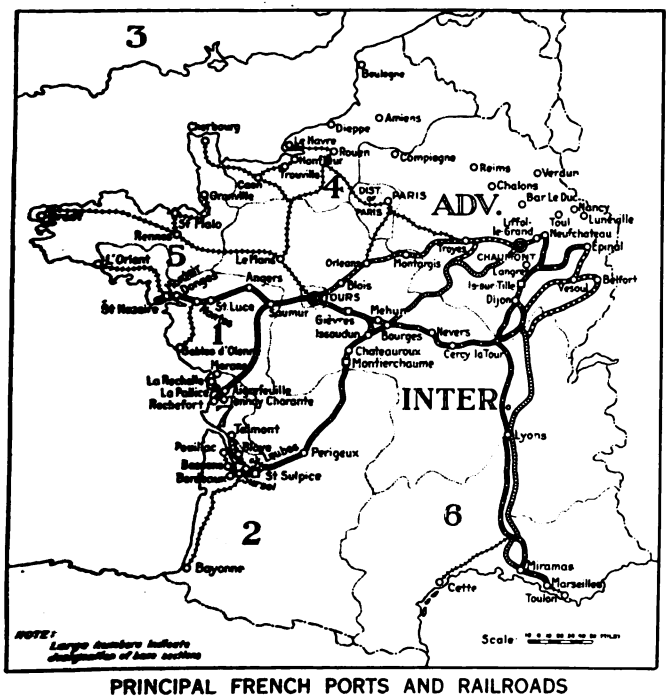
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the Navy with small supplies which, as they said, they could not otherwise obtain for months because of "red tape" in their own department. At the same place I bought paper for an ordnance officer which he could not get from his department. Apparently, the fundamental facts that we were at war and that the United States furnished and paid for everything necessary to defeat the enemy, were not always successful in overcoming the "red tape" methods of peace.

A comparison, based on the number of men engaged, the amounts of materials consumed and money spent, and the results accomplished in a given time, would show that the construction of the Panama Canal, that "greatest feat of man," is overtopped and dwarfed by the work of the engineers in France during the great war.

A similar comparison between the work done under relatively far more favorable conditions in the United States and that done in France, would show that the storage space constructed abroad was almost equal to that provided at home, and that the hospital capacity furnished in France was twice that in the United States. The fact that expenditures at home were many times those in France has been explained by the statements that prices were high in the United States and that many of the supplies used in France were purchased and charged at home.

It is my opinion that the conspicuous success of the division of construction and forestry was due in large measure to the wise policies of Generals Patrick and Jadwin, in fitting their organization to that of the army and in working for and with all local army authorities for the attainment of the common end. And in even greater measure it was due to the spirit and enthusiasm of the Corps of Engineers and the American engineering profession.



PRINCIPAL FRENCH PORTS AND RAILROADS USED BY AMERICAN EXPEDITIONARY FORCES

● GENERAL HEADQUARTERS ● NO. SERVICES OF SUPPLY ● PRINCIPAL PORTS
○ SECONDARY PORTS AND IMPORTANT TOWNS □ LARGE DEPOTS
MAIN LINES SECOND LINES THIRD LINES OTHER LINES

IV.

[Extract from the final report of Gen. John J. Pershing, Commander-in-Chief, American Expeditionary Forces.]

. . . . . .

Among the most notable achievements of the American Expeditionary Forces was the large program of construction carried out by our Engineer troops in the Services of Supply and elsewhere. The chief projects were port facilities including docks, railroads, warehouses, hospitals, barracks, and stables. These were planned to provide ultimately for an army of 4,000,000 men, the construction being carried on coincident with the growth of the American Expeditionary Forces.

The port plans contemplated 160 new berths, including the necessary facilities for discharge of cargo, approximately one-half of which were completed at the time of the armistice. Construction of new standard-gauge railroad track amounted to 1,002 miles, consisting mainly of cut-offs, double-tracking at congested points, and yards at ports and depots. Road construction and repair continued until our troops were withdrawn from the several areas, employing at times upward of 10,000 men, and often using 90,000 tons of stone per week.

Storage requirements necessitated large supply depots at the ports and in the intermediate and advance sections. Over 2,000,000 square feet of covered storage was secured from the French, but it was necessary to construct approximately 20,000,000 square feet additional. The base hospital centers at Mars and Mesves, each with 4,000-bed convalescent camps, are typical of the large scale upon which hospital accommodations were provided. The hospital city at Mars, of 700 buildings, covered a ground space of 33 acres and included the usual road, water, sewerage, and lighting facilities of a municipality.

Advantages of economy and increased mobility caused the adoption of the system of billeting troops. Billeting areas were chosen near the base ports, along the line of communications, and in the advanced zone, as strategical requirements dictated. The system was not altogether satisfactory, but with the number of troops to be accommodated no other plan was practicable. Demountable barracks were used for shelter to supplement lack of billets, 16,000 barracks of this type being erected, particularly at base ports where large camps were necessary. Stables at remount stations were built for 43,000 animals. Other construction included refrigerating plants, such as the one at Giévres with a capacity of 6,500 tons of meat and 500 tons of ice per day; and mechanical bakeries like that at Is-sur-Tille with capacity of 800,000 pounds of bread per day. If the buildings constructed were consolidated, with the width of a standard barrack, they would reach from St. Nazaire across France to the Elbe River in Germany, a distance of 730 miles.

In connection with construction work, the Engineer Corps engaged in extensive forestry operations, producing 200,000,000 feet of lumber, 4,000,000 railroad ties, 300,000 cords of fuel wood, 35,000 pieces of piling, and large quantities of miscellaneous products.

"The scientists said it couldn't be done, but the damfool engineer didn't know that—so he just went ahead and DID IT!"

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Engineer Duties in the Field in War

By

Col. R. R. Ralston

Engineers, U. S. A., Corps Engineer 4th Corps, A. E. F.

Continued from Page 24

work of general construction and road repair and maintenance. Details from the corps engineer regiment of first one and, later, two companies were also furnished the chief engineer, 3rd Army, for work in Coblenz and vicinity, and these companies handled a large amount of general construction work and also provided a depot detail for the army engineer depot at Coblenz. A detail from the regiment also took over and supervised the operation of a steam laundry and power plant connected with one of the 3rd Army hospitials when the surgeons were unable to get the necessary action out of the German operators. About 100 surrendered German trucks were turned over to the 4th Corps by the M. T. O., 3rd Army, for use in maintenance and repair of roads in the corps area. These were received by the corps regiment and issued to the division engineers as required; trucks turned in as unserviceable being repaired as far as practicable and re-issued.

With the establishment of the educational system in the A. E. F. in the spring of 1919, the station of the corps regiment became the site of the vocational schools for the 4th Corps troops; barracks and mess halls were erected and a number of classes started under the direction of the regimental commander; the park of German trucks referred to above, providing good material for the class in motor operation and repair.

The foregoing gives in a general way the engineer duties of the corps engineer troops of the 4th Corps while in the A. E. F., and is given in somewhat greater length than might otherwise be necessary, as it is desired to show that, so far as this regiment is concerned, its duties were practically the same as those of divisional engineers, and hence no special organization of engineers for duty as corps engineer troops appears to me to be either desirable or necessary.

The corps engineer regiment should be organized and trained the same as divisional engineers, and their equipment should be similar, except that some road building equipment might be made available for a corps regiment, in view of the heavier road work which will usually devolve upon them.

I do not regard the pioneer infantry regiment as a suitable organization for assisting in corps engineer operations, mainly for the reason that such a unit would serve a better purpose as a combat regiment. In the 4th Corps the personnel of the pioneer regiment of infantry, both commissioned and enlisted, was very good; but the officers, with few exceptions, had had very little experience in construction work, and hence the organization could not make an efficient working force for general engineer work. The work on which they were engaged could have been handled equally well by a corresponding strength of service or labor troops, and the personnel of the pioneer regiment would then have been available for combat duty.

It is my opinion that the most satisfactory auxiliary to the engineer troops is the service battalion, officered by engineer officers, with white non-commissioned officers, the remainder of the organization being colored troops.

The corps engineer, under tables of organization, was supposed to have the dual function of a corps staff officer and commanding officer of the corps engineer troops—a status similar to that of the division engineer. This arrangement, while generally satisfactory in the divisions, did not work satisfactorily in the corps, due to the fact that regimental headquarters was generally a long distance from corps headquarters; and during active operations it is more important that the corps engineer maintain a closer contact with corps headquarters than with the corps engineer regiment, if he is to be of the maximum service.

The regiment should be commanded by the lieutenant colonel, and if he is not qualified for that duty, the remedy can generally be found in a new lieutenant colonel. The operation of the corps regiment remains under the direction of the corps engineer, and can be directed by him just as well, if not better, if he is not in active command. The corps engineer was furnished by tables of organization, for his office at corps headquarters, with 3 commissioned assistants—1 major and 2 captains—and also a detachment of 9 engineer enlisted men, besides a certain allowance of chauffeurs and orderlies. It was my experience that 2 commissioned assistants and 8 enlisted men were sufficient; 1 officer and 3 men on purely office work, 1 officer and 2 men on the supply of engineer equipment and supplies, while the remaining men were utilized in engineer supervision of jobs at corps headquarters or elsewhere as needed.

The corps engineer's duties in general consist of the direction of the engineer operations by corps troops, the co-ordination of engineer work throughout the whole corps, and the supply of engineer equipment and supplies to corps troops and to division engineers. He is usually called on to prepare the engineer plan included in any field orders, and to advise relative to engineer operations. In his relations with divisions, his actual direction of engineer operations by divisional engineers is neither necessary nor desirable, except in the unusual case where a concentration of all the engineer personnel of the corps is essential to the accomplishment of a definite task, and to

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insure co-ordination of the divisional engineer operations with the general plan. The corps engineer is frequently able to secure from G-2 of the corps information relative to conditions in advance of our front lines that are of importance in indicating the engineering problems that are likely to be met with in case of an advance. In the 4th Corps such information was compiled and furnished by the corps engineer to division engineers in the form of an engineer bulletin. It was continued on the march into Germany in order to disseminate such information as was available relative to conditions of roads and bridges over which the corps was to advance.

In the 4th Corps sector prior to the armistice there were two corps dumps or parks and an army dump or depot, from which engineer equipment and supplies could be issued to division engineers or corps troops on requisition approved by the corps engineer. The approval of G-1 of the corps on engineer requisitions was waived, except in case of doubt as to the advisability of issue. When the 2nd Army was first organized, instructions were given prohibiting the issue of any materials from the army engineer depots without the prior approval of G-4, 2nd Army, which was in accordance with the provisions of general orders in the A. E. F. on matters of supply. The requirements of these orders had been waived, however, while the 4th Corps was in the 1st Army, and when enforced under the 2nd Army entailed a good deal of difficulty in getting engineer supplies, as the supply officer after getting his requisition approved at corps headquarters had to go in to army headquarters at Toul for the necessary approval there. After a week or two of this procedure, and some strong representations as to the unnecessary work and delay in this method of securing supplies, authority was again granted for the issue of engineer supplies, etc., from the army depot on approval of the corps engineer.

Corps dumps or parks were handled by 2nd Army engineer personnel, and thus constituted practically advance army depots, which were at the disposition of the corps engineer. In addition to these sources of general engineer supply, a small dump of camouflage material was maintained by the corps camouflage officer and issued as required. After the St. Mihiel offensive, due to the changed front, a great deal of new shelter became necessary for the troops in the 4th Corps sector. The corps engineer accordingly prepared plans for typical shelters both for men and animals, based on utilizing materials then available, and distributed them to the division engineers, requesting them to submit the requisitions necessary for sheltering their divisions. Delivery of this material was under way at the time of the armistice.

Requisitions were frequently received for articles not available in the corps or army dumps, and in such cases, when the circumstances warranted, it was necessary to send by truck to a depot of the service of supply or to a depot of the 1st Army, in order to receive them, and, if available, they were usually obtained without difficulty.

A card-index system was maintained in the corps engineer's office, showing what engineer materials, etc., were available in corps and army dumps, which enabled action to be taken on requisitions promptly.

The corps camouflage officer in the 4th Corps sector had under him a small detachment of enlisted men from the camouflage regment, and also several commissioned assistants from the infantry and field artillery, who acted as division camouflage inspectors, devoting their attention to correction of defects in camouflage, particularly in the artillery. This camouflage detachment rendered very satisfactory service.

The sound and flash ranging sections on the 4th Corps front also rendered excellent service, but it is believed that this is a service which should pertain to the artillery, rather than to the engineers, and it is understood that it is to be so assigned in the future.

My experience with the special army engineer services in the A. E. F. was quite limited, but all of the special organizations with which I came in contact gave evidence of a high class personnel and excellent performance of the duties for which they were intended. Whether or not such a variety of special units was necessary in the A. E. F. is a matter on which I do not feel qualified to express an opinion, but I believe it to be better practice to hold the number of special organizations to the minimum and rely principally on an all-around engineer organizations, like a pioneer regiment supplemented by special technical supervision by qualified engineer staff officers when considerable technical skill is required.

One company of the 37th Engineers, electrical and mechanical regiment, accompanied the 4th Corps on the march to Germany as part of the 3rd Army engineer troops, and was afterwards stationed at Trier. While some cases came up where the special qualifications of this unit were necessary, it was also engaged while in Trier on work of general construction for which a sapper company should have been used; but the high command will not and can hardly be expected to assign engineer work to organizations according to their specialty, particularly if a special engineer organization is the most available. This condition will always be present, and as the bulk of the engineer work, particularly in the zone of the advance, will be of the "pioneer" variety, I believe the bulk of the troops for duty as army engineer troops should not be special units ,but rather all-around engineer organizations like the divisional engineers.

Discussion

Maj. Gen. Joseph E. Kuhn
U. S. Army (Engrs.), Formerly Commanding General, 79th Division

As a member of the Board on Engineer troops, whose studies were mainly responsible for the organization, equipment and training of our engineer troops as applied in the war with Germany, I was naturally much interested in observing their practical results.

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So far as my own experience is concerned I am satisfied that our divisional engineer regiments rendered uniformly excellent service and that their organization, training and equipment leaves little to be desired. Certainly the 304th engineer regiment, which I had the honor of commanding, demonstrated a high degree of efficiency, was always prepared to undertake any job and never failed me, whether in battle, on the march or in camp.

Colonel Ralston points out that with conditions obtaining in France, map reproduction by lithographic processes was outside the sphere of the divisional regiment. I agree with him and future equipment of divisional regiments should omit all lithographic equipment. The hectograph and blue or brown print processes will ordinarily enable the divisional regiments to supply all plans and diagrams required within the division. I also agree with Colonel Ralston's view as to the engineer train being made a part of the engineer regiment instead of a unit of the divisional train.

The present strength of the engineer regiment is, in my opinion, adequate, either for the divisional organization prescribed in the National Defense Act or for the organization used in the war with Germany. With a three brigade organization, one will habitually be in reserve so that the necessity of a 3rd battalion with the engineer regiment is not apparent. True, occasions arise when one could momentarily make use of a much larger number of engineers and instead of a 6 per cent allowance make ready use of a 50 or 100 per cent allowance. When the 79th Division went over the top at Montfaucon on September 26, it was assigned an axial road which ran obliquely across No Man's Land for a distance of 2 kilometers. This road was vital to the advance, and the entire engineer regiment, less one company with the tanks, was assigned to its repair. Instead of being a question of road *repair* it turned out to be a question of road *construction* over an area of overlapping shell holes, requiring 30 hours of the most strenuous work to make passable for animal drawn vehicles. It was an occasion when I would have readily voted for a 50 per cent allowance of divisional engineers. Organization should however, be based on average conditions, which the war showed were well met by a regiment of six companies in two battalions.

Searchlights played an unimportant role in the field operations of the American army, mainly because it engaged in open or semi-open warfare for which portable electric searchlights are not adapted. In position warfare such searchlights still have their place and engineer troops should at least be trained in their use. The experience of this war has shown that they need not form a standard part of the engineer regimental equipment. Their place is in the reserve engineer depots. Small portable electric lighting plants are simply indispensable for lighting division headquarters and the regimental equipment must provide for them in the future.

The assignment of construction work to the engineers was wise and logical. It certainly worked well within the divisional areas. The experience in field fortifications, demolitions and road work did not present any features different from those anticipated. I agree with Colonel Ralston that traffic control over roads under construction and repair in forward areas should be placed under the engineers until finished. Camouflage should form part of the training of divisional engineer regiments so as to be immediately available when required. I would, however, retain a special camouflage organization for the army, to handle exceptional cases such as arose during the war.

My experience with corps engineer troops was so limited that I do not feel myself qualified to speak. I was not favorably impressed, however, by the numerous engineer units to take care of special duties, such as forestry, quarrying, road construction, flash and sound ranging devices, electrical and mechanical, railroad construction, railroad operation, etc. While some specialization is unquestionably desirable, it seems to me this is carrying it too far. Instead of economizing man power we are actually squandering it. I concur with Colonel Ralston in the general view that corps and army engineer units should be organized and trained essentially the same as divisional regiments, that is, the men disciplined as soldiers, trained in the use of the rifle and in general military engineering. Their equipment should also be essentially the same as that of the divisional regiments. When so organized and trained corps and army engineer units will be prepared for almost any class of work and can be pooled or split up as required. Special equipment such as road-building and quarry machinery should be issued as occasion demands from the engineer depots and not assigned permanently to units. The name "pioneer infantry regiment" is a misnomer so far as the observed work of these regiments is concerned. They should be eliminated from future army organization and their functions performed by engineer service battalions.

Maj. Gen. H. E. Ely

U. S. Army (Inf.), formerly Commanding General Fifth Division, A. E. F.

I believe that the argument that the engineer train should be a part of the engineer regiment is sound, and tends toward desired decentralization. In regard to the divisional engineers, I think an increase in strength would not be justified. These units are already, relatively, much stronger than those of any other nation, and, in the present war, filled all requirements—even as to a reserve in combat.

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While engineers will be called upon to do topographic work, they will be largely relieved by aeroplane photography. The lithographic equipment will not, in my opinion, hereafter be needed with an engineer regiment. On the other hand, I would prefer to have searchlights retained by the engineers, and I concur in the suggestions regarding field fortifications and camouflage, in their relationship to the division engineers.

In regard to the authority suggested to be given engineers when constructing and repairing roads, to act as military police, I would suggest that the military police be required to report to the engineer officer in charge of such work and be under his orders which, perhaps, it would be advisable to have approved by the G-1 in the divisional area. The traffic control would then remain under a single head and responsibility would be definitely fixed.

The present ponton equipment is antiquated and inefficient, but, for the sake of economy, it might be continued until replaced with an up-to-date efficient equipment.

One or more caterpillar tractors for removing ditched trucks or other traffic obstructions, and for helping transportation on steep, slippery hills, should be a part of the engineer train.

I agree, emphatically, with the comment and suggestions relating to "Infantry Duties" of engineer troops. One reason why I approve of the present large percentage of divisional engineers is that in emergencies they can be used as fighting troops, as they were employed to good purpose in both the First and Second Divisions or more than one occasion.

Col. George Grunert
Infantry, U. S. A., G-1 1st Corps and Deputy Chief of Staff 3rd Army, A. E. F.

The historical data requires no comment. In the discussion under "division engineers," I concur, especially, in the suggestion that the engineer train be made an actual part of the engineer regiment, and, further, suggest that the regiment be maintained at the "emergency" strength. Division commanders should not be encouraged to consider such a regiment as a reserve, for the tendency is always to draw on the reserve, thereby neglecting the engineering work.

Under "Duties," I agree in the main with the discussion set forth. I should maintain in the regiment well trained personnel for topographical work, to be employed when and where most needed. I agree, though, that lithographic equipment should not be retained. Searchlights should be retained. The latter properly pertain to the electrical group, should be handled by a technical service, and used where needed. I agree with the suggestions relative to the electric lighting plants, field fortifications and camouflage.

I think the division engineer regiment should especially provide for the rapid movement forward of the two regiments of "seventy-fives." The construction of temporary bridges should be made as strong as time and materials permit, and these bridges should be made sufficiently wide so that the corps engineers will not be under the necessity of rebuilding the whole structure.

Each division should have control over the roads within its sector. This control, and the Division A. P. M., is now under the supervision of G-1 of the division, who regulates the traffic. A close co-operation between G-1, the A. P. M., and the division engineer should, therefore, result in satisfaction to all concerned. Without such co-ordination, I would strongly oppose the handling of traffic by the engineers.

The discussion on ponton equipage and heavy fixed bridges is technical, but the future will certainly require tractor drawn vehicles to handle heavy cargoes of all sorts incidental to modern war. The engineer regiment should furnish and operate any tractors serving as "helpers" on steep grades or required in removing ditched trucks, but their use should be under the control of the A. P. M. who is charged with "traffic control." I agree with the discussion on general demolition and general construction work, but the comment following is technical, and I have nothing to add.

Under "Infantry Duties", I think the engineers should be given both engineer and infantry training. It has been my experience that division commanders are prone to use engineers as combat troops, when there is no real emergency, therby neglecting the engineering work. In this they are aided and abetted by the engineers themselves, who want to get into the scrap. This tendency grew to such an extent in the 1st Corps that several of our field orders strictly forbade the use of the division engineers in the firing line.

In the discussion of the various duties of the corps engineers, I might add that it has been my experience that the engineer troops assigned to a corps were inadequate to carry on the work when advances were being made over a devastated area. The building of roads, light railways, dumps, etc., besides the work on defensive positions and on construction, requires an immense amount of labor. The pioneer infantry regiments are not always available as they are needed for other work, such as burying the dead (men and horses), salvaging, etc. When the advance is rapid, the problem becomes more difficult, and the army troops can not come up rapidly enough to take over the work from the corps troops.

Following the detailed account of the operations of the 4th Corps engineer troops Colonel Ralston discusses the equipment of a corps engineer regiment. It is my opinion that the corps engineers should not be encumbered with heavy equipment, as these troops

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must be mobile. Let the army keep such equipment, subject to call from the corps when it is needed.

In reference to "pioneer infantry", I think the term was a misnomer, at least in so far as the pioneer infantry regiments with the 1st Corps were concerned. They were strictly "labor troops", and as such assisted the engineers and furnished labor for other purposes, acting mainly as "burial detachments" and as "salvage detachments." If the so-called pioneer infantry is eliminated, then in their stead "labor detachments" should be furnished.

I agree with the statement concerning the "service battalion." But it should be remembered that there is other labor to be performed in a corps, aside from that connected with the engineers. The labor for "burials" should be under the supervision of the sanitary corps, and that for the "salvage" under the salvage service, both operating under G-1.

Regarding the dual functions of the corps engineer, I think there should be a corps engineer officer, in addition to the commanding officer of the corps engineer unit. I concur in the recommendation concerning the officer personnel of the corps engineer regiment, and also in the remarks following, provided the corps engineer works in close harmony with the corps G-1. Close liaison between the corps engineer and the army engineer, and the resulting proper stocking of advance army depots should make the approval of the corps G-1 and the army G-4 unnecessary on requisitions; they could then go direct to depots. Army G-4 can issue instructions (through army engineer) to depots to prevent one corps depleting the stock so as to endanger other corps.

The suggestions relative to the sound and flash ranging sections and the electrical and mechanical regiments meet with my approval. G-2 of a corps requires certain draftsmen, printers, etc. These should not be assigned permanently to the corps, because at times they are not needed by the corps, and should, therefore, be available, where neded, for assignment.

Col. John J. Kingman
Engineers, U. S. A., Chief of Staff, 90th Division
A. E. F.

I am convinced that the regimental organization for division engineers is thoroughly sound for war and will prove of great advantage in time of peace, in that it will afford opportunity for older officers of the Corps of Engineers to serve with troops. This is no argument for giving up the civil work of the corps, for without this work we would be deprived of our principal means of getting practical experience in engineer construction. We would tend to become engineers in name only. Those who feel that river and harbor work is of no value to the military engineer can have given but little consideration to the duties that fell to the engineer corps in France, particularly in the service of supply.

In the 90th Division, from August, 1917, to June, 1919, the engineer train was in fact a part of the engineer regiment from its first organization at Camp Travis, where quarters for the train were built adjacent to those of the regiment, and from that time on the training, administration and work of the train were supervised and controlled by the regimental commander. This plan worked very satisfactorily. Colonel Ralston's conclusion that the train should form part of the regiment is undoubtedly correct.

The experience of the 90th Division fully supports Colonel Ralston's views relative to the duties of divisional engineers in connection with map making and reproduction, handling of searchlights and the providing of electric lighting plants for division headquarters and for other purposes.

In our battle experience we found that the infantry looked to the engineers for advice and assistance in the location of defensive lines and depended upon them to lay the wire entanglements during the period of organizing a new position. The construction or improvement of the division post of command also falls to the engineers and at times they may be called upon to provide for the brigade posts of command.

I agree with the view that camouflage work should be supervised by a detachment of the division engineer regiment. When we were preparing for the St. Mihiel drive a camouflage officer was attached to the division and began at once to acquaint himself with conditions at the infantry positions and artillery emplacements. Rumors of German spies in American uniform were rife at that time, and our camouflage officer narrowly escaped being locked up by G-2. It often occurred to me that the so-called camouflage painting of field guns and motor trucks was worse than useless. I think the result tended to draw ridicule upon the whole idea of camouflage, an art which intelligently practiced has an important military value.

While the engineers have many duties, there is one which, for the divisional engineers, overshadows all others in importance, namely, the construction, repair and maintenance of roads and bridges. Success in this work during offensive operations must be assured whatever else is neglected. Unless the artillery and transport can get forward promptly the attack will soon come to a standstill. Too much emphasis cannot be placed upon the importance of putting through the roads. When a division attacks on a broad front with both brigades in line, it will be generally advisable to assign a battalion of engineers (less 1 company) to work in each brigade sector, the battalion commander to keep in close liaison with the brigade commander, but the battalion to remain under control of the division engineer. When a deep penetration is intended and the division attacks on a narrow front with the

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brigades in column, it is then best to employ practically the entire engineer regiment on the axial road.

Where a river crossing is involved, ponton equipage and heavy bridge timbers must be brought up from the rear in ample time. This raises the interesting question as to whether our standard ponton equipage should be modified to carry the heavy trucks, tractors and mobile guns that now accompany an army. In my opinion the 5th Division's crossing of the Meuse River at Dun-sur-Meuse may be considered typical of such operations. In this case most of the infantry crossed on small canvas ponton foot bridges, next a standard ponton bridge was laid, and on this the machine gun units, 75's and regimental trains crossed. Meanwhile the destroyed permanent bridge was replaced by a timber trestle structure which was strong enough to carry the heaviest vehicles, namely, the 155 howitzers, 10-ton tractors, trucks of the supply train weighing 15,000 pounds loaded, and the heavy army artillery. This trestle bridge was completed in ample time to cross the 155 howitzers before the infantry had progressed so far that they could no longer be supported by these guns from the west bank of the river. Under these conditions it is generally practicable to supply the forward units by the regimental trains hauling from a dump near the river crossing.

If this may be taken as the normal method of forcing a river crossing, and I believe it may be, then there is not sufficient advantage to be gained from increasing the load capacity of the ponton bridge to offset the expense, decreased mobility and greater difficulty of construction. I do believe, however, that a metal boat similar to the German ponton is superior to our wooden type.

As stated by Colonel Ralston, it is often advisable to authorize engineers engaged on road work to control traffic on roads undergoing repair. We also found it advisable to charge the engineers with the duty of providing and operating one or more motor trucks with suitable tackle and equipment for the purpose of hauling trucks out of ditches. Travel at night over slippery roads without lights always left the ditches full of trucks in the morning.

The mention of the use of high explosives for wire cutting reminds me of the anxiety with which we studied this problem in preparing for the St. Mihiel offensive. In our sector there were oceans of wire to be crossed. During the hot fighting in the Bois le Prêtre in 1915, the opposing front line trenches were but a few feet apart, but later, as each side despaired of making any advance at that place, they both withdrew somewhat, building new trenches and adding band after band of wire. We had no tanks assigned to the division and the brief four hours of artillery preparation at night precluded any effective wire cutting by that means. Consequently we gave serious thought to the possibilities of bangalore torpedoes, and also the use of chicken wire or matting to be carried forward and unrolled over the entanglements. We found, however, the available amounts of torpedoes and wire were not a drop in the bucket, and even had sufficient quantities been available the large number of men necessary to handle them would have made the plan impracticable. Consequently we placed our reliance upon wire cutters and fortunately were able to secure an adequate supply of large, two-handed cutters, which were issued liberally to the infantry. In each platoon a few men were assigned the job of cutting a lane through the wire. Somehow they got through or over the wire, to the amazement of the French officers attached to the division. However, I recall very distinctly that just following that attack it was necessary to issue new breeches and new puttees to practically every infantryman in the Division.

I do not feel particularly qualified to comment upon Colonel Ralston's views regarding the composition and training of corps engineer regiments, but his conclusion that they should be, in general, similar to the divisional regiment with possibly some added bridge equipment, appears to be sound.

There will often be times when the amount of engineer work in the division will call for more troops than can be furnished by the engineer regiment, and details must be made from other troops. We found this to be the case in Germany, where it was necessary to construct a large number of mess halls, kitchens, stables, etc. The materials, and a certain amount of supervision and assistance were furnished by the engineers. When the spring thaw came, a similar situation arose in connection with repair of roads. The engineer regiment and available civilian labor proved inadequate, and it was necessary for several weeks to call heavily upon the infantry, artillery and machine gun units. This recourse should be avoided, however, when practicable for it always causes a slump in discipline, appearance and morale. Of course, the same objection exists in the case of the engineers, but such work is their legitimate function and it is really surprising how quickly they recover in discipline and appearance as soon as they are concentrated for training and given a few inspections by the division commander in competition with the infantry. The engineers like to believe that they can out-drill the infantry, and sometimes they do. When the personnel of the engineer regimnts is as well selected and qualified as it was during the late war, their training should aim at the highest standard of infantry training, discipline and morale. If this be attained a very moderate amount of time devoted to purely engineer training will be sufficient to assure the successful performance of engineer duties.

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Col. John C. Lee
Engineers, Chief of Staff
89th Division, A. E. F.

This article is so sensible and sound that one hesitates to offer any comment other than endorsement, and, if one many, commendation. Without doubt the Board of Engineer Troops builded well. The regimental organization and general equipment were fully justified. It is felt that the engineers "delivered," and delivered in a manner creditable to the splendid traditions of the Corps. The author clearly points out certain defects in the organization, equipment, and handling of engineers. He has mentioned practically all that I have noticed.

My limited experience with engineer "specialist" organizations, as such, leads me to vote against them. I believe that the specialization needs can be met by selected officers and certain technical N. C. O.s—master engineers and sergeants 1st class—while the rank and file are just the run of hardy, well trained pioneers. Practically every result-getting engineer I talked to in France was opposed to specialist companies, battalions and regiments as such. It is believed that a few really capable specialists—by that I mean practical men of specialist training, not just theorists or extremists—can soon put a good pioneer organization into a special service job with assured success.

One of the great faults in our recent system—quite beyond engineer power to remedy, no doubt—was the curse of robbing organizations of their skilled men. I know of one engineer regiment particularly, and dare say the same conditions held for all others. This regiment was just built up of men from the river counties, mountain counties, mining counties and the two largest cities of Missouri in order to get pontoniers, woodsmen, miners and artisans. Since its division was drawn from agricultural states, it was felt that the engineer regiment should be given this special opportunity to get its personnel. A splendid lot of men were gotten together—a well rounded class of healthy young farmers, rivermen, lumbermen, miners, mechanics, surveyors, enginemen and construction men. All being from Msisouri, there was a basis for *esprit*. The colonel and his officers got a fine start on the rest of the division and gave promise of having the best regiment by long odds. Then came the black hand of fate in the cold night and snatched away the best of the men to go—no one knew where. Company organization, regimental esprit, friendship and mutual confidence among these lads went for naught. They had come in together and had grown keen to see it through in the regiment. Jim was ordered out one night as a specialist (secret destination); Jake was left behind. And so it happened again and again. The regiment was robbed and re-robbed of its best material. The men who were left, felt they were the scum—the goats—the day-labor class—cannon fodder. Morale and esprit were almost impossible. Thus a fine regiment, with full promise of a glorious future was shot to pieces before it left its first cantonment.

Now this happened all through the line. I think it was even worse in the infantry. Instead of fostering the feeling in the foot-soldier's heart that he was the man to win the war, that he was the select of the selected; instead of raising his morale and his *esprit de corps* to the highest—well, it seemed that everything was done to secure an opposite result.

The cure is simple enough. When men are called to the colors and assigned to a regiment, there they must serve unless removed for lack of ability—physical, technical or moral. If skilled artisans are needed to make war-winning airplanes, we can draft older men—not bleed our front line regiments of their splendid young material. For replacements, we must have replacement units—and preferably by division if not by regiment. We had a fine start for territorial esprit in this war and then announced that it was scrapped. 'Twas bad enough not to produce on that sound plan. But why *announce* such a false policy? It only hurt morale.

I feel that this is a vital point. For if we meet it squarely we will have well rounded pioneer units, and under our sound system of organization and training, we wont need specialist organizations. A few practical officers and higher N. C. O.s (Regulars who have specialized but principally reserve men whose qualifications should be well known)—these will know the specialty and apply it to war conditions. They can always find numerous assistants and apprentices in a good unmolested pioneer regiment. And the rest of the men can do the attendant routine and labor, and do it on any job.

As the author says, our training system was sound. It's a good thing to dust off Part I of the Engineer Training Manual now, and re-read (or read) it in the light of the recent experience.

It is felt however that the author goes a little too far in his desire to train and equip engineers for infantry fighting. Perhaps he is leaning intentionally against a predicted wave of opposition. Happily, however, it is felt that the need of such a margin in this respect is unnecessary. The old reactionaries who used to talk about arming the pioneer with pick and shovel, really had their deserved rebuke when certain high staff people agreed and proposed for such troops the duty of policing the battlefield and burying the dead. Was it not a case of Greek burying Greek?

Practically every one now admits the pioneer is a fighting man and must be so trained and equipped—not for the prime purpose of fighting—but of being allowed to help the fighting man to the full measure

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of his ability. In an emergency he must fight and fight well. But his first and normal function is to do engineering during fighting, alongside the fighting units.

The automatic rifle is heavy. Infantrymen frequently throw it away, when they get tired, and pick up a rifle. Their officers select the biggest men who are good shots to carry it—and a detail of ammunition carriers is necessary for each auto rifle. Each infantryman goes into action carrying all he can of his special weapons—grenades, extra rifle ammunition, and always some specialist arm or equipment—unless he is a scout and must be left specially mobile.

The engineer goes along carrying bangalore torpedoes, or heavy wire cutters, or Daly's wire escalier, or parts of a light foot-bridge perhaps. He can't be expected to pack a lot of extra infantry equipment too. He must carry his rifle and bayonet and ordinary ammunition. He must be able to take care of himself. But he is there primarily to work.

The use of the automatic rifle as well as the machine gun can profitably, and easily, be taught to the best shots of an engineer organization. In the past we have given special instruction to expert riflemen in the use of the telescopic sighted rifle. This time might well be spent on the automatic rifle, and the instruction extended to sharpshooters. It is believed moreover that sufficient interest could be aroused for these men to take instruction in automatic weapons outside of regular training hours. If possible, instruction should be given in the operation of enemy automatic weapons.

When the occasion arises where engineer troops are thrown into action to replace infantry, the men who have been trained in the use of automatic weapons will quickly pick up many of these arms from the infantry they have relieved or from the wounded and dead. Particularly this could be done in case of an attack. In case of a stubborn defense there is little advantage in the use of the automatic weapon over the efficient use of a full number of good rifles. Engineer troops have always shot well, far better than average infantry—and they should do so. In minor attack problems, reduction of machine gun nests, etc., our fire superiority must be gained by a group of riflemen, less vulnerable than the single auto rifleman, while the flankers work around to the desired point of vantage. In action, if the best shots have picked up automatic rifles, this training will prove all the more effective.

I firmly believe in infantry training for pioneers—both offensive and defensive—but I feel it would be a mistake to weigh down our troops normally with the heavier automatic rifles or other infantry weapons. All pioneers should know how to throw grenades—but should not have to carry them as regular equipment.

Regarding ponton equipage, it is believed that we should still maintain two classes—light and heavy. The light equipage should accompany cavalry divisions and be only strong enough to sustain cavalry divisional loads. In war of maneuver, these trains will accompany the advanced cavalry. In war of position, following a break through, these light trains might be pushed forward for use by the attacking battalions and their supporting guns, so long as the bridges might be subjected to observed fire. The heavier type of bridge, consisting of boats much larger than those now in use, could be of steel construction, tractor drawn, and designed to support all loads of an army corps.

It should be borne in mind however that a balance must be struck between the constantly increasing loads of military vehicles, particularly artillery and tanks, and the capacity of bridges and durability of roads. It is believed that the heavier loads should be broken up or spread out over a wider base, so as to permit workable size bridge equipment to be used, and a practicable system of road maintenance sustained.

Regarding the control of traffic by engineers in the front areas during an advance, such can be only very local control. The general priority and systems of traffic movement should be decided by the commander himself after careful consideration of the probable tactical situation, supply situation, evacuation situation on one side, and the probable condition of the roads on the other. Here he needs the advice of a good engineer, well informed as to the probable work ahead.

If such priority was determined in the St. Mihiel drive, certainly it was not enforced back of Flirey. I understand that D day in the Argonne and the days immediately following were quite as bad around Avocourt. On the last drive however, Nov. 1, 1918, we applied what we had learned—planned a real system of road repair and maintenance, made a real priority list and enforced it. Transportation not on the list for D day was kept back of a dead line—well to the rear. The engineers up front did control traffic over short sections requiring constant maintenance and repair—but it was strictly local. If a corps is attacking, this proirity is a crops matter, and must be enforced mainly by corps and division military police.

The author makes no comment on the training of mounted engineers. When that long looked for real crossing of the border finally comes, our pioneer squadrons must ride with the best, ready and able at all times to do hard and rapid work. We wonder if they are fit.

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Major R. R. Ralston
Corps of Engineers, U. S. Army

It is possible that the suggestion for an additional battalion in the engineer regiment requires a little more explanation, as it was not the intention to increase the total number of engineers in a division.

The strength of the division, with its three infantry brigades, one artillery brigade, and other troops, as authorized by the national defense act of May, 1917, is practically the same as that of the division as organized during the war; but the six engineer companies, each consisting of 4 officers and 164 men, would total only 24 officers and 984 men, as against a strength of 36 officers and 1,500 men in the emergency organization, which is generally conceded to be adequate. Should, therefore, the organization of tables of organization of May, 1917, be substantially retained, nine companies of 4 officers and 164 men should be provided, which would furnish a total of 36 officers and 1,476 men.

Referring to the subject of military mapping by aeroplane photography, the idea which it was intended to express was that aeroplane photography would largely take the place of the numerous topographical reconnaissances, which, in an advance through a poorly mapped territory, are essential to the preparation of a suitable march map. Such reconnaissances are placed together with little or no control, and, in my opinion, much better results can be secured from aeroplane photographs in the preparation of this preliminary map. Later, when instrumental control becomes practicable, the photographs can still be useful in filling in many of the topographic details of the finished map.

The reference by Colonel Kingman to the crossing of the 5th Division at Dun-sur-Meuse as "typical" is correct, and is another illustration of the principle learned by us at Fredericksburg, in the Civil War, that before substantial bridges can be built the infantry must first secure control of the opposite bank, crossing by any practicable means. I do not think, however, that because a fixed bridge was constructed there, we should conclude that a ponton equipage adequate for heavy army loads is not necessary; for many conditions can be conceived of where the construction of such a fixed bridge would not be practicable in a reasonable time. With a suitable system of sectional—and hence metal—pontons, bridges adequate for the passage of lighter transport can be constructed with one or more sections, and afterwards by the use of additional ponton sections strengthened to pass the heavier transport and artillery.

While on this subject, it seems desirable to invite attention to the desirability of closer co-operation between the engineers who are charged with the preparation and maintenance of roads and bridges, and those services responsible for the design of heavy vehicles for supply and artillery purposes, as it is believed that impedimenta intended for transport overland should have certain limitations as to weight, so as to reduce damage to roads and excessive strength in highway bridges. One instance is recalled of a motor repair shop unit traveling overland to Coblenz in the spring of 1919, when the roads were badly damaged by some of the heavy trailers, one of which weighed 27,000 pounds. It is believed that a unit of this kind could have served its purpose equally well if the machinery it carried had been installed on railway cars instead of on trucks and trailers. Our future military operations are likely to be largely in countries where roads are conspicuous by their absence, or where they are of poor quality, and it is unsafe to base our ideas of overland transport on our European experiences, where we had the advantage of the best highway system in the world.

This article and the discussion thereon serve to establish a consensus of opinion on several important matters, by officers whose natural aptitudes and experiences qualify them to pass wise judgment. These opinions will be of great value in guiding our future policy as to the organization, equipment and methods of training of engineer troops for field service. It is also gratifying to find that in most instances the experiences of the late war confirm in a general way, our pre-conceived ideas on these matters. The following are worthy of special note.

Discipline and the soldierly spirit are the most important items of the field engineers' equipment. The most skilled artisans are almost useless in battle unless they are thoroughly disciplined. There never has been and never can be room for any difference of opinion on this point.

Prior to the great war most engineer officers entertained the view that combatant engineer troops should not be highly specialized. It was generally believed that specialization should be within the regiment and not by regiment. The war has thoroughly established the soundness of this opinion. An engineer regiment with the active army will be called upon to perform all kinds of pioneer duties and should be organized, disciplined and trained accordingly. All our colonels commanding divisional and corps regiments took a jealous pride in developing such organizations. They could and did perform with credit every task that was laid upon them. This demands a well balanced regiment, including civil, mechanical and electrical engineers amongst its officers, and a few practical artisans representing each of the common trades. Such an "outfit," when thoroughly disciplined, can "swing in" and make short work of any task. Specialized units may be usefully employed in the service of supply. Here discipline is of less vital importance

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Construction of Lock D, Cumberland River

By

Rufus W. Pafford

Junior Engineer

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miter wall and opening into the pit below the upper gates. The ones used for emptying the pit are located just above the recesses for the lower gates and the two in each wall discharge into the same culvert, which remains within the wall until it gets below the gates, then each discharges from its respective wall opposite the other.

The erection of these valves presented no special difficulty. The form for the opening in the concrete leading from the valve straight down to the culvert is circular also. The valve seat was removed from the rest of the valve and placed over this circular form and bolted to same after being set with an instrument, level and to the proper elevation. The concrete was finished flush with the floor of the valve recess, and after this had properly set the remainder of the valve was bolted to the seat, and forms for the recess for the valve rod were placed as the work on this section of the wall progressed.

The lock was placed in operation December 21, 1916. During the two months that it has been worked, the valves have given no trouble. All of the eight valves are protected from drift by heavy iron screens. These valves are connected by rods to machines located in recesses in the top of the walls. One man can easily operate a machine.

The backfilling which the contractors did is behind the upper and lower guide walls and the land wall of the lock. This was made from waste from the excavation for the foundation of the walls, and a considerable part of it was gotten from the bed of the river with the dredge, unloaded with the regular unloading derrick and brought over the same tracks as the material for the concrete. This material was not screened but deposited just as it was taken from the bed of the river. It was necessary to dispose of practically all of the excavation from the pit before the land lock wall was built, so that the material for doing the backfilling had to be borrowed, and besides the specifications would not allow the use of rock behind the lock wall. The contractors considered this pumping plan to be the cheapest way of obtaining backfill and were allowed to use this natural mixture of sand and gravel and were required to compact it by pumping water on the pile as it was being dumped from the cars. This work was completed in August, 1914, except for the part back of the lower guide wall, which was done in the fall of 1916 with sediment from the lock pit.

Work on this contract has been completed, except about 300 cubic yards of earth excavation in the lower approach cofferdam and about 3,200 cubic yards of rock excavation at the same place. Parts of both cofferdams yet remain to be removed.

The contract was let to the Foster-Creighton-Gould Company, and they did the major portion of the work covered by the contract; but they have been succeeded by Foster and Creighton Company. Practically all of the work has been done under the supervision of Mr. W. F. Creighton as superintendent and his assistant, Mr. J. S. Dunbar, Jr. Major H. Burgess, Corps of Engineers, was in charge of the river work in this U. S. Engineer District until July 22, 1916, when he was relieved by Captain Jarvis J. Bain, Corps of Engineers; Captain Bain in turn having been relieved September 26, 1916, by Major Lytle Brown, Corps of Engineers. Mr. Jno. S. Butler, Assistant Engineer, had supervision of the Cumberland River. The writer was resident engineer.

Discussion

Lt. Col. Lytle Brown

Corps of Engineers

The construction of this lock, taken as a whole, was an excellent piece of work. The contracting firm, though not backed by great resources, was directed by men of sterling character, and sound judgment. Their local representative, a young graduate civil engineer, was exceptionally energetic and zealous, and worked for his firm with perfect loyalty. These are the principal facts which led to the successful completion of the work.

A point which may be criticised is the coffer of the lower approach. It was inadequate to keep out water. Experience shows that a failure to appreciate the importance of solid and adequate cofferdam protection is the source of most loss and trouble in lock and dam construction.

While this article treats of the construction of the lock only, an incident in the construction of the dam illustrated the lack of appreciation on the part of the contractors for the dam, other parties than for the lock, of the power of the stream.

The abutment lay against an alluvial bank; half of the dam, a rock-filled crib structure, rested on gravel as a foundation; this was the half next to the abutment. The half of the dam adjacent to the lock rested on solid rock as a foundation. Had there been any failure of the dam it would have been in that half next to the abutment. With such a failure, the other half remaining intact, the river would have opened a considerable channel around the abutment by attack from down stream. At least this is most probable, though

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good rip-rap was placed on the bank below the abutment.

To insure protection to that part of the dam resting on gravel, a very heavy rip-rap apron of derrick stone was provided in the plans. The placing of this apron was slow and heavy work, and in rushing the work on the dam the contractors pushed the structure up to full height before they placed the rip-rap apron. High water caught them before they could place the apron, and they could not then approach the dam, either from above or below with their plant in order to complete the apron. A season of high water was before them, and the weak end of the dam, without adequate protection, was exposed for the entire high water season.

A cableway was borrowed from the Louisville District and strung across the stream below the dam so that derrick stone could be taken from barges in the lock and dropped into the apron area below the dam.

This was a simple piece of work without any striking features, but is typical of its class.

The author has well presented a number of features of economic importance which will be of interest to those engaged in construction in streams subject to flood. Amongst these the following are noted:

1. Accurate predictions as to the number of available working days or when they will occur, depending on the stage of water, are very difficult in river work. It appears to be a wise rule, when operating in flashy streams, to make the utmost use of periods of low water to concentrate on work which can not be done when the water is high.

2. The most important feature of work of this class is the proper design and construction of the coffer-dams. Colonel Brown points out that inadequate coffers are the chief cause of loss, delay and failure in lock and dam construction. In this case the author considers that an inadequate coffer was responsible for two years of delay in the completion of the work. Considerable latitude was apparently allowed the contractor in the construction of the coffer-dams. Whether or not this is wise depends on the contractor. It invites taking chances. Generally speaking, the government representatives, who are familiar with conditions on the river, are best qualified to determine what coffer-dams are necessary and to prepare the designs for same. Alternative designs submitted by the contractor should, of course, be given consideration. But the loss due to inadequate coffers does not fall alone upon the contractor. A few failures due to this cause give river work an undeservedly bad reputation amongst contractors, resulting in difficulty in obtaining bids and unnecessarily high prices to the government. Skill and good judgment in working under flood conditions have enabled some contractors to make good profits and bad judgment has meant failure and ruin.

3. Difficulties of channeling in hard rock. It may be better to excavate farther back from the face desired, by other methods.

4. Cyclopean or rubble concrete was advantageously employed in this case. The disadvantage of cyclopean concrete is that if constructed with sufficient care to insure ample strength the excess cost of labor may outrun the saving in material.

5. It does not pay to break rock too fine, as this usually increases the cost of subsequent handling. In this case larger pieces were handled more economically. This, of course, would not be true when the rock was removed by a steam shovel loading into cars or wagons.

6. The long boom derrick seems generally to best meet the situation in handling material on lock and dam construction. It is, however, a matter to be decided locally in each case, but before a cableway is installed it should be quite plain that the conditions call for its use. Derricks are used on nearly all construction jobs and are never "white elephants" on a contractor's hands, which a cableway is very apt to be.

7. Superior speed of erection of panel forms. Time is of the essence in river work, as it is in war. Better structural results are probably obtained with continuous forms.

8. A chute would appear to be the best way to place concrete on such a job as this. Specifications should not limit a contractor in this respect, since chutes are now successfully used in high grade column, beam and slab construction.—Ed.

Protection of Piles with Gunite

"Gunite," or dense mortar applied with a cement gun, is being employed to incase the piles of wharves and railroad trestles as a protection against marine borers, the teredo and limnoria. A single "gun" can cover about 75 square feet of surface to a depth of 2 inches in an hour, according to the statements of the manufacturers. The thickness of the coating of gunite varies from a thin scale up to 8 inches, depending on the condition of the pile. The latter thickness, of course, amounts to a re-building of a damaged pile. The treatment is applied only to that portion of the pile subject to the attack of the marine borers. It is claimed that after a seven-day set it was difficult to fracture even the thinnest scale with a hammer. When a coating of some thickness is applied better results are obtained by using a chicken-wire or expanded metal reinforcement. Piles which have been slightly damaged retain the coating better than new ones, as the mortar is forced into the holes, thus forming an anchorage for the casing, and killing any worms in the pile.

There is not as yet sufficient data to prove the durability of piles thus treated, but it seems a conservative estimate that in teredo-infested waters the life of piles may be increased from five to ten times or even more.—*Stone and Webster Journal.*

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Engineer Duties in the Field in War

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and such units may be organized after the outbreak of war.

The organization of the pioneer regiments is regarded as satisfactory and the proportion of engineers as about correct. The engineer train should, however, be a part of the regiment, probably included in a supply company.

Road and bridge work constitute by far the most important duties of engineers with the active army.

Mapping and map reproduction on a large scale are proper functions of special troops. But a certain amount of such work will be required of all combatant engineer units who should therefore be provided with a simple equipment and the necessary personnel for this purpose. Lithography in the field will seldom be required of combatant units and a field lithographic equipment is hence regarded as unnecessary.

Aeroplane photography will to a great extent obviate the necessity for "filling in" topography by ground methods. It is as yet a moot question to what extent ground forms may be portrayed by this method.

Small electric lighting plants for divisional headquarters and other uses will be required. The divisional engineer units should be able to operate them.

Searchlights find little application in open warfare except for anti-aircraft defense. They should be procurable if needed, and the engineers should know how to operate them.

The impedimenta of the modern army demand heavier bridges than were necessary in the past. At the same time there is as great a need as ever for a light, portable equipment, including foot bridges. The solution would appear to be a floating equipment capable of being readily reinforced to carry at least all the divisional artillery with its tractors and heavy trucks, and probably even the 6-inch corps artillery. This should be supplemented by standardized trestle bridges of wood, or wood and steel, capable of carrying the heaviest loads. It seems doubtful whether a single type of floating bridge (in addition to foot-bridges) will meet all requirements, but this might be accomplished by the use of sectional pontons. The Lampert type bridge, which is a miniature canvas ponton, seems admirably adapted as a foot-bridge, and is the lightest, most portable and most quickly installed of any outfit that has been devised.

Divisional engineer regiments should be provided with a few tractors for hauling heavy materials and helping out stalled vehicles. If these were regarded as desirable in France they are certainly apt to be much more so in any other locality where the American army might operate.

The term "pioneer infantry" is regarded as unsatisfactory. The labor auxiliaries of the engineers should be "engineer service battalions," whose officers are engineers.

The corps engineer should not be the immediate commander of the corps engineer regiment.

There is no unanimity of opinion as to the extent to which engineers should be intrusted with traffic control. The solution is apparently a degree of control on roads actually under improvement by the engineers, and a close liaison between the engineers, G-1 and the A. P. M.

There is the usual sharp difference of opinion as to the extent to which engineers should be employed as infantry. A reasonable compromise between these divergent views is perhaps this. The engineers, being trained and equipped as infantry, form a reserve available as infantry in case of grave emergency. They should not *habitually* be so employed, nor to an extent which would unduly interfere with the performance of their proper functions. Engineers can be and will be used as infantry on occasions. They should have thorough training in infantry duties, and will be better engineers if so trained and in fact will not be good engineers *unless* so trained. This idea is well expressed in the last paragraph of the discussion by Colonel Kingman.

The practice of robbing engineer organizations of their skilled personnel, referred to by Colonel Lee, was undoubtedly carried to excess, and in many cases was most injurious to the working capacity, and still more to the morale of these organizations. It is, however, an inevitable procedure in the case of a nation plunged suddenly into a great war without previous preparation. It is one of the many evils resulting from our policy of leaving the national defense to chance.

There was, accordingly, some justification for the practice during the late war. Each commander and soldier should remember that, as Kipling says, it ain't the engineers, nor yet the infantry that win the battle, but "the bloomin' 'ole." If it can be shown that a certain man will be more useful elsewhere, and sufficiently so to justify the damage done to the organization from which he is transferred, then the transfer is proper, and in the interests of "the bloomin' 'ole." If the transfer of a few men will raise the efficiency of the machine as a whole, even if it temporarily lowers that of a certain organization, it is justifiable. We are all very prone to jealousy of our own personnel and equipment, and to feeling that the entire burden rests on us, instead of upon the whole army and the nation. Of course the way in which each commander can best help is to make his own "outfit" as good as possible. But he may do this and still not disregard the general efficiency. It is a fact that some of the engineer regiments that went to France were too "rich," that is they contained too large a propor-

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tion of highly skilled mechanics who had often to be used as common labor. It is not a few good organizations that we need, but a high average, with all close to the average. A company composed entirely of marksmen is better than one containing a few experts and a corresponding proportion of "unclassified." It may not make as good a showing in a team competition, but it will be more dangerous in battle. An organization all of whose members were skilled mechanics would have a fine esprit, but it would not be an economical organization. The British learned this to their cost at the beginning of the war.

Local pride, resulting from all the members of the organization being from one locality, is a splendid thing and should not be wantonly destroyed. But there is a higher and more stimulating pride based upon *what we have done*, as many an engineer and infantry "outfit" in France has proven.

The robbing of organizations is most hurtful if carried to excess. This was well expressed by a captain in the writer's old regiment, who was protesting against the transfer of some of his best men. He said: "If a house is held up by 14 props don't knock them all out at once, or the house will collapse. If you must have props for other houses we will give them to you. But take a few at a time, and give us a chance to put in new ones before you take any more."

The only way in which this evil can be avoided is by creating a properly balanced organization in the first place, so that violent disarrangements will not be necessary. This requires a military policy such as the United States have never possessed.—ED.

Largest Bascule Bridge

The new bascule bridge across the Chicago River, installed by the railroads, is the largest of its type, being 260 feet between bearings of the movable arm. It is of the Strauss heel trunnion type. The two concrete counterweights weigh 885 tons each.—*Eng. World.*

Canal Across New Jersey

The state of New Jersey has surveyed a route for a canal from Bordentown on the Delaware River to Raritan Bay, and has appropriated $1,000,000 for right-of-way, contingent on the construction of the canal by the Federal Government.—*Eng. World.*

Extension of Our Highway System

The Federal Goverment has undertaken the construction of some 65,000 miles of paved highways throughout the United States. The various states of the union will construct and improve some 250,000 miles. Counties and municipalities will construct and improve 300,000 miles. This will make a total of over 600,000 miles of metalled road, the approximate cost of which will be 14 billions of dollars, divided as follows:

To the federal government, 2 billions.
To state governments, 6 billions.
To counties and municipalities, 6 billions.

All of this will be paved or metalled road. In addition to these figures 3 billions will be expended for earth roads. The approximate average costs per mile according to the above figures are

National highways	$30,000
State highways	24,000
County and municipal highways	20,000
General average	23,000

During the year 1918 some 250 millions were expended for roads, and during 1919 some 500 millions. It is expected that the rate of construction will be greatly increased in coming years.

Upon the completion of this work the United States will have, for the first time in their history, a nation-wide system of good roads, but there will still remain nearly 2 million miles of unimproved earth roads.

Engineers and National Defense

At a meeting of the American Society of Civil Engineers on October 15, 1919, in New York City, the subject of the "Relations of the engineer to the future military activities of the United States" was discussed by a number of prominent engineers from the army and civil life, and a resolution was passed referring the matter to Engineering Council for action. Maj. Gen. W. M. Black, Chief of Engineers, and Maj. Gen. W. C. Langfitt, former Chief Engineer of the A. E. F. were present.

Engineering Council has appointed a committee, designated as "Military affairs committee," which consists of the following:

Wm. Barclay Parsons,
Harold W. Buck,
Roger D. Black,
George Gibbs,
Fred J. Miller,
F. A. Snyder,
G. D. Snyder,
Leonard Waldo,
Paul G. Brown,
Lincoln Bush,
W. A. Starrett,
H. S. Crocker,
G. P. Solomon.

Wm. Barclay Parsons, 60 Wall Street, New York City, was designated as chairman, and George D. Snyder, 30 Church Street, New York City, as secretary.

The committee wishes to make a broad and comprehensive study of the problem of utilizing the technical resources of the country, in both men and material, in the event of war, desires the co-operation of the technical men of the country, and will welcome suggestions and information.

The recommendations of the Society, when formulated, will be presented to Congress.

The program for road construction in France involves the expenditure of about two billion francs which is expected to produce a road system even better than that existing before the War.

Building Cost in 1919

It is estimated that building projects in the U. S. in 1919 cost $2,600,000,000 which is nearly a billion dollars above the previous high record of 1918.—Eng. World.

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When Are River and Harbor Improvements Worthy

of Being Undertaken by the Federal Government?

By

Maj. J. R. Slattery
Corps of Engineers

THIS is a question that recurs frequently in every river and harbor district. Most district officers have probably felt the lack of rules for their guidance. Congress has stipulated only that decisions are to be based on the commerce to be benefited. Hard and fast rules could not advantageously be laid down, on account of the numerous phases the problem presents, but it is proposed to submit certain rules, which, it is believed, do offer a conservative and more or less rational guide for most cases.

In considering this subject, improvements will be grouped in two classes. Under the head of rivers will be included channel improvements, such as those of the Ohio, and Mississippi above New Orleans—in other words, channels intended to provide for the continuous movement of freight. Under the head of harbors will be considered harbors proper, and such river improvements as are undertaken principally to serve as part of a port; for example, the Mississippi below New Orleans, the Delaware below Philadelphia and the Columbia below Portland. The former class corresponds to that portion of a railroad system between termini; the latter class corresponds to that portion of a railroad system at a terminus.

River Improvements

Persons investing money in the construction of a railroad, expect that within the reasonably near future there will be such a movement of freight and passengers as to produce a revenue sufficient to pay operating costs (including maintenance), a fair return on the capital invested, and allow the accumulation of some surplus. It is believed that the Federal Government can properly adopt a much more liberal policy in undertaking improvements than a private corporation would be justified in following, but on the other hand it is certainly wrong for the Government to embark on improvements that are economically unsound, or to continue improvements which, though economically sound in the beginning, have become unsound through changes in conditions. For example, before railroads are built in some part of a country, undeveloped, but capable of development, it might be sound policy to undertake the improvement of waterways capable of serving that country, with a view to assisting in its development. As the country develops, however, and railroads are built, there may come a time when so little use is made of waterways that their further improvement becomes economically unsound. The Erie Canal is, perhaps, a case in point. Before such improvements are altogether abandoned, however, consideration should be given to their possible use in the future, when further development overtaxes the railways, and it may become necessary to utilize all possible methods of transportation in order to care for the needs of the territory.

Consider first the case of undeveloped territory in which there are neither railroads nor improved river channels. This is the most difficult case for which to suggest a reasonably convincing rule, and any rule must be more or less arbitrary. Manifestly, development will not occur more rapidly than the produce of the country can be placed on the market, and sold at market prices, with profit to the producers. The real question to decide would seem to be to what extent the Federal Government is warranted in undertaking river improvement in order to offset the excess cost of profitably placing the produce of this undeveloped country on the markets, over that of produce actually coming to markets from other sections of the country.

If it were known, that unless certain territory were developed, the market price of such produce as could be obtained from that territory would increase by an amount which would represent at least 4 per cent interest, plus all fixed charges, on the capital that would be necessary to develop that territory and start its produce moving in such quantities as to prevent the market price rising, it would certainly be to the advantage of all for the Government to invest

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that amount of capital in the development of the country. It would seldom be possible to determine just when such conditions would be fulfilled. If the market prices of what this undeveloped territory might produce were such that, if transportation facilities were provided, this produce would move in quantities, and at freight rates such that the revenue produced would at least equal cost of operation, maintenance, renewals and improvements, and 4 per cent interest on the first cost of such facilities, then, too, investment by the Government of the capital necessary to aid such facilities would be to the advantage of the country as a whole, provided the revenue from such facilities accrued to the Government.

It has not been the usual policy of the Government to construct and operate either railroads or boat lines, and it would not seem reasonable to base Government investment on earnings that do not accrue to it. Would there not, however, be reason in basing Government investment on *saving* in cost of transportation that might result from its investment, provided the amount of saving was commensurate with the amount invested, and provided, further, this saving was based on the difference in cost between more or less economical methods of transportation? If the amount that the Government was warranted in expending in the improvement of a river were measured by the difference in cost between hauling freight by wagon and by water, very large expenditures would appear to be warranted, and the Government might be assisting the locality, at considerable expense to, and therefore to the disadvantage of, the people as a whole. The locality might, however, be able to produce such great quantities of certain things, of which there was such a great scarcity on the market, so affecting their market price, to the country as a whole, as to fully warrant investment based on such great differences of cost. But it is probable that, generally long before such conditions existed, the possibilities of the country would have become so attractive to private capital as to have brought about the construction of railroads. Would not the difference in cost between hauling freight by rail, and by moderately improved river channels, seem to offer a fair measure for the saving to be considered? This difference may be taken as 4 mills per ton mile as a general average, although it would not be safe to assume that this was true in every instance.

If it should appear probable that, as a result of improving a river channel, the products of the territory served by such channel would move in such quantities, that if charged channel dues of 4 mills per ton-mile, the revenue produced would amount, annually, for an indefinitely long period of years, to the annual cost of maintenance plus 4 per cent of the first cost of the improvement; or would amount, in total, during a limited period of years to the total expenditures that would be necessary during that period for new work and maintenance; then it is believed such expenditures would be economically sound and fully warranted.

When railroads are built by private capital, this capital provides both the roadbed and the rolling stock. When the Government improves a river channel, private capital provides only the boats. In order that the Government investment in the river channel should be economically sound, there should be a saving in the cost of transportation such that it would represent a reasonable return on the amount of public money invested. It is believed that a reasonable return would be an annual saving, probable for an indefinite future period, at least equal to the cost of maintenance and other fixed charges and 4 per cent on the first cost of the improvement; or a total saving probable, during a limited period of years, at least equal to what it would be necessary to expend during this period for both new work and maintenance.

It would not be sound economics to double-track or better a railroad unless as a result of this work the earnings of the road could be increased, either through reduced cost of handling, or increased tonnage that could be carried, by an amount sufficient to pay a fair return on the sums that would have to be expended. Similarly, when a waterway has been or is improved to the extent of providing a usable channel, its further improvement is warranted only where as a result of the improvement there will be such a reduction in the cost of handling freight, or such an increased amount of freight handled, that the increased savings effected will at least equal the increased cost of maintenance plus 4 per cent interest on the additional cost of the new work.

When, therefore, it is a question of undertaking the initial improvement of a river in the interest of navigation, it is submitted that in order to warrant the Federal Government in doing so, one or more of the following conditions should be fulfilled—

(1) If there are no railroads serving the tributary country, it should be reasonably probable that such an amount of commerce will move over the stream that, if it paid channel dues of 4 mills per ton-mile (or whatever the figure might be) there would be produced (*a*) during a long and unlimited future period an annual revenue at least equal to the cost of maintenance, and 4 per cent interest on the first cost of the improvement; or (*b*) during a limited period, a total revenue at least equal to what would have to be spent during such period for both new work and maintenance.

(2) If there *are* railroads serving the tributary country, it should be reasonably probable that commerce will move over the stream, in amounts, and at costs such that the saving over what it would cost to move this commerce by rail at the established rates,

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would at least equal (*a*) annually for an unlimited number of years, the cost of maintenance, and 4 per cent interest on the first cost, of the improvement; or (*b*) in all, for a limited period of years, the total amount that would have to be expended, during that period, for both new work and maintenance.

When it is a question of the future improvement in the interest of navigation, of a channel already improved, so as to be usable, it is submitted that in order to warrant the Federal Government in doing so, at least one of the following conditions should be fulfilled.

(1) There should be probable such a *reduction* in cost of transportation or such an increase in tonnage as to effect (*a*) an increased annual saving, for an unlimited period of years equal to the annual cost of maintenance plus 4 per cent of first cost of the later improvement, or (*b*) an increased total saving during a limited period of years equal to the total increased expenditures that would be necessary for new work and maintenance during that period.

(2) There should be probable, as a result of the new work, such a reduction in the cost of maintenance, including maintenance of the new work, as to at least equal 4 per cent on its first cost.

Harbor Improvements

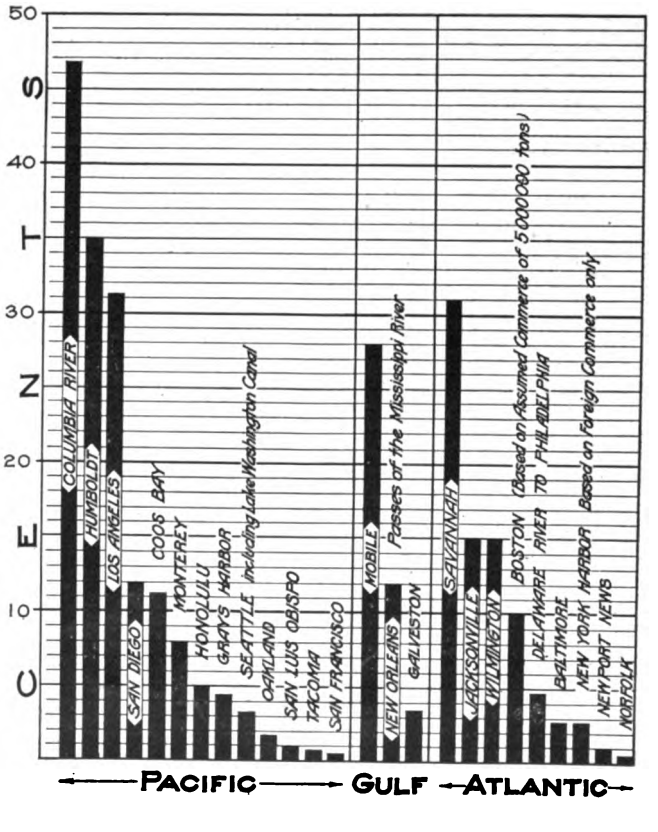
The ton-mileage cost of handling freight at a railroad terminal or in a port can rarely be determined, and even if it could be determined would probably serve no useful purpose. The efficiency of a port or railroad terminal is measured rather by the cost per ton of handling freight through it. In each case this cost might be divided into two parts—in the case of a railroad terminal, into the cost of getting the freight in cars from the running tracks through the yards to the teaming tracks or freight houses, and the cost of handling through the freight houses, and in the case of harbors, into the cost of getting the freight in ships from the open sea up to the wharves, and the cost of handling it across the wharves. In many foreign ports where improvements were carried out by private or municipal capital, as distinguished from state appropriations it was, and in many cases still is, the practice to charge channel or harbor dues. In fixing these dues the aim was to secure an adequate return on the capital invested in the improvement. In the United States the cost of port channel improvements has been borne principally by the Federal Government and no dues have been collected with a view to securing a return on the sums so spent. If, however, it is determined what would have had to be charged per ton of freight handled at the various ports of this country in order to produce a revenue equal to the annual cost of maintenance and other fixed charges, plus 4 per cent of the first cost of the improved channels, the results will indicate to some degree how well these improvements have been warranted. This calculation has been made in the case of a number of ports, the dues determined in each case representing what would have had to be charged the average annual tonnage of commerce during the period 1914-1918, or 1914-1917, in order to produce a revenue equal to the annual cost of maintaining the harbor plus 4 per cent interest on what has been expended on both the present and previous projects where the present project has been completed, or, otherwise on what will have been expended on both present and previous projects when the present project will have been completed. The results are shown in illustration herewith. When channel dues are not collected, it means that whoever pays the cost of the channel improvements, pays a certain amount on every ton of freight that is handled through the port. The chart may therefore be considered as representing what the improvements now completed or under way, at the ports considered, would cost the Federal Government per ton, should the average movements be only equal to the average for the last four or five years.

It s therefore submitted:

(1) That the Federal Government is warranted in undertaking the improvement of a commercial harbor in the first instance, only

(*a*) When there will probably be handled through the port such an amount of freight that, if required to pay *reasonable* harbor dues, the revenue produced would at least equal the cost of maintenance of the

Cost of Federal harbor improvements per ton of commerce



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harbor plus 4 per cent interest on the first cost of its improvement; or

(*b*) When, as a result of the improvement, there would be probable such a reduction in the cost of transporting freight to and from the hinterland of the port, that the amount saved would equal the revenue specified under (*a*).

(2) That the Federal Government is warranted in undertaking the further improvement of a harbor in which usable channel depths and widths have been provided, as compared with other successful ports, only

(*a*) When it is probable that there will result in the reasonably near future such an increased tonnage that if it were required to pay reasonable channel dues the increased revenue would at least cover the increased cost of maintenance, and 4 per cent on the first cost of the additional work; or

(*b*) When it is probable that there will result such a further reduction in the cost of transportation to and from the hinterland of the port, that the amount saved will at least equal the revenue specified under (*a*); or

(*c*) When it is probable that there will result such a reduction in cost of maintaining the harbor that the amount saved will at least equal 4 per cent of the cost of the new work involved, plus the annual cost of maintaining it.

What could be regarded as reasonable channel dues must be determined independently in every case. Dues that, as a general rule, might be properly regarded as prohibitory, might in special cases be entirely reasonable. It is thought that data, such as can be obtained from the preparation of such charts, will afford a starting point in the study of this question, and a possible index of what would constitute warrantable expenditures on a port, the probable commerce being considered, where it is impossible to determine with at least some degree of accuracy the probable effect of a proposed improvement on the cost of transportation. For example, referring to the chart, it is seen that the cost, to the Federal Government, of the commerce of the Columbia River, during the past four years, has been very high, if it is assumed, as would seem reasonable, that this cost is equal to the cost of maintaining the improvement plus 4 per cent interest on its first cost. The thought immediately occurs that possibly the Government has expended a good deal more on this improvement than is warranted, and with such data before him, one would hesitate long about recommending a harbor improvement, when the probable cost per ton of commerce handled would be so high to the Federal Government, unless more or less conclusive evidence could be adduced, that the benefits to be derived from the improvement would be fully commensurate with such costs.

A detailed study of the commerce of the Columbia indicates that the most important items are fuel oil, inbound, and lumber, outbound, and that for at least some years to come about 700,000 tons of each of these articles will probably be handled on the river.

The fuel oil is brought in tank steamers from points in California to points on the Columbia and distributed thence to inland points. The cost of bringing the oil by steamer from California to points on the Columbia is calculated to amount to $1.48 per ton. The railroad freight rate for the same deliveries would be $6.50 per ton. If it were not possible for the oil to be brought to Columbia River points by steamer, these ports and the inland points which they now supply would probably find the next most economical distribution centers from which they could secure oil to be the Puget Sound ports. The rail freight rate on oil from these points to Columbia River points is $1.00 per ton. About 25 per cent of the oil (175,000 tons) is consumed in the immediate vicinity of Columbia River ports, and on this amount it is estimated that a saving of $1.00 per ton is effected as a result of these ports being able to obtain it directly from ships instead of by rail from Puget Sound ports. It is more difficult to determine the probable saving on the 75 per cent (525,000 tons) that is sent into the hinterland. The most reasonable assumption would seem to be—

(*a*) That on that part of it which moved to points more remote from Puget Sound than Portland is, the same saving would be effected as at Portland, namely, $1 per ton;

(*b*) That on that part of it which moved to points nearer Puget Sound than Portland is, the saving would vary from zero to $1 per ton and would average about 50 cents per ton; and

(*c*) That the average saving on the 525,000 tons now distributed from Columbia River ports would be 75 cents per ton. Under these assumptions the saving on oil attributable to the improvement of the Columbia River would be as follows:

175,000 tons, at $1.00	$175,000
525,000 tons, at .75	393,750
Total	$578,750

The lumber that is exported from the Columbia is manufactured principally at mills on the lower Columbia and Willamette Rivers. The logs are brought by logging roads to these rivers or their tributaries, and are then towed in rafts to the mills. It is doubtful if these mills would have been built on the Columbia and Willamette Rivers, if the deep-water improvement had not been carried out. Without the improvement the lumber certainly could not have been shipped from the Columbia, and it seems probable that it would have moved through Puget Sound ports and would have possibly also been manufactured there. The lumber freight rate by rail between Columbia River and Puget Sound points,

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varies from $2.60 to $2.80 per ton. The charges for towing rafts of logs from points on tributaries of the Columbia to mills on the Columbia vary from 50 cents to $1.10 per thousand feet board measure, which is approximately equivalent to from 25 cents to 55 cents per ton, or say, an average rate of 40 cents per ton. It is assumed that the lumber would have been manufactured at mills on the Columbia River, even though the river had not been improved, and would have been shipped thence by rail to Puget Sound for export, then there would have been an additional transportation cost in laying down this lumber ready for export, equal to the freight rate between Columbia River and Puget Sound points—namely $2.60 to $2.80 per ton. It seems more probable, however, that the greater part of the logs would have come to the Columbia River for manufacture into lumber, but would have been shipped to Puget Sound for manufacture there. If it is assumed that the average cost of shipping these logs to Puget Sound would have amounted to $1.35 per ton, then the improving of the Columbia may be estimated to have effected a saving in the cost of laying down lumber at the sea-board equal to the difference between the rail rate of $1.35 per ton and the towing rate of 40 cents per ton—namely 95 cents per ton. The total saving thereon the lumber usually exported from the Columbia would amount to:

700,000 tons lumber, at $0.95..... $665,000

The combined saving on lumber and oil then becomes $1,243,750 per year, which is more than the cost of maintaining the improvement and 4 per cent interest on its first cost. There is therefore a sufficient saving being effected by the improvement in the cost of handling these two items alone to fully justify all that has been done. It would rarely be possible to satisfactorily prove in advance that the saving in cost of transportation would be as great as it appears to have been in this case, and it would therefore seldom be conservative to recommend improvements when the ton cost of commerce to the Federal Government would seem likely to run as high as on the Columbia.

The following table shows the channel or port, dues or tolls, per net registered ton, collected at some European Ports.

Manchester	$0.04 -	$0.15	; according to distance travelled.
London	.02 -	.13	
Southampton		.03	
Kaiser Wilhelm Canal		.144	; on the first 400 net registered tons.
Do.....		.10	; on each ton above 400 up to 600.
Do.....		.075	; on each ton above 600 up to 800.
Do..... ...		.05	; on each ton above 800.
Hamburg		.081	
Bremerhaven		.043	
Antwerp		.095	
Rotterdam	.02 -	.06	
Amsterdam	.02 -	.054	
Brest	.05 -	.095	
Marseilles		.08	
Le Havre.....	.052-	08	; apparently also covers quay dues.
Bordeaux		.12	
Stockholm		.065	; per net registered ton or $0.104 per metric cargo ton—whichever produces the greater sum.

The ratio of net registered tonnage to dead weight tonnage capacity of freight steamers is about 1 to 2, and if a chart such as that herewith were prepared, based on net registered tonnage of ships, the costs would be probably at least 50 per cent higher. Statistics of the net registered tonnage of vessels using a port could be obtained with much greater accuracy than statistics of short tons of freight, and would, it is believed, as a general rule, form a better guide as to the extent to which improvements under way are being justified. Statistics, however, of freight actually carried are also of great importance, as improvements that would appear entirely unwarranted, from consideration of the former alone, would sometimes be found to be thoroughly warranted by consideration of the latter.

Harbor improvements that represent an expenditure by the Federal Government of not to exceed 7 cents per short ton of commerce or 10 cents per net registered ton of vessels, are believed to be, generally speaking, reasonably conservative and warranted. Improvements that promise to cost much in excess of this are believed to be warranted only in special cases, when it can be clearly demonstrated that transportation costs will be so reduced as to warrant the greater expenditures. These figures may seem high when compared with the port dues actually charged, as given in the table preceding, but inasmuch as the dues actually collected rarely afford more than a nominal return on the cost of the improvement, and frequently not even that, expenditures higher than consideration of the table alone would indicate as warranted, may still be conservative.

Topographic Map of United States.

On July 1, 1919, the Geological Survey had mapped 42.6 per cent of the United States (exclusive of Alaska). About one-fifth of this area requires resurvey, leaving but 35 per cent of the country properly mapped.

Of the states, Connecticut, Delaware, District Columbia, Maryland, Massachusetts, New Jersey, Ohio, Rhode Island, West Virginia, are completed. The following states are at the bottom of the list: Mississippi, 4 per cent; Florida, 7 per cent; Minnesota, 9 per cent.

It is estimated that about 40 millions of dollars will be required to complete the work, and that if appropriations are forthcoming as needed this can be accomplished by 1932.—*Eng. and Cont.*

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Surges in Gaillard Cut from Lockages at Pedro Miguel, Panama Canal

By

Maj. R. Z. Kirkpatrick
Engineer Reserve Corps, Chief Hydrographer
and
H. G. Cornthwaite
Assistant Chief Hydrographer, Panama Canal

AN interesting phase of the operation of the Pedro Miguel Lock is the surges set up in parts of Gatun Lake by the drawing of water for lockages. In some respects the surges resemble tidal seiches that occur in enclosed bays or gulfs or at the heads of inlets along the seacoast. The surges are recorded on the hydrographs at Pedro Miguel, Gamboa, Juan Mina and Gatuncillo, and have been noticed as far as 6 miles west of Gamboa. The water-stage register stations mentioned are 8¾, 4½ and 3 miles apart, respectively, as shown on the map herewith. In the experiment shown in the accompanying hydrographs, the surge traveled from Gamboa up the Chagres River arm of Gatun Lake in direct opposition to 1260 c. f. s. of inflow. It has been found, however, that a considerable freshet here wipes out the tendency to surge at the two upper stations.

Conditions attending the surges. Pedro Miguel Lock is at the west end of the 8¾-mile long Gaillard Cut. The immersed portion of the Cut prism is theoretically 300 feet wide by 45 feet deep at lake elevation 85 feet, a cross-sectional area of 14,500 square feet. Due to removal of slides, there are many places which have a greater cross-sectional area than this. To cut down current velocity in the neighborhood of the lock the Canal was excavated 600 feet wide, tapering to 300 feet at a point 4,300 feet from the Lock.

A complete filling of a chamber with Lakes Miraflores and Gatun, at elevations of 54 feet and 85 feet, respectively, requires about 3,800,000 cubic feet of water in a lockage. The wall culverts have minimum clear openings of 255 square feet. If both a side and center wall culvert are opened, a lock is filled in 7½ minutes. If a side culvert only is used, 13½ minutes are necessary. Thus there are about 8,440 and 4,690 c. f. s., respectively, being drawn, according to whether two or one culvert is drawing water. If both chambers are receiving water simultaneously, with all three culverts open, there are 7½ minutes in which water will be drawn at the rate of 13,130 c. f. s. This is the maximum case; and while such operation does not often occur, it would theoretically give a uniform velocity of about 1 f. s. or nearly .6 knot an hour in the Cut during a draft of water. A glance at the hydrograph at Pedro Miguel shows that this flow is *not* uniform.

Surges from lockages. When the valves are opened the canal basin above the locks rapidly falls in elevation (sometimes as much as 1.5 foot, according to the number of valves open); that is, the inertia of rest of the canal water plus the friction from the sides and bottom of the canal, prevents an immediate response to the tendency for a flow of water to set up toward the lock.

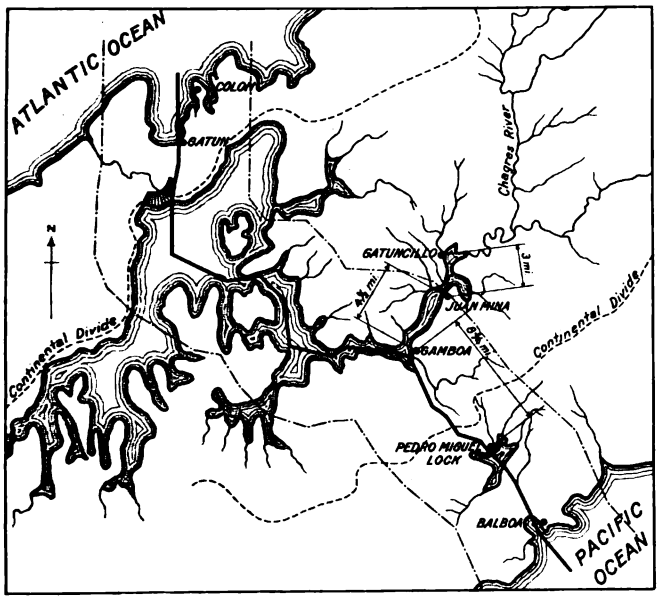
When the valves are closed and the effect of the difference in elevations overcomes the tendency for a retardation of flow in the Cut, an acceleration sets up, which results in a surge or overtravel, the crest of which, is as much above the original lake level as the depression was below. Equalization of levels is finally reached after a series of wave amplitudes, with decreasing intensities, unless their movement is complicated by another lockage.

It is probable that harmonic action may increase or decrease the currents and amplitudes; that is, if a new draft of water should make a depression in phase with a returning depression or trough of a surge from a previous lockage, the resulting oscillations would be unusually large. It is fortunate that the theory of probabilities decrees that these coinciding phases do not often occur but are either partly or totally antagonistic to each other, thereby cutting down the heights of oscillations.

A study of the accompanying hydrographs shows that from crest to trough the oscillations at *all* stations are about 45 minutes apart. Examination of many such hydrographs have shown this definite period occurs daily. During the six lockages of August 3, 1919, the *average* period of time between the same phase of the surges at each station was as follows:

(*a*) Effect of opening valves at Pedro Miguel Lock

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The Panama Canal. Sketch map showing station hydrographs affected by Pedro Miguel lockages

appears on the Gamboa hydrograph in 18 minutes; at Juan Mina in 60 minutes; at Gatuncillo in 78 minutes.

(*b*) Effect of closing valves at Pedro Miguel Lock appears at Gamboa in 19 minutes; at Juan Mina in 60 minutes; at Gatuncillo in 82 minutes.

(*c*) The peak of the return surge after the closing of the valves is observed at Gamboa 25 minutes after it appears at Pedro Miguel; at Juan Mina in 65 minutes; and 87 minutes afterward at Gatuncillo.

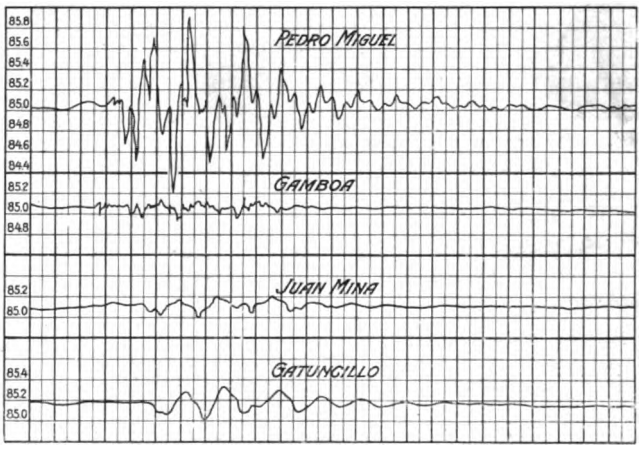
When the crest of a wave is at Pedro Miguel a trough phase is approximately at Juan Mina, and vice versa. The relative heights of successive waves at the various stations vary somewhat, but the wave at Gamboa averages about one-eighth the height of the wave at Pedro Miguel. Wave heights at Juan Mina are about the same as those at Gamboa, while at Gatuncillo, at the head of the Chagres River arm of Gatun Lake, the wave heights are approximately 50 per cent greater than at Gamboa or Juan Mina.

Effects on Navigation

(1) *From currents.* The currents that accompany these surges are generally too feeble to seriously hinder navigation. The currents toward Pedro Miguel are much stronger than the return currents toward Gamboa. Only the former need be considered as constituting a possible danger to navigation. Vessels are required to navigate the Gaillard Cut section of the Canal at slow speed (not over 6 knots). With the precautionary measures that are taken and moderate currents experienced, no serious accidents to navigation have occurred in Gaillard Cut, and but few minor accidents.

In the case of a restriction of a cross-section, as, for instance, by a wrecked hull or a slide, the current and wave effects would assume values that would make rapid filling of Pedro Miguel Lock unsafe for navigation in the Cut. That is, either no water should be drawn during the passage of ships in the Cut, or the culvert valves should be only partly opened so as to draw water slowly.

(2) *From changes in lake level.* These surges have a maximum range in height from trough to crest of nearly 3 feet; that is, the highest crest levels are nearly 1.5 feet above mean lake level and the lowest troughs are about the same distance below the average level of the lake. These changes in the surface level of the lake due to surges, may affect navigation when the lake is down to its minimum operating level by reducing the navigable depth of water in the canal approximately 1.5 feet at the trough phase of the surge. When the lake stands at or near its maximum operating level there would be a tendency for the water to spill over the lock gates into the lock chambers and machinery pits at the crest phase of the surge. This tendency is not important as the gates and masonry walls at the upper end of Pedro Miguel locks were built higher than the maximum operating level to prevent spilling over.



Hydrographs at various stations, showing effects of lockages at Pedro Miguel

Remarks

It is believed designing engineers may find points of value from a study of these surges. Surges may be expected where heavy intermittent drafts of water occur through a long channel. Somewhat similar surges are said to occur in the Soo Canal. The magnitude, period and character of the surges will depend upon the quantity of water drawn per unit of time, the frequency of operations, the size and shape of reservoir drawn upon, and the mean hydraulic radius and length of canal through which the water is drawn.

A designer of a ship canal subject to intermittent draft by lockages, should carefully consider the points above with respect to

(1) Disturbing currents,
(2) Reduction of navigable draft of water at trough phase of canal and
(3) Height of lock masonry and gates with reference to the crest phase of the surges.

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CURRENT NEWS

Note.—This department will include news items of professional or personal interest concerning individuals and organizations in the Army, National Guard, Reserve Corps, Reserve Officers' Training Corps, the Service Schools, the U. S. Engineer Department, other departments or bureaus of the Government, and other related activities, both civil and military.

In the PROFESSIONAL NOTES section will appear news items, short articles and digests on matters relating to current developments in engineering and allied sciences and the art of war—of special interest to the military engineer.

Contributions to these columns, whether from original sources or from other periodicals, are solicited from all our readers. Such contributions should be submitted in time to reach our office not later than the 15th of the month preceding each issue of THE MILITARY ENGINEER

News of the Services

Engineer Districts

Charleston District: Maj. G. R. Lukesh

Two contracts have just been entered into for dredging in Cooper River near Charleston, S. C. The work is part of a project for a channel 40 feet deep at mean low tide and 1,000 feet wide and 22 miles long, estimated to cost $7,500,000. The channel is designed to afford access from the Atlantic Ocean to a projected 1,000-foot dry-dock at the Charleston navy yard for the largest vessels of the Navy.

While the channel is intended to serve the Navy Department, it will be a decided asset to the commercial interests of southeastern United States passing, as it will, the wharves of Charleston. It will furnish a commodious deep-water channel of very short length and easy navigation from the ocean to wharves where facilities for interchange of freight between boat and rail are already to some extent in existence and where they will doubtless be established to greater extent as commerce demands them.

The unit prices of the two contracts are 33½ and 34 cents per cubic yard; the contract consideration in each case is, in round numbers, $300,000. The material to be dredged is sand, broken shell and some clay and mud. The dredging will be by pipe-line, and a convenient and suitable dumping ground is found near by on the marsh forming part of the naval reservation. The specifications were so drawn as to require dumping on this land and regulating its distribution, so that the material dredged will form valuable land for Navy Department uses.

New Orleans District: Lieut. Col. H. Deakyne

Mississippi River

A contract was entered into September 27, 1919, with L. F. Alexander for the construction of 10,600 feet of bulkhead placed between the jetties at the Southwest Pass, Mississippi River. These bulkheads will consist of double rows of close-spaced piles. The purpose of these bulkheads is to contract the channel between the jetties to a uniform width of 2,400 feet.

The work of constructing submerged deflecting dikes and spur dikes at the Head of Passes, Mississippi River, in connection with the maintenance of channels through South and Southwest Passes, is practically completed. The submerged dike, located on the left bank of the river immediately above the head of Pass a l'Outre, consists of a fascine mattress, 200 feet wide and 1 foot thick, extending at right angles from the left bank of the river for a distance of about 2,000 feet, and thence turning downstream and connecting 2,200 feet below the headland between South Pass and Pass a l'Outre. This dike is supplemented by a system of pile dikes along the left bank of the river immediately above the head of Pass a l'Outre. The object of the dikes is to control the flow through the Passes and to destroy the shoals that form periodically in the wide channel at Head of Passes.

Intracoastal Waterway

All bids for the Mermenau-Colcasieu Section of the Intracoastal Waterway were rejected and the work will be readvertised with slight changes of specification. The work includes 37.5 miles of channel, through marsh land and existing waterways, to have a least cross-section of 5 by 40 feet.

Mobile District: Maj. R. S. Thomas

Survey of Mulberry Fork, Black Warrior River

By authority of Congress, a survey has been made of Mulberry Fork (including Sypsey Fork) to 7 miles above Sanders Shoals. The purpose of the survey is to locate sites for locks and dams to extend slackwater navigation of the Black Warrior and Tombigbee system into the great coal fields of Alabama, known as the Black Creek Group, estimated to contain 200,000,000 tons of coal of high grade. The survey was made between June and December, 1919, at an approximate cost of $30,000.

Galveston District: Lieut. Col. Spencer Cosby

The tropical storm of September 13, 1919, caused considerable damage to jetties and dykes in the vicinity of Port Aransas, Texas. The center of the storm passed inland from the Gulf near Corpus Christi, Texas, (about 20 miles from Port Aransas). All the bridges over the intracoastal canal from Galveston to Corpus Christi were carried away. The storm also caused some damage to construction work on the Galveston seawall extension, due to scour around the completed portion of the work. Construction work on the seawall extension was again begun after an interval of six weeks which were devoted to repair of storm damage. The dredging fleet in the Galveston district was not severely damaged, but some portions of it were scattered by the storm.

The U. S. 12-inch pipe-line dredge *Guadalupe* was completely destroyed by fire November 27, 1919, near Freeport, Texas. The cause of the fire is unknown, but it was probably due to waste oil catching fire. No lives were lost. The

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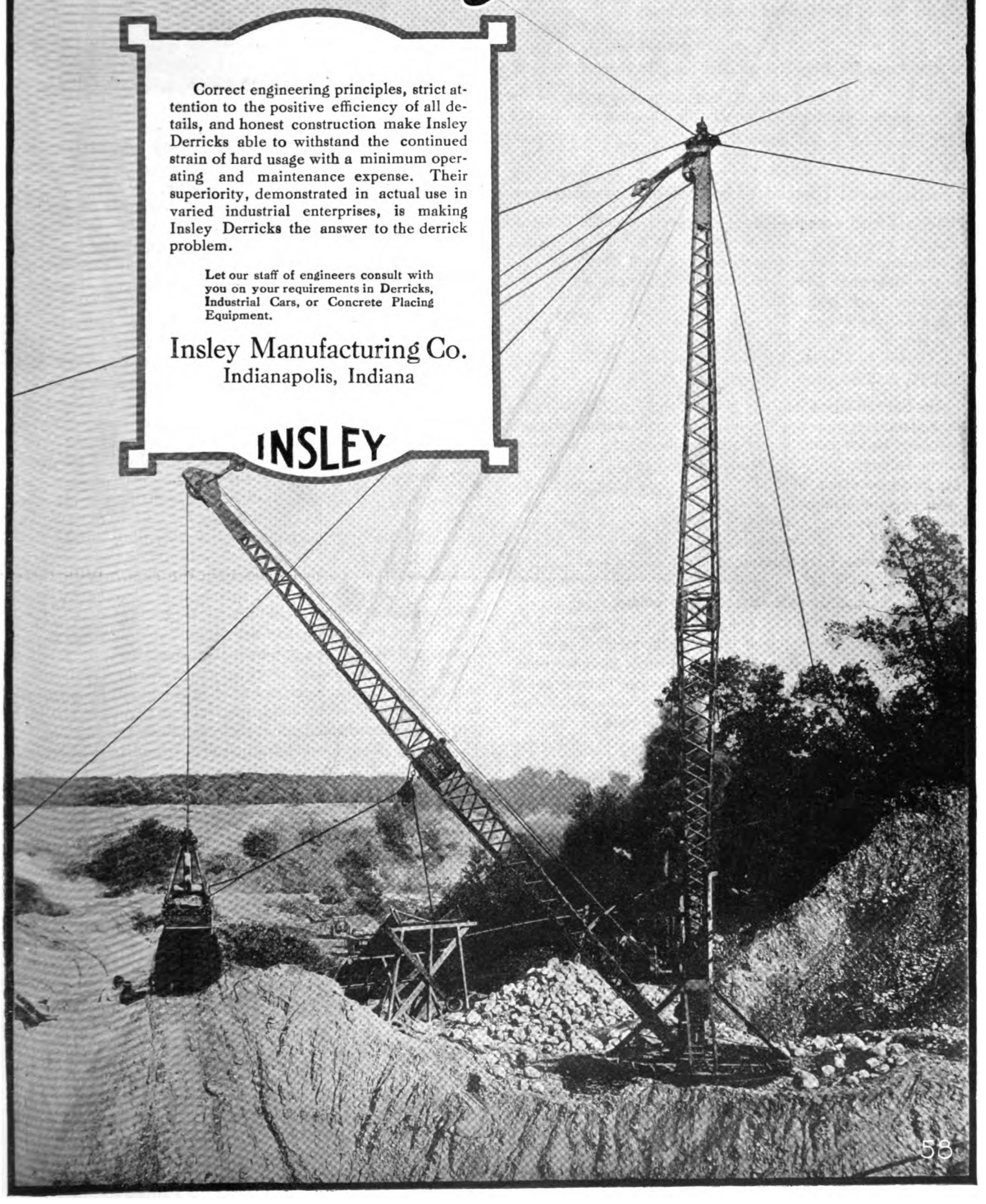
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dredge was employed on light-draft projects in the Galveston district.

Major Raphael C. Smead (Engineer Reserve Corps), principal assistant engineer in Dallas and Galveston Districts, and engineer in charge of the Galveston District during the War, died suddenly in his office November 28, 1919. Major Smead had been in charge of much of the construction work on the Washington Aqueduct and on the dam across the Potomac River at Great Falls, Va. He had been in the Engineer Department continuously since 1885.

Maj. C. L. Hall, Corps of Engineers, has reported for duty under the orders of the District Engineer at Galveston.

Rock Island District: Lieut. Col. Harry Burgess

With a view to equalizing the work in the Rock Island and St. Paul districts, that portion of the 6-foot channel improvement of the upper Mississippi River from St. Paul to the Wisconsin River was transferred December 1, 1919, from the Rock Island district to the St. Paul district, taking from the former 212 miles of river. Included in the transfer were the sub-offices and personnel at St. Paul and La Crosse, in charge of assistant engineers J. D. DuShane and W. A. Thompson, respectively.

Jr. Engr. Robert Iakisch was on October 31, promoted to assistant engineer. Mr. Iakisch was for several years on duty under Asst. Engr. Edwards, on the Mississippi River between the Wisconsin and Le Claire, and has now for two years been in charge of the section between Hamburg and the Missouri River.

Kansas City District: Maj. R. T. Ward

Missouri River Improvement

The work of providing a 6-foot depth of channel from Kansas City to the mouth of the river, by regulating works, is about 32 per cent completed. The work includes revetment on concave bends and pile-dikes on convex bends. The revetment consists of a continuous willow mattress paved with concrete on both edges. The cost of this mattress is about $14.00 per linear foot and of the pile dikes about $20.00 per linear foot.

No systematic improvement of the river above Kansas City has ever been undertaken. Present operations are confined to snagging.

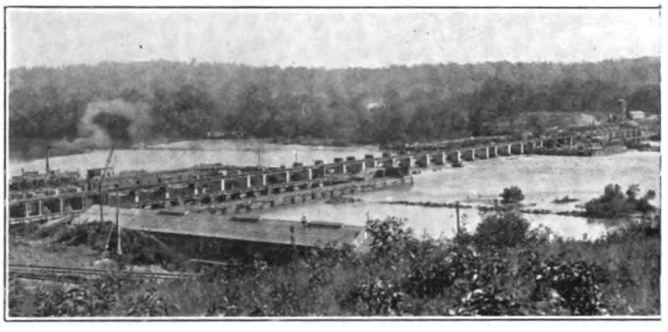
Maj. Wm. M. Hoge was relieved from duty as assistant to the district engineer on November 5, and ordered to the Virginia Military Institute as instructor.

Florence, Ala., District: Lt. Col. Lytle Brown

As the result of a recent transfer, the entire Tennessee River is now included in the Florence District.

Progress on Wilson Dam, Tennessee River

The Wilson Dam at Muscle Shoals (Dam No. 2), will be 96 feet high from bedrock to pool level, and over 4,000 feet long. With its volume of masonry, nearly a million cubic yards, this dam will be one of the largest ever constructed. The fifteen turbines, each of 30,000 H. P., at the south end of the dam are designed to develop a yearly output of



between 300,000 and 375,000 H. P., net—only four of these will comprise the initial installation. Of the 100,000 net H. P. thus first generated, the bulk of the power will be supplied to nitrate plant No. 2, close by. A flight of two locks, each 60 feet wide and 300 feet available length, at the north end of the dam, connects the lower and upper pools. Thus, with the later completion of Dams 1 and 3, below and above, the Muscle Shoals, which has always constituted the most serious obstacle to navigation on the Tennessee, will be completely eliminated.

Construction work on the dam is in the preparatory stage. About 10 miles of railroad have been built. The first of six cofferdams was unwatered in August, 1919, and the rock has been largely removed from the excavation for the cut-off wall along the heel of the dam. A construction bridge, with concrete piers, and track level above ordinary flood heights, is being built upon the apron of the dam. About two-thirds of the total mass of 10,000 cubic yards of concrete in the piers has been placed. This bridge will carry four standard-gauge tracks and will handle all supplies and material going to the dam. On a fifth wider track will be mounted seven 10-ton travelling tower derricks, with 90-foot booms, which will lift the concrete in skips from the cars and place it in the dam. With these derricks in operation by next spring, it is planned to place 2,000 yards of concrete per day.

In order to provide the aggregate for the concrete, a dredging fleet is being assembled at Buck Island, 9 miles below Florence. Two powerful suction dredges will work at a bar of excellent sand and gravel, which will be screened and washed, and then towed upstream in barges. The last 2 or 3 miles' haul will be by rail to the three mixing plants. The largest plant, located on Jacksons Island in midstream, is equipped with two 4-yard mixers; the other two each have 2-yard mixers.

Work on the south side of the river at the power-house site has just fairly commenced. A railroad connecting the nitrate plant with the abutment is nearly completed. Three additional traveling tower derricks will handle the concrete for this section of the dam.

The work is being prosecuted with hired labor, and the growing pay-roll now numbers 4,000 men. A construction camp, with facilities to house and mess about half this number, has been completed on the north bank, 3 miles from Florence, while housing facilities at nitrate plant No. 2 are available on the other side.

The construction is under the immediate direction of the District Engineer, Lt. Col. Lytle Brown. Of his assistants, Maj. S. C. Godfrey is in charge of Administration and Supplies, Assistant Engineer D. A. Watt of the Engineering Division, and Assistant Engineers Joseph Wright and J. S. Butler of Construction Divisions 1 and 2 (north side and south side).

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Lackawanna Steel Sheet Piling Cofferdam

For Building U.S. Government Dry Dock No. 4

Norfolk, Virginia



The cofferdam, in which the outer or gate section of this dry dock was constructed by George Leary Construction Co., consisted of 14-inch by ⅜-inch Lackawanna Arched-Web Sheet Piling in 40-foot and 65-foot lengths.

The original boring indicated materials to be sand, shell, clay, and muck, very unstable and apt to be very porous.

The preliminary excavation was completed, temporary timber forms set, and the steel sheet piling assembled around these forms complete. The closure was then made and the walls were driven to refusal. The 65-foot steel sheet piling lengths were cut off at the dock floor level and the bottom ends left in position as a permanent protection wall for the outer end of the dry dock.

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PITTSBURGH DISTRICT
Lt. Col. H. B. Ferguson

Contracts for the Emsworth locks and dams on the Ohio River, 6 miles below Pittsburgh, Pa., were let to the Dravo Contracting Company of Pittsburgh, Pa., July 22, 1919. The work consists of building two locks, 110 feet by 600 feet, and 56 feet by 360 feet; one main channel fixed concrete dam and one abutment; and one back channel fixed concrete dam and two abutments. These structures will replace locks and dams Nos. 1 and 2, and will furnish pool water to the first dams on the Allegheny and Monongahela rivers. The total amount of the contracts is approximately $2 298,600.00. To date the following work has has been accomplished: upper guide wall, 50 per cent; back channel fixed dam, 50 per cent; abutment No. 2, 70 per cent; and abutment No. 3, 30 per cent. Two wooden cofferdams, generally known on the Ohio River as the box type, have been built and unwatered, inclosing parts of the upper and lower guide walls. Earth cofferdams are being used for the back channel dam and abutments, a heavy pile trestle supporting the movable derricks, which were used to excavate sand and gravel, bank the coffer and handle piles, crib timber, stone, forms and concrete.

On the Monongahela River, a large amount of construction and miscellaneous repair work has been done by hired labor. The Betwa wickets on dams 1 and 5, and the Chittenden drums on dams 2 and 3, are being replaced by fixed concrete tops, and the downstream slopes reduced to 1 on 3. The total concrete required for the four dams amounts to 20,000 cubic yards on 2,900 linear feet of dam crest. This work is 43 per cent complete and was much hindered during October and November by unusual rises in the river. Wooden miter gates were erected at lock No. 2, replacing the steel ones which were badly eaten by acids in the water; the upper guard wall at lock No. 6 was extended 100 feet, and the upper miter sills in the outer chambers of locks Nos. 3 and 5 were raised, 1,800 cubic yards of concrete being used.

Plans and specifications for lock and dam No. 4, Allegheny River, about 24 miles above Pittsburgh, have been approved by the Chief of Engineers. Plans and specifications for lock No. 5, 30.5 miles above Pittsburgh, have been completed. It is expected to ask for bids for these two structures during the month of January.

LOUISVILLE DISTRICT
Lt. Col. G. M. Hoffman

The construction of lock and dam No. 44, Ohio River, at Leavenworth, Ind., was begun November 20, 1919, with the sinking of the first section of the lock cofferdam. This work will be done with Government plant by hired labor. This is the third dam to be started below Louisville in the 9-foot channel project for the Ohio River.

Lock and abutment No. 45, Ohio River, at Addison, Ky., twice advertised for construction by contract during 1919, will be again advertised in the spring of 1920, no bids having been received as a result of the previous advertising.

Assistant Engineer Malcolm Elliott, in charge of the construction of lock and dam No. 43, Ohio River (Louisville District) has been transferred to the Florence, Ala., District.

DULUTH DISTRICT
Maj. F. A. Pope

Enlargement of Superior Harbor Basin

The project dredging for enlarging the Superior harbor basin (160.2 acres to 20-foot depth, L. W. D.), was carried on the past season with two large dipper and one hydraulic dredge. Project consists in the removal of 3,000,000 cubic yards of sand and soft material; the present contract covers 2,083,000 cubic yards. Work closed November 14 on account of ice, to be resumed early in 1920. An average of more than 150,000 cubic yards per month were removed. Contract now about 69 per cent completed.

A large amount of pier repairs and dredging for maintenance was carried on during the season at Grand Marais, Michigan, Keweenaw Waterway, Michigan, Ontonagon, Michigan, and Grand Marais, Minnesota. Heavy storms during November did considerable damage to construction work at Grand Marais, Minnesota, Ontonagon and Keweenaw Waterway, Michigan, all of which will have to wait until spring for repair. The storm of November 11 wrecked several large ore and grain carriers near Grand Marais, Michigan, with loss of the steamer *John Owen* and crew of 25. From the steamer *Runnels* the life savers removed the crew of 17 but the boat was a complete wreck. On the 23d the steamer *Myron* (lumber laden) was wrecked near Whitefish Point, with a loss of 17 lives. lives.

River and harbor improvements at Warroad, Zippel Bay and Baudette, including operations on Lake of the Woods boundary waters. were transferred from the St. Paul district to the Duluth district July 31, 1919.

Plans are being prepared for the construction of a steel derrick scow of about 800 tons carrying and 25 tons lifting capacity for general use in this district.

Work in Prospect

The Superior harbor basin will be completed as early as possible.

Removal of shoal at East Gate Basin will be done by U. S. dredge *Gaillard*. The usual maintenance work will be carried on at all points in the district. Work on the cut-off channel three-fourths of a mile long, 200 feet wide and 20 feet deep, at Princess Point, Keneenaw, will be started as soon as the necessary land can be purchased, negotiations for which are now in progress.

E. J. Dugan, Assistant Engineer was transferred from St. Paul to the Duluth district, September 1, 1919.

MILWAUKEE DISTRICT
Lt. Col. Edw. H. Schulz

Harbor of Milwaukee

In furtherance of the outer harbor at Milwaukee, Wis., the city has awarded a contract to the Great Lakes Dredge & Dock Co., for the construction of 1,375 linear feet of timber revetment on the inner side of Jones Island, along a new bulkhead line, approved by the Department, Nov. 19, 1919.

The amount of the contract is $99,487, or about $72.35 per linear foot. This does not include the dredging to be done in front of the revetment, which will be carried out later.

It is proposed to use the dredged material in filling behind the revetment, and along the lake shore of Jones Island. The wharfage to be created by this revetment will probably be used as a public wharf for miscellaneous freight.

Manistee (Mich.), Breakwater

Work on the construction of 1,200 linear feet of shore arm extension of the south breakwater, Manistee, Mich., was suspended Nov. 8th for the season.

The work, originally begun under contract, was carried on the past season by hired labor and use of available government plant. The shore arm consists of a substructure of round and sheet piles surmounted by a concrete superstructure. The substructure is entirely completed. About one-half was done during the past season, the other half having been previously built under contract. About 54 per cent of the concrete superstructure is completed, all of which was done during the past season.

It is expected to complete the work by June 30, 1920. The completion of the substructure has produced a marked stilling effect in the harbor entrance.

Sturgeon Bay—Turning Basin

Dredging for the formation of a turning basin near the easterly end of Sturgeon Bay Canal, was completed in October, 1919. The work was done during the past season by the Government dredge *Kewaunee*.

The basin is 500 feet by 1.600 feet, with a depth of 19 feet. It is to be used for turning vessels which have run in from Lake Michigan for shelter in the canal.

Wreck of Steamer "Muskegon"

Early on the morning of October 26th, while attempting to enter Muskegon Harbor, Mich., during a severe westerly gale, the Crosby Line Steamer *"Muskegon"* was totally wrecked, with the loss of 27 lives.

The *"Muskegon,"* formerly the *"Holland,"* was an iron hull, side wheel passenger steamer, built in 1881. The vessel was lifted and thrown against the outer end of the south pier, the starboard paddle wheel becoming firmly lodged in one of the pockets of the pier. The entire wooden upper works were carried away in about fifteen minutes after the vessel struck. The wreck was abandoned by owners and underwriters.

As it partly blocks the harbor entrance and in heavy weather would be a dangerous obstruction to navigation, a contract for its removal was awarded November 15th to Thomas L. Durocher, of Detroit, Mich., in the sum of $35,000, including all salvage of vessel or cargo. It is expected that the wreck will be removed during December.

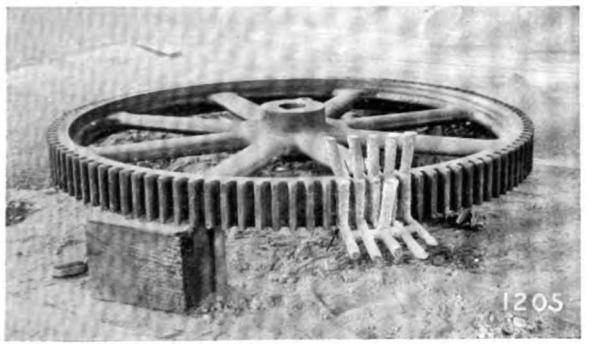
BUFFALO DISTRICT
Lt. Col. C. S. Smith

Buffalo Harbor

Redredging the Buffalo river entrance channel, including the removal of two small bed rock shoals, which was begun July 8, 1919, is now practically completed. The Empire Engineering Company is the contractor for the work, the estimated cost of which is $72,760. The company's drill boat *E. C. C. No. 1*, and dipper dredges *Peconic* and *Pocantico* were used on the work.

Other dredging is the removal of an area at the junction of the Buffalo River and Black Rock Canal, and deepening of two areas in the outer harbor, for which the Great Lakes Dredge & Dock Company holds the contract (estimated cost $178,868). The company's dipper dredge No.8 was employed on the work, which was suspended for the winter, November 6, 1919.

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Oswego Harbor

In anticipation of the completion of the enlarged Welland Canal by the Dominion of Canada, dredging the eastern part of the outer harbor, to a depth of 2 feet at low water datum, is now in progress, operations having been begun October 27, 1919. The United States dipper dredge *Sodus* and attending plant is being used. The estimated cost of the work is $50,000.

LOS ANGELES DISTRICT
Maj. F. B. Downing

The Los Angeles County Flood Control District, in accordance with legal agreements, provided for the United States the right-of-way for the silt diversion works for the protection of Los Angeles and Long Beach Harbors, California, on October 21st; and on October 25th a contract for the construction of the works was let by the U. S. District Engineer, Los Angeles, to the United Dredging Company. The contractor began preliminary work at once, and on November 17th commenced dredging in the lower section of the channel with two hydraulic dredges. The contract calls for the completion of the work by December 31, 1920. The Federal appropriation is one million and eighty thousand dollars.

The purpose of the project is to prevent the deposit of silt in Los Angeles and Long Beach Harbors by restraining the Los Angeles River in a leveed channel, and preventing it from entering the harbors. The project comprises the construction of a channel about six and one-half miles long from the upper end of a diverting dam along the river to the ocean. The channel will be built on the flood plain of the river. It will be 530 feet wide on the bottom, and for a mile and a quarter of its lower reaches will be in excavation; the upper portion will be formed by earthen levees averaging 30 feet wide on top. The channel will enter the ocean between stone jetties, and its banks on the water side will be strongly protected with stone revetments.

FIRST DISTRICT, PORTLAND, ORE.
Lt. Col. J. B. Cavanaugh

Coos Bay Bar

During a season exceptionally unfavorable on account of bad weather the dredge *Col. P. S. Michie* removed 767,000 cubic yards of sand from Coos Bay bar, between April 1 and November 21, 1919. The result was a deepening of the channel through the bar from 19 to 29 feet.

PORTO RICO DISTRICT
Col. J. C. Sanford

San Juan Harbor, P. R.

It is expected that, under favorable conditions, the work of improvement of the harbor at San Juan, Porto Rico, will be started at an early date. The improvement proposed embraces the dredging of an area of approximately 230 acres in the harbor to a depth of 30 feet and depositing the dredged material on adjacent swamp lands for their reclamation. The project was adopted by the river and harbor act of August 8, 1917, but because of the excessive bids received in response to advertisements of the work, its prosecution has not yet been begun. A dredge has been recently purchased by the United States for use on this improvment, however, and it will be towed to San Juan from New Orleans as soon as arrangements for the purpose can be completed, thus permitting an early beginning of operations. The law adopting this improvement required the Government of Porto Rico to reimburse the United States to the extent of $600,000 of the cost of this project, at the rate of $50,000 annually, but in view of the increased cost of executing the work, the legislature of Porto Rico has obligated itself to reimburse 70 per cent of any sum the United States may expend on the work to a limit of $1,200,000. A full report of the project is contained in House Document No. 865, 63d Congress, 2d session.

FOURTH MISSISSIPPI RIVER DISTRICT
Maj. H. S. Hetrick

Levee Building

Eight levee building machines and two mattress placing plants are being operated by hired labor. Twenty contracts for levee building, involving 6 million yards of earthwork, are in force.

PUBLIC BUILDINGS AND GROUNDS, DISTRICT OF COLUMBIA
Col. C. S. Ridley

The office of Public Buildings and Grounds, Washington, D. C., has entered into contract for the excavation of a reflecting pool in West Potomac Park. Work on this project will be commenced at once. This pool will be located between the Lincoln Memorial and the Washington Monument, the main axis being the line through the two aforesaid memorials and the National Capitol. The project contemplates the construction of a main pool or basin 2,018 feet long on the main axis, by 160 feet wide, and a secondary transverse pool 160 feet on the main axis and 300 feet long on the normal axis, together with the necessary drainage, water supply, conduit. pump, control house, etc. Surrounding and outlining the pool, there will be a rather massive granite coping with concrete base. The bottom of the pool will be paved.

Engineer Troops

2ND ENGINEERS, CAMP TRAVIS, TEXAS
Col. G. E. Edgerton, Commanding

The training program for the 2nd Engineers and the 2nd Engineer Train inaugurated November 1, includes general service training and disciplinary exercises, one and one-fourth hours daily, and special engineering training of 3 hours daily. About three and one-half hours daily are devoted to vocational schools and fatigue. At present the special engineering training covers the following subjects only: carpentry, drafting, mining, demolitions and explosives, and hippology. The regimental school system is employed, with officers as instructors. All available enlisted men are enrolled in one of these schools, each man being assigned to a subject in which he has not already attained a considerable degree of proficiency, but otherwise individual preferences and adaptability have been the governing considerations in making assignments to classes. Other schools in special engineer subjects are to be opened as equipment becomes available and desirable students are secured. As almost all of the enlisted personnel have had several years service in the engineers, no general engineer training is planned except for recruits.

The 1st Battalion under the command of Captain W. A. Snow, is temporarily at Ft. Riley, Kansas, engaged in the reconstruction of a highway bridge across the Kansas River. The original structure, which was partly burned, was built in 1906-7 by the old 3rd Battalion, under command of Colonel (then Major) Thos. H. Rees, Corps of Engineers.

Lt. Col. L. E. Oliver was relieved by Col. G. E. Edgerton as commanding officer of the 2nd Engineers, on October 20, 1919. Colonel Oliver left for duty in the office of the Chief of Engineers on October 23rd.

Capt. Wm. C. Atwater was relieved from duty October 30 and ordered to Camp Humphreys.

2nd Lieut. D. A. Newcomer reported for duty on October 15th.

Capt. James M. Farrin was relieved from duty Nov. 16 and has been assigned as Assistant Professor of Military Science at the University of Illinois, Urbana, Illinois.

5TH ENGINEERS, CAMP HUMPHREYS, VA.
Col. Richard Park, Commanding

Though but recently organized this regiment has had a strenuous and interesting existence. On May 21, 1917 the regiment was officially born at Headquarters of the 2nd Engineers, then stationed at Camp Newton D. Baker, El Paso, Texas. On June 24th the first battalion and headquarters went to Camp Scurry, Corpus Christi, for training and recruiting to full strength, while the second battalion was assigned to Fort Brown, Brownsville, Texas. Colonel Barden was the first regimental commander.

On November 20, 1917, the second battalion joined the first at Corpus Christi. Training proceeded until June 13, 1918, on which date orders were received to proceed to Camp Merritt, N. J., under command of Colonel J. C. Oakes, in order to join the 7th Division. After the usual inspections and drawing of equipment the regiment sailed on the U. S. S. *Mallory* on July 31, 1918.

After disembarking at Brest the regiment was speedily moved into the 15th Training Area, Yonne Department. September 27th orders were received to move to Minourlle. Final training occupied the regiment until Oct. 8th, when it went into the line with the 7th Division in the Puvenelle Sector. After a month in the Puvenelle Sector the regiment participated in the offensive of the Second Army on November 10th and 11th.

On February 2, 1919, we started for the United States. Soon after its arrival the regiment, with exception of "A" and "C" companies, which went to Washington Barracks, took up general camp and garrison duties at Camp Humphreys. Since that time it has rendered varied service in the activities around Washington, such as the Victory Loan Drive, the race riots, reception of the Prince of Wales (the regiment is very versatile) and also on several recruiting trips to eastern cities, duty with the transcontinental motor convoy, etc.

The month of November saw little change in the strength of the regiment. A few men were furloughed to the reserve but their loss was offset by recruits.

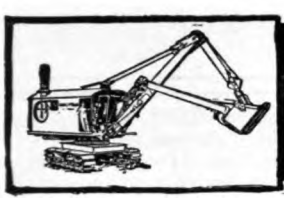
The band of the 5th Engineers played during the presentation of medals on November 13th by H. R. H. the Prince of Wales, at the Belmont House in Washington. With reference to this ceremony the following letter was received from the British attaché:

November 20, 1919.

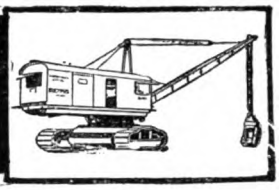
"His Royal Highness, the Prince of Wales, asked me to express his thanks to the Officer Commanding the 5th Regiment Engineers for the very good selections of music played by their band at the presentation of medals yesterday."

A regimental field meet was held on November 19th, and included the following

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BUCYRUS



The Power that Moves the Earth



"The 8 (Bucyrus) Caterpillar Draglines are Making Especially Gratifying Records"

This is the report of the U. S. Reclamation Service Engineers on the Rio Grande Project, involving over 15,000,000 cu. yds. of excavation. Eight Bucyrus Class 9½ dragline excavators, mounted on caterpillars were used. These draglines were equipped with internal combustion engines, using distillate as fuel, due to the poor quality of water and to no electricity.

These draglines averaged 12.4 cu. yds. per gal. of distillate at a cost of 0.0123 per cu. yd. One of these machines excavated 80,210 cu. yds. in a month, working 3 8-hour shifts, averaging 1055 cu. yds. per 8-hour shift. Another dug 76,464 cu. yds. in a month, averaging 946 cu. yds. per 8-hour shift. These are just a few of the many high records of output these machines have made.

The U. S. Government has purchased more than 20 Class 9½ draglines for use by the U. S. Reclamation Service, the Mississippi River Commission and the Alaska Railroad Commission. This is in itself a proof of the efficiency of this machine. It will pay you to investigate. Write for bulletin G-91-H.

Let our representative confer with you.

Bucyrus Dragline Exavators are built in the following sizes:

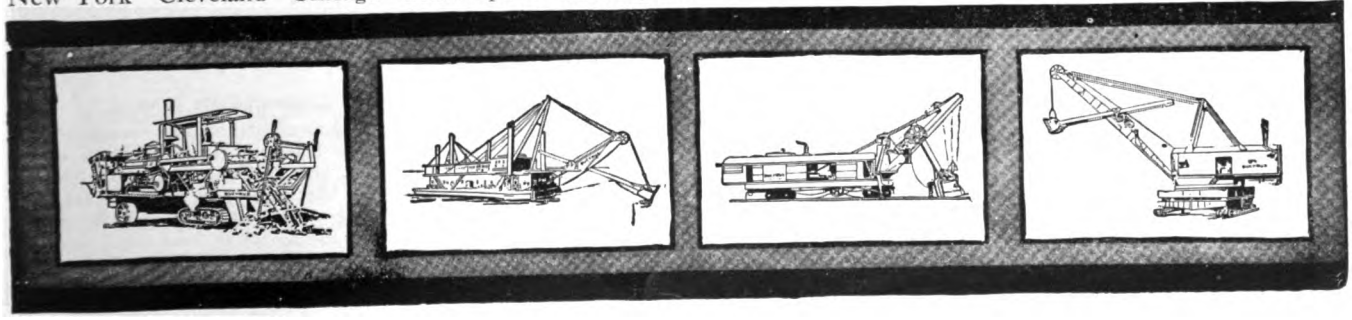
Class 7	1 yard bucket	Class 20-2½	yard bucket
Class 9½-1½	yard bucket	Class 24-3½	yard bucket
Class 14-2	yard bucket	Class 175-4	yard bucket

Send for Bulletin GH

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New York Cleveland Chicago Minneapolis Birmingham San Francisco Denver Porland, Ore. Salt Lake City



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events: Bayonet fighting, wall scaling contest, tug of war, dry land bridge building contest and a football game.

As a result of the firing on the rifle range during the previous month six expert riflemen, sixteen sharpshooters, and fifty-eight marksmen qualified from the regiment.

6TH ENGINEERS, CAMP PIKE, ARK.
Col. C. L. Sturdevant, Commanding

Sixth Engineers' Colors are Decorated

The colors of the 6th Engineers were decorated with the Croix de Guerre with palm on Thursday morning, November 20th, by Col. E. G. Peyton, acting Commander of the Third Division, Camp Pike, Arkansas.

The award was conferred upon the regiment by Marshal Pétain of France, the citation being forwarded to division Headquarters through the War Department.

The decoration was awarded in recognition of the work of the Sixth Engineers in constructing ponton bridges across the Marne in the middle of July, 1918, under heavy bombardment from the enemy, and later throwing down their tools and helping the infantry push the enemy across the Vesle River.

The translation of the order follows:

With the approval of the General, Commander in Chief of the American Expeditionary Forces in France, the Marshal of France, commander in chief of the French army of the East, cites in army orders the Sixth Regiment, American Engineers.

In the most difficult situations, it has given demonstration of the highest qualities of perseverence and faithfulness, proving at all times its ability to surmount every obstacle. It particularly distinguished itself in the organization of positions on the south bank of the Marne, 15th July, 1918, and thus largely contributed to the breaking up of the German attack. In spite of violent bombardment it constructed ponton bridges over the Marne and, taking a direct part in the combat, aided the infantry in driving back the enemy across the Vesle.

Signed:—The Marshal of France, Commander in Chief of the French Armies of the East.

PETAIN.

318TH ENGINEERS, CAMP GRANT, ILL.
Col. J. J. Bain, Commanding

The regiment have been unusually fortunate in the amount of construction work they have been able to handle, which insures that both officers and men benefit materially in gaining a large amount of experience.

The demand for skilled workmen has been so great that practically every man of the organization is on construction work a large share of the time.

Among the more important works that have been accomplished since Colonel Bain assumed command in October, are the construction of the building for the Automotive School, including the installation of steam-heating, and plumbing and electric lighting, the erection of a 10-ton stiff-leg derrick for use of the camp at the railroad yards, the operation of a one-half yard caterpillar steam shovel. At present the regiment is occupied altering certain buildings in camp for school purposes and also have a detail engaged in the alteration of the hostess house.

The regiment furnished a platoon for the provisional regiment organized for duty during the coal strike.

The personnel of the regiment has not been greatly increased, for although a large number of new men have reported, many men have been furloughed to the reserve. Special efforts are being made to increase the number of recruits and to that end two non-commissioned officers, Master Engr. Bentley and Corp. Kenaugh, have been sent out on recruiting service with a set of sixty slides depicting the activities of the engineers, which they will exhibit at various towns in the middle west and in conjunction with the exhibition a talk will be given.

The enlisted personnel now numbers one hundred and forty-six men as compared with one hundred and fifteen men on November 15th.

Col. Jarvis J. Bain assumed command of the regiment on October 15, 1919, relieving Major J. W. Fraser. Colonel Bain commanded the 309th Engineers and the 315th Engineers and was Corps Engineer, 7th Corps, and before coming to Camp Grant was secretary of the Mississippi River Commission with station at St. Louis, Mo.

Major J. W. Fraser, 319th Engineers, (1915 U. S. M. A.) resigned on November 5, 1919, and now resides in St. Louis.

Lieutenants Henry Berbert and George Consoer have been relieved from duty and ordered to Camp Humphreys for instruction at the Engineer School.

Lieutenants Don G. Shingler and Sidney W. Gould (1921 U. S. M. A.) have been assigned to the regiment, upon their return from temporary duty in Europe.

Service Schools

ENGINEER SCHOOL, CAMP HUMPHREYS VA.

History of Belvoir on the Potomac

The historical significance of the ground now occupied by Camp A. A. Humphreys at Belvoir on the Potomac River in Virginia, was certainly not considered when the site was selected. It seems a far cry from the Camp Humphreys of 1919 back to the time of the earliest settlers on this beautiful Potomac peninsula where the camp is situated, yet the connection between these widely separated periods of our national history is not as remote as might at first be supposed.

That the engineer school and training camp should be even temporarily located on this ground is extremely appropriate when its genealogical history is considered and that it is the place where Washington, the first Engineer of the U. S. Army, received his engineer training from his aristocratic preceptor, Lord Fairfax. It was Washington who at one time managed this property for the lord of the manor, and who surveyed for him the boundaries of the original grant, consisting of something like five million acres and comprising twenty-one of the present counties of Virginia.

When Thomas Fairfax built here for himself the most pretentious residence of its time, in the new country, he little dreamed that two hundred years later the site of his old Belvoir dock from which the ocean greyhounds of his day departed directly for the old country laden with tobacco, would be the site of our first engineer training camp, that his "beautiful primeval forest" would be spotted with barracks to accommodate thirty thousand soldiers, or that his fertile tobacco plantation, the source of his wealth, would be the drill field for the training of troops to fight at the side of his country's troops in a foreign land, a great war for civilization.

Yet such is the history of Belvoir peninsula, the location of the engineer school and training camp, Camp A. A. Humphreys.

School Courses

Since the return of the instructors and students of the engineer school from their overseas trip, the work has settled down to serious business, reports show excellent progress with the courses completed and those being carried on at present, also an ambitious program for future courses for the education of engineer officers in all engineering subjects and allied branches.

The engineer school consists of three sections all under the direct command of Major General C. A. F. Flagler who is also the commanding general of Camp A. A. Humphreys. The school staff consists of Lt. Col. R. W. Putnam, Secretary; Captain Hastie, Supply Officer and the heads of the three sections of the school. These are the post graduate school, the undergraduate school and the vocational training school.

The post graduate school commanded by Colonel Warren T. Hannum, includes engineer officers who have completed the full course at West Point before graduation. There are seven instructors and thirty-three students, six of whom serve as assistant instructors.

The courses at present in progress and those proposed for the post graduate school are:

Department of Military Art

Interior guard duty,
Rules of land warfare,
Training methods and principles,
Army organization,
Troop leading: Infantry squad, platoon and company,
Machine guns,
Duties of engineers,
War games and map problems involving not more than a company,
Bayonet fighting and physical exercise,
Gases and chemical warfare,
Tanks,
Hand to hand fighting and boxing,
Artillery,
Grenades,
Liaison,
Mass games and athletics,
The defensive,
The offensive,
Lessons from the World War,
Night movements.

Department of Military Engineering

Map reading and use of compass,
Military sketching,
Field fortification,
Light railways,
Military roads,
Mining and demolition,
Camouflage,
Military bridges and hasty stream crossings,
Surveying and field astronomy,
Photography and map reproduction,
Practical engineering problems.

Department of Military Administration and History

Military courtesy,
Customs of the service,
Administration, company and regiment,
Military hygiene and first aid,
Military law,
Hippology,
Military history.

Undergraduate School

The undergraduate school, commanded by Col. V. L. Peterson, has three heads of departments, sixteen instructors and eighty-six students. The students in this class are those who on account of the war were graduated before the full course at West Point was completed.

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Deming

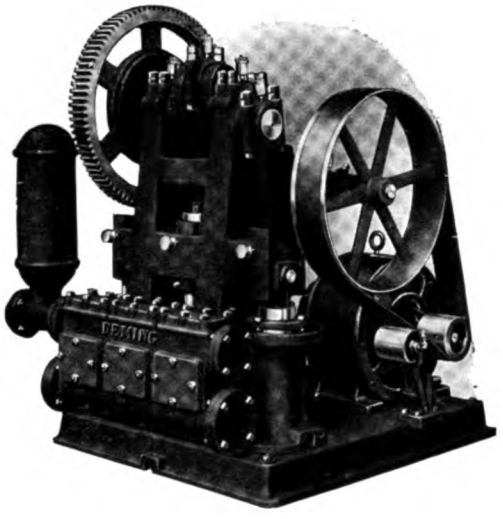


Fig. 50. Single-Acting Triplex Pump 5 1-2 x 8 Type, "C" Drive

Power Pumps

Triplex and Double-Acting Power Pumps; Deep Well Power Working Heads and Artesian Well Cylinders; Hydro-Pneumatic Water Systems, etc.

Deming Triplex Pumps as shown above are the acme of efficiency—seldom need attention such as repacking, etc. Operating expenses in many cases more than 50 per cent less than steam pumps. Made both single and double acting for various duties and in capacities up to 132,000 gallons per hour for operation by belt, electric motor, gas engine, etc.

Catalogue to engineers, architects and manufacturers on request.

The DEMING CO., *Salem, Ohio*

Chicago: Henion & Hubbell. *New York:* Ralph B. Carter Co. *Pittsburg:* Harris Pump & Supply Co. *Buffalo:* Root, Neal & Co. *Boston:* Chas. J. Jager Co. *Richmond:* Sydnor Pump & Well Co. *San Francisco:* Simonds Machinery Company *Philadelphia:* W. P. Dallett Co. *Denver:* Hendrie & Bolthoff Mfg. & Supply Co.

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The three heads of departments are: Colonel Earl North, director of structural engineering; Colonel A. K. B. Lyman, director of sanitary engineering; and Lt. Colonel C. F. Williams, director of electrical and mechanical engineering.

The courses in progress and the proposed work for this class in the order of their sequence are:

Army organization,
Guard duty,
Rules of land warfare,
Training methods and principles,
War games, map problems (small units),
Troop leading, squad, platoon and company,
Duties of engineers,
Physical exercises,
Bayonet fighting,
Boxing,
Athletics and mass games,
Artillery,
Tanks,
Grenades,
Rifle and pistol,
The defensive,
The offensive,
Night operations,
Lessons from the World War.
Structural engineering, including:
- Roads and pavements,
- Foundations,
- Wharves and piers,
- Masonry structures,
- Reinforced concrete,
- Materials of construction,
- Roofs and bridges and building construction.

Sanitary engineering, including:
- Hydraulics,
- Water supply,
- Sewerage,
- Sewage disposal.

Electrical and mechanical engineering will include the usual engineering school course in this subject with the necessary preparatory work for the undergraduate classes, and heating and ventilation.

The subjects of law, ordnance, astronomy, field service rgulations, army organization and civil war campaigns will also be taught.

Vocational Training

The vocational school in charge of Captain B. C. Dunn, is the third section of the engineering school. Schools in both educational and vocational training were established during the summer months but were not actually attended in force until the return of the 5th Engineers from target practice on October 31st.

It is contemplated to establish the vocational school in the 'F' section of the camp and shortly to have a large percentage of men in camp learning one of the later vocations which will make them better soldiers and better civilians. All enlisted men in camp have the privilege of electing one or more school courses; i. e. one vocational and one educational.

Schools are now being conducted in English, automotives, electricity, sheet metal work, surveying and topography.

Funds and equipment are available and men are anxious to apply themselves. It is hoped that the enlisted strength of the command will soon be increased so that more men may profit by the special facilities and equipment offered for training.

It is well known that Camp Humphreys is particularly well adapted to vocational training, due to the quantities of war equipment of a mechanical nature amassed during the world war for the instruction of engineer specialists.

Library

The former A. L. A. Librarian, Mr. Langdon, has been placed in charge of the local branch of the school library which contains some 1,800 volumes from the Washington Barracks Library. More books of an engineering nature are being secured daily which will soon make the library complete for all technical engineering reference. There is also to be added a map library to be used in connection with the school work and composed of all procurable engineering maps of the United States and its dependencies.

The first floor of one of the barrack buildings in the engineer school section has been transformed into a day room for the school detachments. Everything for the comfort of the men has been installed including billiard table, writing tables and reading space with comfortable seats and excellent light.

Engineer Museum

In the engineer museum at Camp Humphreys, there is now being placed on exhibition all of the museum formerly displayed at Washington Barracks, and in addition, all the "World war exhibit material" of an engineering nature carefully selected and brought back by the A. E. F.

In general the Washington Barracks equipment includes various models and pictures of work pertaining to seacoast fortification, sea power, pioneer operations, ordnance and gunnery, and rivers and harbors.

"War exhibit material" comprises the technical, electrical, mechanical, pioneer, water supply, railway, ponton, ordnance and miscellaneous equipment of an engineering nature used by all the great nations (allied and hostile) in the world war.

All exhibits are plainly marked, giving any items of information which may be deemed of interest, and an up-to-date filing system will be used in which will be placed copies of all available information of interest from a military, engineering, and historical standpoint.

Officers' Quarters

There has been a great shortage of quarters for married officers at Camp Humphreys. Originally, six sets were built of portable barrack material, each including living room, dining room, three bed-rooms and bath, kitchen and servants' quarters, with bath. When the school was moved from Washington Barracks to Camp Humphreys, the need for more quarters became pressing. Thirty-two additional bungalows, similar to the original six, were started, and twenty-one were completed when work was stopped by War Department order.

Appropriations were asked for a total of 68 officers' sets, which would accommodate nearly all the married officers. The amount granted, however, provides only for the completion of those already started, with heating plants for each. This work is nearing completion. Quarters in the old training camp have been altered for use of married officers. Bachelor officers are quartered in Harris Hall, or near their organizations. There is an excellent officers' club and mess, and a resident mess in Harris Hall.

An old log cabin has been altered to serve as a "country club," bath houses along the Potomac are built, and a garage for officers' cars is to be built in the bungalow section.

Athletics

The baseball and foot ball teams have had successful seasons, and four "mounted" athletic meets were held.

The Camp Humphreys Athletic Association has been organized, and there will be teams representing the camp in every branch of sport.

Examining Boards

A board consisting of Colonels George B. Pillsbury, Warren T. Hannum, and Lewis H. Watkins, Corps of Engineers, was recently appointed to meet at Camp Humphreys, to examine the following provisional officers in order to determine their fitness for permanent commission:

Maj. L. R. Lohr
Capt. T. M. Curry
Capt F. C. Albert
Capt. I. Medine,
Capt. A. H. Bond
Capt. H. W. Collins
Capt. R. A. Love
Capt. R. D. Ingalls
Capt. W. A. Lyon
Capt. F. S. H. Smith
Capt. F. B. Hastie
Capt. E. F. Gaebler
Capt. P. S. Cristal

Officers who are due for promotion will appear before the board appointed by par. 47, S. O. 281-0, W. D., 1919. The board consists of Cols. Sanford, Hannum and Adams, Engineers, and two medical officers. The board will begin sessions at Camp Humphreys at an early date.

A permanent board has been appointed for the examination of officers applying for promotion to a higher rank in the Reserve Corps and consists of Colonel Harrington, Lt. Col. Larkin, and Major Kelton, Corps of Engineers.

Company "B" of the 1st Engineers, Captain J. E. Brown, Commanding, is now at Camp Humphreys preparing to go overseas about December 16th as a railroad unit.

ARMY SERVICE SCHOOLS, FORT LEAVENWORTH, KANS.

Engineer Instruction at Fort Leavenworth.

1. All instruction at the Army Service Schools at Fort Leavenworth is now comprised under the one subject of Military Art. The former departments of engineering, law, and modern languages have been abolished, and there is no instruction in modern languages and in law in the present course. The instruction in engineering which was formerly part of the course in engineering is now the general instruction in Military Art.

2. The engineering instruction consists of the following:

(a) Map reading. Five periods in the Line Class and 3 periods in the Staff Class.

(b) Fortification sketching. Fourteen periods in the Line Class and 11 periods in the Staff Class.

(c) Field fortification. Fifteen periods in the Line Class and 19 in the Staff Class.

(d) Four general terrain exercises in the Line Class and 3 map problems in the Staff Class, in addition to the regular terrain exercises in map reading, fortification sketching and field fortification.

(e) Nine lectures in the Line Class on map reading, fortification sketching, combat engineers (3), corps and army engineers, S. O. S. engineers, engineer staff officers, and map reproduction; 12 lectures in the Staff Class on map reading, fortification sketching, combat engineers (3), corps and army engineers, S. O. S. engineers, engineer staff officers, sieges, seacoast defense, mapping large areas, and map reproduction.

3. The engineer instructors are Major W. A. Mitchell, Major J. W. N. Schulz and

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Capt. X. H Price. Major Schulz in addition to his duties as engineer instructor, also is in charge of the instruction in Chemical Warfare comprising several lectures and map problems. Capt. Price, in addition to his duties as engineer instructor, is in charge of the personnel of the schools, and is superintendent of the drafting department, lithographing department and printing establishment. He also gives lectures on the British Army, troop movements by railroad and certain operation orders.

OFFICERS' RESERVE CORPS

Information Relative to Appointment in the Officers' Reserve Corps

The present policy governing the selection and appointment of members of the Officers' Reserve Corps, contemplates the establishment of a competent Reserve Commissioned Personnel, the individual members of which will be qualified to perform fully duties of their respective grades when ordered into active service in case of emergency. All officers who have demonstrated their fitness and who so desire, are being appointed if their service has been satisfactory and if they are properly recommended. Appointments are limited to discharged officers, to men of demonstrated fitness and gallantry in action, and to training camp and Reserve Officers' Training Corps graduates, with the exception of a small number who had been found qualified for special services and whose appointments as temporary officers were stopped by the Armistice.

In general, discharged emergency officers are appointed in the Reserve Corps in the grade held at time of discharge. An advance of not to exceed one grade, and in no case above the grade of Colonel, may be made on account of special fitness, long and distinguished service or because of recommendation for a promotion not received, due to the termination of hostilities. Promotion received after November 11, 1918, is considered to have been given under such special conditions that increase over grade held at time of discharge, in general, will not be given. Appointees should accept the original commissions tendered them and await such subsequent action as may be determined upon with reference to promotions.

Approximately 7,500 applications for recommission in the Officers' Reserve Corps have been received from officers who have been discharged from the service since the signing of the armistice. Of this number about 4,000 have been recommissioned and if the present rate of progress can be maintained all applications will have had final action taken on them within two months.

At the present time there are commissioned in the Corps about 30 Colonels, and 85 Lieutenant Colonels. The total strength of the Corps, by grade, will be noted in our next, and subsequent, issues.

RESERVE OFFICERS' TRAINING CORPS

History and Purpose of the R. O. T. C.

Among its many provisions the National Defense Act, approved June 3, 1916, authorized the establishment and maintenance in civil educational institutions of a Reserve Officers Training Corps, to consist of a senior and a junior division. Units of the senior division may be organized at universities and colleges requiring four years collegiate study for a degree, including institutions benefited by the land grant act, and those essentially military schools which, though they do not confer an academic degree, are deemed to be specially qualified Units of the junior division may be organized at all other public or private educational institutions.

Under the terms of the act those institutions desiring units must agree to establish and maintain a two years course of military training, and the work done therein must be credited to the student in the requirements for graduation. No unit may be established or maintained until an officer of the army has been detailed as professor of military science and tactics, and at least one hundred physically fit students must be under military instruction. An average of three hours per week per academic term must be devoted to the work under courses or schedules to be prescribed by the Secretary of War. The military instruction given during the academic year is to be supplemented by training camps of not over six weeks duration in any one year. Students will receive transportation to and from the camps and subsistence while on duty as well as while in the travel status. Provision is also made under certain circumstances for commutation of subsistence at the expense of the United States for students who have completed two academic years of service in the senior division and who have been especially selected for advanced work of a military nature.

The primary object of the Reserve Officers Training Corps is to provide systematic military training at civil institutions for the purpose of qualifying selected students of such institutions as reserve officers in the military forces of the United States. It is intended to attain this object during the time the students are pursuing their general or professional studies, with the least practicable interference with their civil careers, by employing methods designed to fit men physically, mentally, and morally for pursuits of peace as well as pursuits of war.

The World War awakened the patriotic spirit of our people and brought out in clear relief the democratic privilege and obligation of every citizen to take a direct and personal part in the defense of his country. The educational institutions of the land very early realized their responsibilities to the young manhood of the nation and took their proper place in the vanguard of this great movement. It should be and, in a gratifyingly large measure, it is the aim of all educational institutions to assume a definite place and responsibility in our country's system of training military leaders, and to maintain one or more units of the R. O. T. C. In time of national emergency the country will have instantly available through this means a large number of educated men, physically efficient, versed in the fundamentals of military science and fitted to lead intelligently the units of the armies upon which the safety of the country will depend. The extent to which this object is accomplished will be the measure of success of the Reserve Officers Training Corps.

Aside from this constitutional purpose of "providing for the common defense," it is not to be denied that military training will aid greatly in the development of better citizens and thus "promote the general welfare" of the nation.

The Reserve Officers Training Corps will enrich the educational resources of schools and colleges by contributing new problems, applications, and equipment. This will not only vitalize the course of study but give to the student a training which will be as valuable to him in his industrial or professional career as it would be should the country call upon him to act as a leader of its defensive forces. In carrying out the provisions of the policy adopted by the War Department, it is intended to give all students of the Reserve Officers Training Corps a thorough physical training, to inculcate in them a respect for lawful authority, to teach leadership, and special knowledge required to enable them to serve efficiently in the various branches of the military service.

Progress to Date

Under the provisions oof the act, the War Department has recently organized in selected civil educational institutions a number of R. O. T. C. units, and has thus established a system of training which will tend toward making better citizens, and which will furnish a means whereby the graduates of these schools may function promptly and advantageously to the best interests of the nation in time of military necessity.

Recent reports show an enrollment in the various units of the Senior Division as follows:

Infantry	46,424
Field Artillery	5,389
Coast Artillery	3,142
Cavalry	741
Engineers	2,055
Motor Transport	524
Signal Corps	799
Total	59,074

As a matter of special interest to the readers of THE MILITARY ENGINEER the following list shows the institutions at which engineer units have been established with the names of the engineer officers in charge.

Alabama Polytechnic Institute, Auburn, Ala., Capt. Wm. Michener.
Alabama, University of, University, Ala., Major E. W. Cochran.
Carnegie Institute of Technology, Pittsburgh, Pa., Major Paul Reisenger.
Cincinnati, University of, Cincinnati, Ohio, Lt. Col. C. H. Rankin.
Colorado School of Mines, Golden, Colo., Major G. C. Dobson.
Illinois, University of, Urbana, Ill., Captain J. M. Farrin.
Iowa State College, A. & M. A. Ames, Iowa, Captain J. H. Jones.
Kansas, University of, Lawrence, Kans.
Massachusetts Institute of Technology, Boston, Mass., Maj. H. F. Clark.
Missouri School of Mines, Rolla, Mo., Major H. J. Wild.
Northwestern University, Evanston, Ill.
Oregon Agricultural College, Corvallis, Ore., Captain W. Y. Stamper.
Rose Polytechnic Institute, Terre Haute, Ind., Captain W. D. Weidlein.
Tennessee, University of, Knoxville, Tenn., Captain C. A. Rothwell.
Throop College of Technology, Pasadena, Calif., Captain A. M. Engle.
Virginia Military Institute, Lexington, Va., Major W. M. Hoge, Jr.
Virginia Polytechnic Institute, Blacksburg, Va., 1st Lieut. E. P. Ketchum.
West Virginia, University of, Morgantown, W. Va., Captain H. Swenholt.
Yale University, New Haven, Conn., Major E. B. Murray.

Changes in Special Regulations No. 44, War Department, governing this work, are under consideration by the General Staff, with a view to greater flexibility in adapting the military instruction to local conditions and requirements at the various institutions.

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It may be that legislation for the re-organization of the army now under consideration in Congress, will affect this work but, if any statutory changes are made, it is quite safe to assume that they will be in the direction of greater liberality and will tend to harmonize the military instruction with the fundamental educational aims of the various colleges and universities. The outlook is very favorable for greater interest, larger enrollment, and higher efficiency in this work with the beginning of the next college year. The work for the current year, in many cases, was slow in starting, with the result that the colleges were obliged to make up their plans without a detailed knowledge of the military courses, and students had likewise disposed of their time. The work now in progress is therefore, in a large measure, preparatory for the work of next year, by which time many questions now at issue will have been solved and the situation will have crystallized to an extent which will permit of a definite program.

Personals

Losses of Officer Personnel

During the quarter ending December 31, 1919, the Corps of Engineers suffered 26 losses by retirements and resignations, as follows:

Maj. Gen. William M. Black, retired; Col. John M. Wright, resigned; Col. Earl G. Paules, resigned; Col. Lindsay C. Herkness, resigned; Col. Albert H. Acher, resigned; Maj. Francis L. Palmer, rtired (disability); Maj. John W. Fraser, resigned; Maj. Joseph H. Earle, retired (disability); Capt. Roland Stenzel, resigned; Capt. Geo. Sherrerd, Jr., resigned; Capt. R. W. Parkhurst, resigned; Capt. Thos. K. Meloy, resigned; Capt. W. L. Mackenzie, resigned; Capt. S. J. Leonard, resigned; Capt. W. A. Clark, resigned; Capt. B. G. Chynoweth, resigned; Capt. F. C. Albert, resigned; Capt. W. H. Smith, resigned; Capt. N. K. Sheppard, resigned; Capt. A. S. Niles, resigned; Capt. C. O. Isaakson, resigned; Capt. H. P. Hart, resigned; Lieut. P. V. Hauf, resigned; Lieut. J. J. Gromprie, resigned; Lieut. B. S. Goodman, resigned; Lieut. Carl E. David, resigned; Lieut. Geo. O. Consoer, resigned.

Between the signing of the armistice and December 31, 1919, 96 officers of the regular corps have resigned from the service, as follows: majors, 5; captains, 25; 1st lieutenants, 63; 2d lieutenants, 3. The colonels listed above were all in temporary rank.

Engineer Post of American Legion

The engineers in Chicago and vicinity who took part in the World War have formed a local branch of the American Legion, to be known as the Castle Post. The membership embraces engineers of all schools, civil, chemical, electrical, mechanical, and others who served, whether in the Engineer Department, Chemical Warfare Service, Motor Transport Corps, Construction Division or any other staff department, or in the combatant branches. Its purpose is to get the technical engineers under one roof irrespective of the insignia which they happened to wear on their collars when in uniform; its policy is one of preparedness and looks to the development and organization of army engineer reserve units of every sort.

Such an organiation with such an objective, had it been in existence prior to our entry into the World War, could have rendered service of incalculable value in facilitating the organization of special technical troops.

Lt. Col. R. W. Stovel, formerly chief of the terminal facilities division in the Army Transport Service in France, has accepted a position as consulting engineer to Westinghouse, Church, Kerr & Co.

Maj. Harry D. Williar, Engineers, recently discharged, who served in France with the 1st Division, A. E. F., has been placed in charge of the Washington District of the Asphalt Assn., this district including the states of Maryland, Pennsylvania, Delaware, Virginia, and West Virginia.

Maj. H. S. Hetrick, Corps of Engineers (U. S. M. A., 1906), was shot by an unidentified assailant in his home in New Orleans, January 1, and died January 3. Major Hetrick was commissioned Colonel of Engineers during the war, and prior to his death was District Engineer Officer at New Orleans.

Lieut. Col. Claude H. Birdseye, who served as topographic officer on the staff of the Chief of Artillery of the First Army, A. E. F., has been appointed Chief Geologician of the United States Geological Survey, succeeding R. B. Marshall, who resigned to go into private business. Colonel Birdseye has been connected with the Geogical Survey since 1901, and was in direct charge of work in Hawaii and in the Rocky Mountain Division. At the outbreak of the War he was commissioned in the Engineer Officers' Reserve Corps. He was assigned to duty in France in the early fall of 1917, and continued on duty until June of 1919, when he was "demobilized" and returned to service with the Geological Survey.

Col. Walter Fry, formerly sanitary officer at Camp Funston, has accepted a position as health officer at Lincoln, Nebr.

Col. Theodore H. Dillon (U. S. M. A., 1904), who organized the 37th (Electrical-Mechanical) Engineers for service in France, is now Professor of Electrical Engineering at the Massachusetts Institute of Technology. His attention is devoted principally to electrical railway work, electrification of steam railways, and power transmission. Prior to leaving the military service, Colonel Dillon was engaged for a time on the Dalles-Cellilo lock and dam work in the Columbia River and later he served on the Panama Canal as superintendent of the Gatun locks. His service in France included duty as executive assistant to the Chief Engineer, First Army, during the St. Mihiel and Meuse-Argonne operations. After the armistice he served in similar capacity under Gen. C. H. McKinstry, Chairman of the Board for the evaluation of damages due to enemy operations in the allied countries.

Col. Henry W. Hodge, an officer of the Engineer Service during the World War, died in New York on December 21, of heart disease at 54 years of age. He was noted as a designer and builder of bridges and was also engineer for the construction of the Singer, Woolworth, and other large buildings in New York City. He had practiced extensively also in Mexico and South America. Before the war, Colonel Hodge was a public service commissioner of New York City. He served in France as chief of the department of roads in the Division of Light Railways and Roads, which was one of the four major administrative divisions of the Engineering Service of the A. E. F.

Col. E. G. Paules, Corps of Engineers (U. S. M. A., 1912), has resigned from the service to accept a position as employment manager with Crompton & Knowles, Worcester, Mass. Colonel Paules commanded an engineer regiment in France during the war. His last assignment with the Corps of Engineers was as Editor of PROFESSIONAL MEMOIRS.

Gen. E. J. Spencer, formerly Colonel commanding the 32nd Engineers in France, is now manager of the newly organized Electrical Board of Trade of St. Louis, Mo. Col. Spencer is a graduate of the U. S. Military Academy, class of 1882, and served in the regular army until 1892, when he resigned to go into private business. In 1898, he reentered the Service as Lieutenant Colonel of the 3rd U. S. Volunteer Engineers in the Spanish-American War, returning to civil life at the close of the war. In 1917 he was made Colonel of Engineers in the National Army. He organized three regiments of Engineers in succession and personally conducted the last (32nd Engineers) to France, where he served for a time as Chief of Staff of Base Section No. 2 of the Services of Supply, headquarters at Bordeaux, and later as Section Engineer. General Spencer's career as an engineer has been in the electrical field, conducting research work for the Thomson-Houston Electric Company and various light and power companies in the Mississippi and Missouri valleys. For many years he was connected with the Missouri National Guard, appointed a Brigadier General in 1913.

Capt. N. P. Lee, Engrs., recently discharged, has accepted a position with Clarkson & Gains, Fort Worth, Tex., as engineer in charge of their Amarillo office.

Col. Francis F. Longley, Engrs. (U. S. M. A., 1902), formerly commanding the 26th (Water Supply) Engineers in France and principal assistant to the Chief Engineer, A. E. F., on water supply, is now associate director of the Division of Sanitation in the Bureau of Hygiene and Public Health of the League of Red Cross Societies, with headheadquarters at Geneva, Switzerland.

Col. Edgar Jadwin, Corps of Engrs., who returned from overseas about Dec. 1, 1919, has been assigned to duty as District Engineer, Second Cincinnati District.

Col. Thomas H. Jackson, Engrs., has returned from overseas and has been assigned to duty in the office of the Chief of Engineers.

Lt. Col. John C. Gotwals, Engrs., who returned recently from duty overseas, has been assigned to duty as Department Engineer, Eastern Department, with station at New York City.

Lt. Col. Howard S. Bennion, Engrs., recently returned from overseas, is now on duty in the office of the Chief of Engineers.

Col. Ulysses S. Grant, 3d, Engrs., formerly Secretary, American Section, Supreme War Council, at Paris, is now on duty in the office of the Chief of Staff.

Col. DeWitt C. Jones, Engrs., who has just returned from France, has been assigned to duty in the Office of the Chief of Engineers.

The American Bridge Co., through its Chief Engr., Mr. F. W. Dencer, states that discharged engineer officers may obtain positions at the Gary Plant, Engr. Dept., as draftsmen and engineers at salaries from $125 to $250 per month, depending on men's experience and ability.

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PROFESSIONAL NOTES

OF MILITARY AND ENGINEERING INTEREST

Federal Public Works for Fiscal Year 1921

The estimates of the Secretary of the Treasury for public works in the fiscal year 1921 total $283,921,810, as against $93,872,092, for the previous year. The principal items of this estimate are:

Rivers and harbors	$ 53,659,265*
Lighthouses and aids to navigation	6,759,900
Reclamation service	20,134,000
Naval bases, yards, depots, training stations, etc.	29,795,000
Panama Canal	18,245,931
Military posts	14,225,251
Fortifications	117,793,300
Arsenals and powder depots	7,278,259
Public buildings	6,735,396

—*Eng. World.*

* Cut to $12,000,000 by House of Representatives.

German Floating Foot Bridges

At Louppy, France, on November 9th, 1918, a large German dump was taken over by the 7th Engineers and two types of floating foot bridges were discovered among other equipment.

One type of bridge consisted of rectangular sections, twelve feet six inches long by three feet four inches wide, and seven inches deep; the sides being one solid piece and the bottom being constructed of one-inch by two-inch slats, running longitudinally. The deck was designed with a twelve-inch center, running board, on each side of which were two longitudinal strips or slats, the remaining width being covered with solid planking. Each section was divided into four equal compartments and in each of which were placed pillows made of eight ounce duck stuffed with kapok and varnished.

Each section was provided with two perforated hinged straps on one end, and two locking pins on the other end. It was therefore necessary in launching and constructing these bridges that correct ends be butted together, and right side up.

Three handles on each side were provided for carrying the sections, which could be easily done by six men for a distance not exceeding two hundred yards.

Near the center and on each side of every section were attached steel rods with their upper ends bent to form a ring, through which were passed the hand ropes. These rods when not in use were secured to the sides of the sections by clip springs, and raised to a vertical position by hand when needed.

Between the end handles and the section locking device were secured U-shaped straps between which a small wooden roller was fastened. This no doubt, was used for securing L-iron pickets, driven into the bed of a shallow but swift stream in order to prevent the bridge from arching down stream.

The second type of bridge, similar in general design to the first, varied to the extent that in lieu of four compartments and pillows, it had only one full length compartment and pillow.

The deck of this bridge was composed of two planks, laid longitudinally, and the sides of two pieces of 4 by 4, spaced three inches vertically and forming a side rail approximately one inch above both top and bottom. There being no difference in the construction of the top and bottom, either could be used as the deck, which is a decided advantage.

Both types were well constructed and showed careful workmanship, the second being somewhat more expensive. As to buoyancy, a bridge of either type would easily support men in single file as close as they could walk, while one section of either type would safely serve as a dry raft for four men.

A few changes would be advisable, as follows: a longer, narrower, thinner and lighter section with a deck or running board on both sides, and a simple universal section latch that would permit easy fastening, no matter in what shape the sections were launched.

While somewhat bulkier than the present type of ponton in use in our army, this disadvantage might be offset by handling and shipping "knocked down," with the floats or mattresses baled. One distinct advantage is the fact that the above type is much less subject to damage by enemy fire, and once damaged is more quickly and easily repaired.

A large number of sections of a foot-bridge of this type could be kept in readiness in ponton parks and in an emergency could be easily carried and placed by infantry under adverse conditions, and without the use of skilled labor. Stream crossings could therefore be started simultaneously from a number of points, the distinct advantage of such an operation having been seen in the recent crossing of the Meuse River between Dun-sur-Meuse and Brieulles.

Automatic Weapons For Divisional Engineer Regiments

The question of how the divisional engineer regiments should be armed was debated and investigated many times during the late war.

Major W. T. Snow who commanded a battalion of engineers which fought alongside of the marines at Belleau Woods, gives certain reasons why automatic weapons should be issued to combat engineer regiments. He says.

"The engineers are intended *primarily* for engineering work and *secondarily* for emergency fighting, although this is not as well understood as it should be. In an advance the engineers are less apt to be used as infantry than in defense or retreat, although several regiments were so used in some of the offensives of the past year. Although automatic weapons are sometimes needed by the engineers when engaged on engineering work, the great need for the weapons comes when they are being used as infantry. It seems that the chief engineers of the divisions, corps and army are divided in their views on this subject, but by investigating the work of their respective units it is found that the ones who favor having automatic weapons are those who fought on the defensive while those opposed had been engaged in the advances only."

Tanks in Warfare

There is no doubt of the great value of tanks in warfare. They are an answer to the machine gun. As in other automotive design the questions which arise in formulating specifications for tanks relate to overall size, amount of internal space, power, capacity and running speed. There are, of course, numerous other matters involved, by virtue of the characteristics of tank operation, such as balance and ground pressure. The power plant is obviously a vital feature of the tank. The tank now has one-man operation as a feature, whereas several men were required to drive the first European models. Generally speaking, it is to be expected that tanks and tractors

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will not only be equipped with various types of accessories developed and to be developed, but be lighter, faster and less noisy. One interesting phase of tank construction is the feasible life of the machine under strenuous conditions so far as the power plant is concerned. The task of an engine in a large tank is a very severe one. Our army had, however, a goodly number of tanks in operation for a considerable time during the war and these were at the front when the armistice was signed. The tanks are not an independent arm of the service, in that they require infantry support. One of their particular functions is to clear the way for the infantry, especially with regard to enemy machine guns. There is no doubt that the tanks are a decidedly effective humane element in the saving of men in war.—*Society of Automotive Engineers, 1919.*

Invisible Light in Warfare

When a source of light is placed at the principal focus of a converging lens the emergent beam consists of parallel rays and has a constant cross-section. Often the narrowness of such a beam prevents its being observed. Greater accuracy was obtained by using a filter which permitted only the extreme red rays to issue. These would be invisible to an observer unless he protected his eyes from daylight by a similar screen. Through such a screen only the red light could penetrate and the eyes of the observer would be in a sensitive state owing to the exclusion of ordinary light. By such an arrangement secret signals can be transmitted. A variation of method was the use of a screen transmitting only ultra-violet light, which was received on a fluorescent screen. The range of signalling was about six miles.

The following arrangement proved of great value in maintaining communication between ships of the same convoy at night. The light was sent out not as a parallel beam, but diverging in all directions. A Cooper-Hewitt mercury arc was the light source. It was surrounded by a glass chimney through which only ultra-violet light could pass. This caused parts of the eye and natural teeth to fluoresce, while false teeth were black. The receiving apparatus is a barium-platino-cyanide screen placed in the principal focus of a converging lens. The range was about four miles.—R. W. Wood in *Proceedings of the Physical Society of London.*

French Railways, Highways and Canals After the Invasion by the Huns

In a report made to the President of France, March 21, 1919, it is stated that the following losses were inflicted upon the railroads of France during the war: 5,600 km. of single track line, 1,510 bridges, 12 tunnels and 590 buildings. To render the tracks useless the huns employed a crude but effective plow of rails dragged along the road-bed by a locomotive. Some hundreds of mines calculated to explode after a long interval, were left in place. The seriousness of the situation was shown by the fact that of the seven lines formerly connecting Paris to Alsace-Lorraine only one was left in operating condition. Fifty thousand freight cars were lost by France in August, 1914. At the beginning of the present year great numbers of locomotives, freight cars and passenger cars were awaiting repair. Highways:—One hundred and five thousand kilometers of roads were in need of more or less considerable repair. Canals:—The work of destruction embraced 450 bridges, 115 locks and 1,075 km. of canals or canalized rivers.

The later number of *Génie Civil* gives due credit to the assistance of the British and the American troops and presents an encouraging report of the state of the repair work. In the railroad systems of the north by September 1, 1919, all of the single-track lines and all but 6 km. of the double-track lines have been restored. Only four of the destroyed stations

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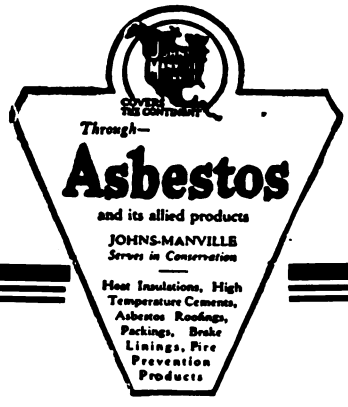
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remain to be cleared away, one viaduct has been put anew in service and others were nearing completion. In the system of the east more remained to be done.

The canal system has been restored to a surprising extent. Paris is again connected to the coal fields of the north by internal water-ways, and also with the east. Electric traction to transport the coal from the Sarre basin is to be installed on the Marne-Rhine canal.

Out of a total of 228 miles of canals or rivers rendered unnavigable prior to the date of the Armistice, only 62 miles remained unserviceable on November 1, 1919, and on a considerable part of these navigation is possible with light-draft vessels. It was expected that the greater part of this remainder would be ready for service by the first of the present year.

Much work has been done in road repair. Bridges amounting in length to a total of 4 km. have been put in position. Seven thousand kilometres of roads have been restored, but much repairing awaits the future.—*Génie Civil, April 5, September 27.*

Water Power of France

In the Alpine region drained by the Rhone and its tributaries 6,000,000-horsepower can be developed at average water flow. Elsewhere in France 3,000,000-horsepower additional may be obtained from streams. These numbers should be divided by two for the output for low-water flow. At the close of 1915, 738,000 horsepower was obtainable from installations in the Alps. This amount has been much increased since that time.

The execution of the project for canalizing the River Rhone will cost upwards of half a billion dollars and will require fifteen years for its completion. It is computed that it will produce hydraulic power equivalent to five million tons of coal per annum and will materially improve the navigation now practically impossible on account of the extremely rapid current. The canal section is designed to accommodate boats of twelve hundred tons capacity. The project will also permit of the irrigation of large tracts of land.

Extermination of Squirrels by Gassing

Squirrels and other rodent pests which injure embankments by burrowing have been destroyed by gassing them in true war time fashion with engine distillate which is forced into their burrows by a vapor machine.—*Eng. and Cont.*

Hauling Heavy Loads on Highways

The two fundamental rules to be observed in hauling heavy loads on highways are:

1. To apply the motive power as close as possible to the load.
2. To have tires broad enough to avoid cutting the road.

Land Values Increased by Drainage

Mr. Isham Randolph, of Chicago, cites a number of cases in which land values have been increased from $10 to $20 an acre to $75 to $300 per acre by drainage.

Captain André Tardieu is authority for the statement that the losses of the French Army during the World War were 26 per cent of the total number of men mobilized, and that of men under 31 years of age serving with the colors 57 per cent were killed.

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Suez Canal During the War Period

Although international agreements under which the Suez Canal is operated prohibit its blockade the war influenced materially the traffic through it, particularly in view of the activity of the submarines of the Central Powers. As the German-Austrian surface navy was practically swept from the seas in the early days of war, it is probable that if submarine activity had not occurred but little difference would have been found in the canal traffic. The data for 1918 in comparison with those for 1912, for instance, show a falling off of over 50 per cent, in number of ships, and somewhat less than the same percentage in total tonnage. Notwithstanding the concentration of submarines on the English commerce, the canal traffic under the English flag was, during 1918, over 79 per cent of the total. Throughout the years, England has led by a large margin, Germany being second. German tonnage, of course, disappeared, and that of Holland which was third in 1912 fell to a single ship of less than 5,000 tons. The falling off of the Dutch tonnage is probably due to the diversion of the East India traffic to the Cape of Good Hope route for safety. Italy and Japan have increased somewhat their canal tonnage. The United States tonnage is, as might be expected, quite small; for some recent years less than half a dozen ships a year, with a total tonnage of less than 10,000. Comparative statistics show that the average tonnage per vessel has been, as a rule, increasing.—*Jour. Franklin Inst.*

Aeroplanes Locate Forest Fires.

F. A. Elliot, state forester of Oregon, reports that aeroplanes are being used with success to locate forest fires. He recommends that a complete squadron with photographic and radio equipment be provided.—*Eng. News-Record.*

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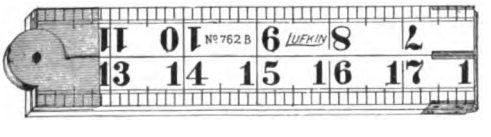
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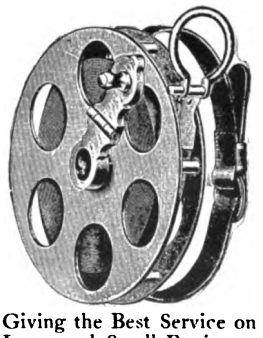
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Army Reorganization

The Senate Army Reorganization Bill (S. 3688), introduced January 9, contains the following provisions of special interest:

The following are classified as "combat arms": Infantry, Cavalry, Field Artillery, Coast Artillery Corps, Corps of Engineers, Air Corps, Signal Corps. The Tank Corps is merged with the Infantry.

The following officers are provided for the regular army:

General (during tenure of Gen. Pershing only)	1
Major generals	20
Brigadier generals	50
Colonels	611
Lieutenant colonels	688
Majors	2,292
Captains	4,584
1st lieutenants	4,355
2nd lieutenants	2,752
Total officer personnel	15,353

This personnel is to be decreased 10 per cent during a period of 5 years after the establishment of universal training.

Officers may be assigned to arms, or transferred between different arms at the will of the President, any arm being thus increased or decreased not more than 20 per cent.

A chief for each of the above combat arms, with the rank of major general, is provided.

The enlisted strength of the combat arms is as follows:

Infantry, 94,000; cavalry, 14,000; field artillery, 39,000; coast artillery corps, 28,000; air corps, 21,000; corps of engineers, 16,000; signal corps, 5,000.

The General staff will be filled by appointment of officers specially qualified for such service.

An "Undersecretary" of War is provided.

The old "Departments" are designated as "Services."

Temporary officers who served during the war are to fill out not less than half the total number of vacancies created by the act, but their distribution as to grades is not prescribed.

One of the most important features of the bill, from the army's point of view, is promotion from a single list, which, if enacted, would forever remove the inequalities of rank between different arms. The "single list" as used in the bill means a list in which all officers are arranged according to total commissioned service, regardless of present relative rank. A peculiar provision of the bill is that former army officers who may return to the service, shall be placed on the list according to their total active commissioned service, which debars them in many cases from high rank, but a civilian who had no service prior to the war may be appointed to the grade of colonel.

Officers will be classified into three classes, A, B, C. Class A officers are those qualified for promotion; Class B those not qualified; Class C those to be discharged or retired. Promotions to include the grade of colonel shall be made by seniority from Class A officers of the next lower grade. Promotion of general officers is to be by selection, but the selection is limited to Class A officers of the next lower grade. Class C officers, retired, shall be placed on the unlimited list.

The bill provides Universal Training for all male citizens of the continental United States between the ages of 18 and 21 years. The period prescribed is 4 months plus time necessary for mobilization and demobilization. The provision becomes effective Jan. 1, 1921. Any alien who secured exemption on the ground of being an alien shall be forever after debarred from citizenship in the United States. The instruction is to include vocational training. Persons liable for training who do not speak the English language may be required to undergo not more than two months of preparatory education.

Men liable for Federal military training may obtain exemption therefrom by joining the National Guard for a 5-year enlistment, provided that not more than 200 men for each Senator or Representative shall be permitted such exemption in any one year.

Reservists (men who have completed their training as above) shall be assigned to the National Guard or to reserve territorial units for 5 years, after which they pass to the unorganized reserve. While in the organized reserve they shall be subject to mobilization and additional training for two periods not to exceed two weeks. Those who desire to qualify as non-commissioned officers will be given additional training and may be retained in the organized reserve for 10 years.

Except as above, reservists shall not, without their consent, be subject to military service except in case of war.

Any person who served honorably as an officer in the war may, upon application be commissioned in the Reserve Corps at the rank held at the time of his discharge. If recommended for promotion prior to discharge he may be commissioned in a higher grade.

Men who served honorably as enlisted men during the war, or who have completed the prescribed military training, or who are specially qualified for service in some branch are eligible to commission in the Reserve Corps.

Commission in all grades, including general officer, is provided for. Commissions in grades above that of Colonel must have the approval of the Senate.

Promotion in the Reserve Corps shall be according to merit, but so far as practicable shall follow the general principles applicable to the regular army.

Reserve officers may be assigned to any duty by the President.

The National Guard shall have a strength of approximately 800 officers and men for each Senator or Representative in Congress.

A National Guard Division of the War Department whose chief will be a reserve officer, replaces the present Bureau of Militia Affairs.

War Department Conferences

With War Department staff officers, the commanders of six departments and seven regular army divisions in attendance, the first of a series of conferences, unique in the history of the Department, was held Jan. 12, at Washington. These conferences are for the purpose of familiarizing the various department and division commanders with the policies and activities of the War Department.

General March opened the conference, outlining its purpose, speaking of the value of education and recreation as applied to the new army and the necessity for universal training in time of peace.

Secretary Baker followed, and said in part that there were two important purposes of the series of conferences: The first, to bring together the officers in the field and those in the War Department to promote co-operation and understanding between them; the second to explain the Department's views in the matter of training soldiers, and maintaining the army at the highest point of efficiency, based on the lessons of the war.

He eulogized the American soldier and spoke of the splendid record he had made for himself in the war. He outlined the three principal ways of obtaining men for the army in time of peace: First, to offer such pay as to compete with private employers. Mr. Baker said this would make soldiering merely a "job" and would remove the inspiration which should go with the profession of arms: Second, by compulsory service: Third, by making the army so attractive by means of education, recreation, etc., that the nation will be glad to see their sons in the army.

Major General Willliam G. Haan, formerly in command of the 32d (Red Arrow) Division overseas, now Assistant Chief of Staff, and in charge of the War Plans Division, addressed the conference at some length. He explained the functions and activities of the War Plans Division of the General Staff, and spoke of the relations between staff officers and those on duty with troops. The new and important work of educational and recreational activity as applied to the army is under General Haan, and he laid great stress on the importance of this work, which is to make the army in time of peace a vast university in khaki.

At the 2d conference, Jan. 13, Gen. Haan, presiding, outlined the War Department's scheme for training camps for candidates for reserve officers in each territorial division. Under this policy the camps would be controlled by Department Commanders, each of whom would thus have at his disposal a trained reserve of officers of all branches, line and staff, in case of a national emergency. As yet no appropriations for these camps are available.

The use in time of peace of the Sam Browne belt, divisional insignia and blue uniform, was also discussed.

At the third session, Jan. 14, took place a discussion of publicity for the army and the program for educational work.

A motion for the adoption of the Sam Browne belt as part of the uniform was made and unanimously carried. The sentiment of the meeting was also in favor of permitting officers to wear civilian clothes when off duty. Sentiment in favor of the blue uniform was not general.

Much discussion took place with reference to living conditions for officers at cantonments, as affecting the morale of the service and the number of resignations. Many officers are now compelled to keep their families in nearby towns and the motor transport corps is not permitted to furnish them transportation to and from their places of duty.

Maj. Gen. Henry Jervey, Assistant Chief of Staff, gave an account of the activities of the Operations Section of the General Staff (G-3).

The decisions of the Conference as to regulations and policies will be forwarded to the Secretary of War for review and action.

Among those attending the conferences were Lieut. Generals Hunter Liggett and Robert L. Bullard; Major Generals Leonard Wood, Clarence R. Edwards, Henry G. Sharpe, John L. Hines, Edward M. Lewis, Charles P. Summerall, James G. Harbord; and Brigadier Generals Douglas MacArthur and W. P. Richardson; also officers of the General Staff and heads of the various War Department bureaus, together with many staff officers from the field.

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Strength of Engineers Before and During the War

Prior to our entering into the war the engineer forces of the U. S. Army consisted of some 360 officers and 2,000 men. At the date of the armistice they included some 11,0000 officers and 285,000 men.

A Substitute for Jute Burlap for Sandbags Used in Military Work

Preliminary laboratory tests have been completed in the investigation of substitutes for the jute burlap ordinarily used for sand bags by the Army. It has been shown that while paper does not equal burlap in tensile or bursting strength, it may, nevertheless, be made up into bags which will be of value for this purpose. Further tests are to be made on four types of paper, as well as on burlap and cotton fabrics and all these materials will be subjected to weathering tests to determine their deterioration under service conditions.—*Technical News Bulletin, Bureau of Standards.*

Slag as an Aggregate for Concrete

The results of the investigation made during the past two years on this subject have been summarized in a report called "Crushed Slag as Aggregate in Concrete." The products of three companies, the National Slag Company, the Birmingham Slag Company and the New England Slag Company, were used in the investigation. The conclusions of the report are as follows:

According to the tests reported, crushed slag as a coarse aggregate produced concrete of as high or higher strength than gravel. The tests have not been extensive enough to determine the durability of slag, but so far as they have gone, no signs of disintegration have been observed due to sulphide sulphur. Slag sand, because of its lack of fine material, does not produce easily workable concrete when used as fine aggregate. If it must be used, its working qualities can probably be improved by the addition of small amounts of fine sea-sand and hydrated lime, or other similar material. In all probability, a larger amount of fine aggregate to replace some of the coarse aggregate would aid workability. Provisions in specifications for slag aggregates calling for a maximum sulphide sulphur content of 1½ per cent and a minimum weight per cubic foot of 70 pounds have been tentatively recommended.—*Technical News Bulletin—Bureau of Standards.*

Cost of Concrete Pipe

The cost of standard concrete pipe made for the Modesto Irrigation Project (Cal.) was as follows, per foot: 8 in., 12½ cts.; 16 in., 36 cts.; 24 in., 68 cts.; 36 in., $1.50.

The pipe was in 2-foot lengths, bell and spigot ends, thickness from 1¼ ins. (for 8 in.) to 3 ins. (for 36 in.). The mix was 1 cement to 3½ sand. The force consisted of 10 to 12 men at $4.00 per day. Cement cost $3.25 a bbl. and sand $1.50 per ton.—*Eng. and Cont.*

Lining Irrigation Canal with Reinforced Concrete

An old canal of the Naches-Selah Irrigation Project was relined with reinforced concrete. The lining is 1: 2: 4 concrete, 3 ins. thick, reinforced with 12 by 12 in. wire mesh. It was laid in 5-foot strips and screeds were placed at intervals to regulate cracks due to contraction.

The mesh was rolled out along the sides and bottom and blocked up with large gravel just ahead of the concrete laying.

Concrete was placed with shovels, roughed into place and finished off with trowels. The cost was $23 per cubic yard, including wire mesh.—*Eng. and Cont.*

Placing Steel Pipe Under Water

The town of Queensborough, Tasmania, has laid 700 feet of 30-inch steel pipe in a maximum depth of 26½ feet of water.

A row of guide piles was driven at 100 feet intervals and a stone foundation dumped and graded alongside. The pipe,, in 48-foot lengths with ends closed, was floated to position, lined up on the guide piles, sunk by opening the ends, and adjacent sections bolted together by divers The pipe was then covered with a rock fill.—*Eng. and Cont.*

What Risks Should Cities Take in Installing Untried Processes?

In a late issue of *Eng. News-Record* a number of prominent engineers express their views on this subject.

They favor a conservative procedure in spending the money of tax-payers. Recoging that progress is often impossible without experiments on a large scale, they believe that large municipalities may often be justified in spending money not for "experiments" but for "experimental study." Small municipalities are advised to stick to current standard practice. In every case the advice of a competent, disinterested engineer should be obtained.

Value of Irrigation

During 17 years past 2,000,000 acres of arid land have been reclaimed by irrigation. The increase in land values amounts to $356,000; the value of the crops produced is $70,000,000 annually, and 400,000 people have established homes on the land reclaimed.—*Reclamation Record.*

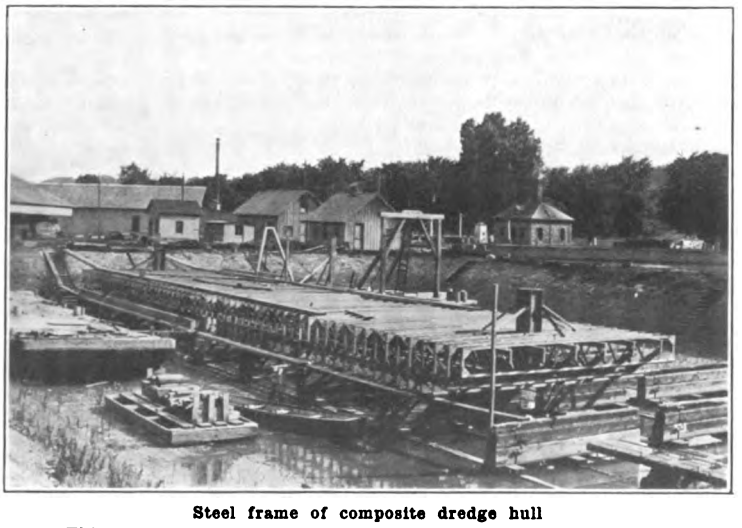
Comparative Durability of Steel and Pressure Creosoted Wooden Dredge Hulls.

Mr. C. W. Durham, Principal Assistant Engineer, Rock Island district, has furnished some interesting information on this subject. He states that three 18-inch hydraulic pipeline dredges built by hired labor at the United States dry dock at Keokuk in 1912 with steel frame trusses, untreated timber bottoms, creosoted timber sides, reinforced concrete decks, showed in December, 1918, no evidence of rot, rust, or distortion, and no hull repairs have been necessary. These dredges have had seven seasons of moderate use, usually with double crews working 16 hours a day. In comparison, three dipper dredges of steel construction, while in excellent condition, have required scraping and repainting at considerable cost.

In 1908 and 1909 there were built at the various yards in the Rock Island district 79 standard barges of Douglas fir, creosoted by the open-tank or dipping process. After 10 years' service, 40 of these were reported good, 37 fair, and 3 bad. Most of the barges classed as "fair" showed some decay. The principal deterioration, however, was the abrasion and wear of the decks.

In 1911 and 1912 there were built 90 standard barges of Douglas fir, treated with coal-tar creosote by the pressure process, 10 pounds to the cubic foot. Of these, 80 were reported to be in good condition December 31, 1918, showing no evidence of decay; 10 were reported fair, and none bad. All barges can be placed in the "good" class at small cost for repairs.

The experience in the Rock Island district does not show that creosoted lumber is weakened by the pressure process, although it may become less resilient. Mr. Durham believes that creosoted lumber will not decay to the depth of the creosoted penetration, but that when the abrasion goes deeper than that decay is invited. (See figure, next page.)



Steel frame of composite dredge hull
This frame was erected by 1 blacksmith and 5 laborers in 5 days

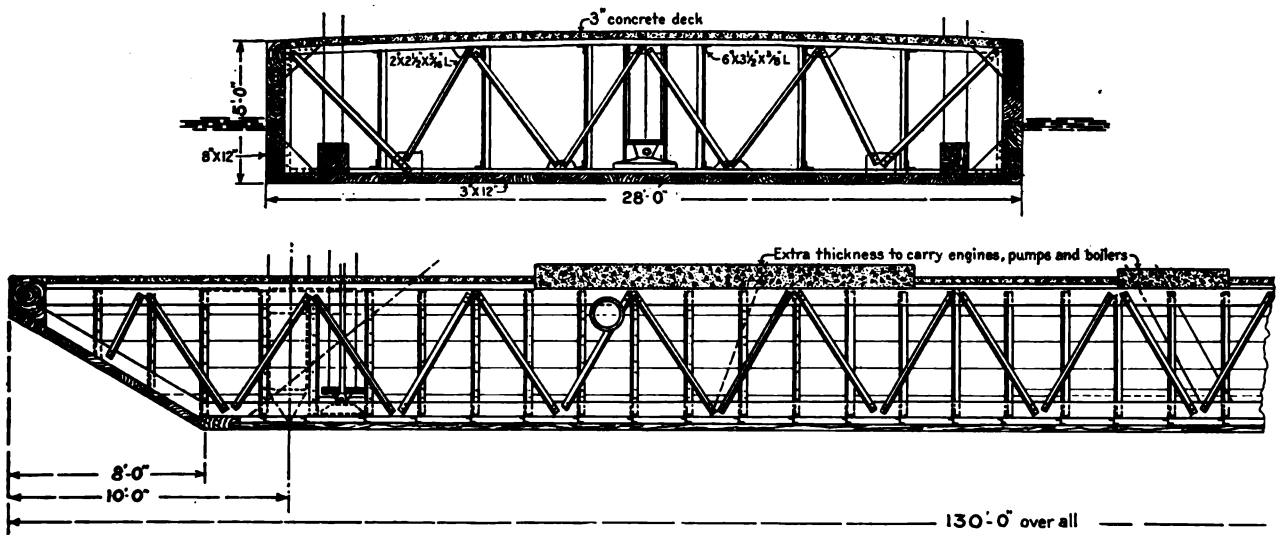
Building Roads With a Hydraulic Dredge

Hydraulic dredges were used to construct a 250,000-yard embankment for a road connecting Atlantic City, N. J., with the state highway system. The fill, mostly sand, was pumped from Absecon Bay. It was 5 to 6 feet high in places and was retained by side walls built of meadow sod, raised as the fill progressed. The longest discharge was about one mile. A 12-inch and a 16-inch hydraulic dredge were employed, but these were regarded as too small to be economical on a task of this size. The unit cost was 30 cents a yard.—*Eng. News-Record.*

Cast Iron Solid Car Wheels

Fifty plants for the manufacture of cast iron freight car wheels in the United States and Canada have an output of 20,000 wheels per day or some 6 millions per annum. These wheels are guaranteed for a life of 5 years; but usually exceed that period.

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Composite Dredge Hulls.

Displacement, 204 tons. 3-inch bottom, 8-inch sides of Oregon fir. Cost, in 1911, $7,500.

Comparative Strength, Location and Classification of Engineer Troops in the World War

	In U. S. and insular possessions			In A. E. F.			Aggregate		
	Officers	Men	Total	Officers	Men	Total	Officers	Men	Total
Entire army	106,344	1,635,005	1,741,349	76,495	1,889,2S8	1,965,783	182,839	3,524,293	3,707,132
Engineer corps	4,198	56,191	60,380	6,001	236,115	242,116	10,199	292,306	302,505
Engineer corps, per cent of total	3.95	3.44	3.47	7.84	12.50	12.50	5.58	8.30	8.12

	Number of troops	Per cent of Total
Combatant	86,634	35.8
Transportation	44,412	18.4
Labor	37,726	15.6
Construction and forestry	33,956	14.0
Light R. R. and roads	15,796	6.5
Special service	14,888	6.1
Unclassified	8,714	3.6
Total	242,116	100.0

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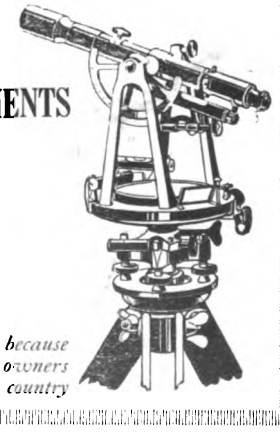
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Military Railways and the Corps of Engineers

The following decisions of the Secretary of War have been announced:

SUPPLY OF RAILWAY MATERIAL.

(*a*) The Corps of Engineers will procure and develop all railroad equipment.

(*b*) In order that army reserves be set aside, surpluses determined and current needs of all branches of the army met, the transportation services will maintain an inventory of all railroad equipment in use or in storage. The Corps of Engineers will procure and issue to the army, or will issue from stocks on hand, railroad equipment on requisitions approved by the chief of the transportation service.

(*c*) In order that railroad transportation for military service may be placed in such status with respect to appropriations that it can be freely assigned and utilized on any activity under the War Department without necessity for transfer of funds in each case, the transportation service will submit estimates for all railroad construction, operation and maintenance, for the military service at large. Such of these funds as are stated by the chief of engineers as being necessary for construction, maintenance and operation of railroads under his control will be set aside under the estimate for that purpose.

CONSTRUCTION, OPERATION, AND MAINTENANCE OF RAILWAYS.

(*a*) The extension of railway lines into the theater of hostile operations devolves upon the Corps of Engineers.

(*b*) The Chief of Engineers in conformity with the basic supply plan furnished by the purchase, storage, and traffic division of the general staff, will make working plans and preliminary preparations necessary to carry out the construction, maintenance, and initial operation of railroads of all gauges in contemplated theaters of operations. In order to avoid the possibility of duplication of effort, or of construction of unnecessary lines, and in order to insure necessary liaison between existing lines under civil control or under control of the chief of transportation, basic supply plans should receive consideration by the chief of transportation before lines to be constructed by the chief of engineers are determined.

(*c*) The extensions above referred to will be absorbed by transportation service into the railway system of the line of communication when, by decision of the commanding general of the expeditionary forces, the engineering features have ceased to be predominant and the operating features have become reasonably secure from hostile interference. The chief

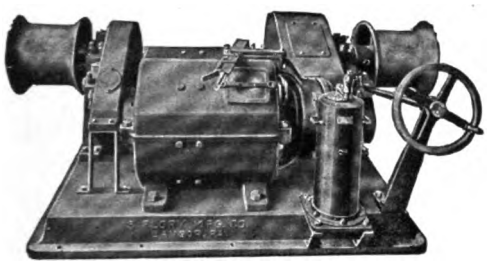
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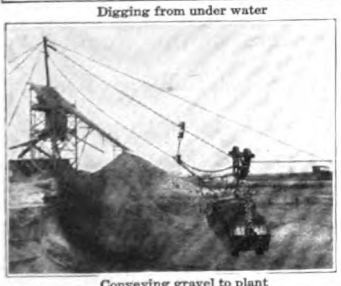
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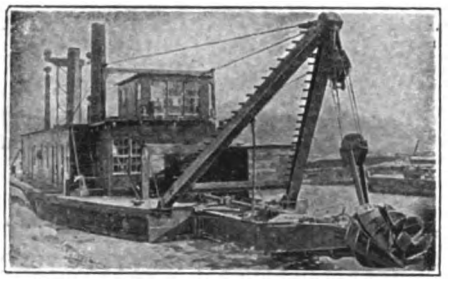
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of transportation service will plan to extend his service accordingly.

(*d*) The Corps of Engineers will procure, organize and train all military personnel for construction, operation and maintenance of railroads. The Corps of Engineers will furnish to the transportation service such troops as the transportation service may requisition for operation and maintenance of railroads assigned to that service.

(*e*) Standard gauge railroad facilities at posts, camps and other establishments are not considered to be military railroads as the term is used in paragraph 1493, Army Regulations. They are either terminal facilities or part of specific projects, constructed and operated as such. As a rule, their construction is an incident in the construction of the plant to which they pertain and can not be separated therefrom. Their operation, under supervision of a transportation officer responsible to local commander for the proper administration of all maintenance matters, is in accord with the past practice of the War Department. No change in this respect is contemplated. The installation of light railway systems at camps and cantonments by the Corps of Engineers or the assignment of engineer troops to the operation of such roads for the purpose of instruction, are matters for special authorization in each case.



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The Military Engineer



THE LINCOLN MEMORIAL
Washington, D. C.
Erected under the supervision of the Corps of Engineers, U. S. Army

JOURNAL OF
THE SOCIETY OF AMERICAN MILITARY ENGINEERS

IN THIS ISSUE

"Concrete Caissons for Breakwater Construction"
"Army Construction and the Corps of Engineers"
"Military Road Building Not A Science —Only A Job"

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The Society of American Military Engineers

It is with pleasure that we are able to announce that the Society of American Military Engineers is now an accomplished fact. Many prominent engineers are already numbered amongst its members, and the list is growing daily.

Since the first draft of the constitution of the Society was promulgated a number of minor changes therein have been found advisable. The constitution and by-laws of the Society, as amended, are printed elsewhere in this issue. Pamphlet copies of these, and application blanks for membership, may be obtained from the Secretary of the Society, at Washington Barracks, D. C.

There has been some misunderstanding and confusion, largely due to changes in the tentative plans, with reference to charter membership in the society. All persons who are eligible to membership are at present eligible to *charter* membership. It has been decided by the temporary Board of Directors that applications for charter membership will be received until the permanent organization is effected, after which it will scarcely be practicable to admit applicants as *charter* members. A former tentative plan provided that all former subscribers to PROFESSIONAL MEMOIRS, who were eligible to membership in the Society would be *automatically* admitted to *charter* membership upon payment of amount necessary to carry their dues and subscriptions to December 31, 1920 at the new rate ($4.50 per annum). Thus in the case of a subscriber paid at the old rate of $3.00 per annum to include No. 65, September-October, 1920, an additional payment of $2.00 would be required (No. 60 at 50 cents, Nos 61 to 66, $4.50, total $5.00, less $3.00 paid, balance due, $2.00). However, as all subscribers do not necessarily desire to become charter members, it has now been decided that all be given an opportunity to express their wishes in the matter and to take a positive action in the premises. Accordingly all persons eligible, who desire to become charter members, should so inform the Secretary, at their earliest convenience, when they will be so admitted, and confirmed upon payment of any amount or additional amount due to December 31, 1920. To save correspondence it is requested that the necessary remittance accompany the application for charter membership.

It is not practicable at this time to fix a final date for closure of the list of charter members, but it is anticipated that under the provisions of the constitution and by-laws a permanent organization of the society may be effected on or before July 1, 1920.

The Secretary
Society of American Military Engineers
Washington Barracks, D. C.

Sir:

I desire to apply for membership in the Society of American Military Engineers.

Please furnish me with formal application blank.

Name _____

No. and Street _____

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Lansing H. Beach

Major General, Chief of Engineers
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Duties of a Corps Engineer

By

De Witt C. Jones

Colonel, Engineers; formerly Corps Engineer, 1st Corps, A. E. F.

At the time the United States entered the war against Germany, the corps was not a unit of the United States Army. The duties of the chief engineer of any unit were known in a general way or could be deduced from the general duties assigned to the Corps of Engineers by Army and Field Service Regulations, but the specific office of Corps Engineer did not exist. We had been thinking in terms of regiments and divisions. The "Division Engineer" was a familiar character, at least upon paper, but the "Corps Engineer" or the "Field Army Engineer" had not reached even a satisfactory paper stage in his development.

With the revival of the corps as a unit of our service, the questions of duties, office organization, and Corps Engineer troops became important and received consideration, but even after the publication of an organization table allowing him an office force of three officers and a small enlisted detachment, the Corps Engineer of the First Corps had great difficulty in securing this personnel. Even the corps staff did not recognize the importance of promptly organizing the corps engineer's office.

It was intended to provide a special regiment of engineer troops for each corps, but this plan was not carried to completion, and, at the signing of the armistice, the troops assigned to the various corps consisted of such divisional engineer regiments, parts of corps regiments, pioneer infantry regiments, labor and service battalions as had become available for such assignment.

In the absence of definitely prescribed duties, each corps engineer performed the duties which the conditions of service in his particular corps rendered necessary and which were possible with the troops at his disposal. Our corps engineer who served with the British troops worked under conditions quite different from those in the American sectors.

Relations between Division, Corps and Army Engineers

The Corps Engineer supervises the work of his Division Engineers. He should in no sense command the division engineer troops. His supervision is exercised by keeping in touch with the situation throughout the corps, providing and distributing engineer materials and supplies to best serve the common cause, distributing corps engineer troops so that their work shall supplement that of the division engineers, and advising division engineers as to the general engineering situation in the corps, the object to be accomplished and the part each division engineer must take to complete the task.

Corps engineers should be especially careful not to give the division engineers any orders which will infringe upon the province of a division commander. The Division Commander rightly considers his engineer regiment as an integral part of the division and as absolutely within his own control. He is responsible for everything within his division and should be permitted to exercise entire control of his engineers. He has a right to expect assistance from the corps engineer but will resent undue interference.

If the division engineer is competent and keen to foresee coming events, his division commander will allow him great latitude in doing his work. He will in general find it possible to work towards the ends desired by the corps engineer and at the same time meet all requirements in the division.

Should a division commander work his engineers at cross purposes to the general engineer plan the matter can usually be adjusted by a personal conference between the corps engineer and the division chief of staff.

To sum up, the division engineer should look to the corps engineer for information as to the general engineer plan, the part he is to play, and what he can expect in materials and help from corps troops. Combining this knowledge with the known plans of the division commander, he should arrange his work so as to meet both requirements. He must do all this *in advance,* and must inform his division staff of his proposed actions in order to forestall the issue of division orders which will run counter to the corps engineer's plans.

The relations between the Army Engineer and the Corps Engineers are somewhat different. The corps engineer can usually count upon having the corps

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engineer troops absolutely at his disposal for engineer work. The corps commander will seldom think of the corps engineer troops as a part of his fighting force. On the contrary, the division commander always has in mind the fighting value of his engineer regiment, and when he wants to throw it into the fight he seldom if ever asks the opinion of the corps engineer. It follows that arrangements made between army and corps engineers are less apt to be disturbed by tactical situations and commanders than are those between corps and division engineers.

The army engineer supervises the work of the corps engineers by fixing upon each the responsibility for executing certain works and himself assuming responsibility for the remaining work. He then assigns materials and troops to the various Engineers and to the Chiefs of Section in his own office. In general the corps engineer's work lies completely within the corps area, still there is no definite geographical line which separates the corps and army engineers' activities. As an example, the corps engineer may be maintaining a certain highway in his corps area while the army engineer is constructing a railway and operating quarries alongside the highway in question. This relationship was a development of the St. Mihiel and Meuse-Argonne operations. It is an emergency product, and is thought by some corps engineers to be wrong in principle. These officers hold that the corps engineer should be held responsible for all work in his corps area and should be given troops and equipment to accomplish this work. A corps engineer who had experience with British methods has stated that the corps engineer should be able to furnish all connecting facilities between the divisions at the front and the Service of Supply in the rear, thus eliminating the army engineer as a commander of large numbers of troops.

Under the system as developed in the First Army, at the signing of the armistice, the chief engineer of the army was exercising direct command over more than 50,000 army troops while the corps engineers each commanded about 5,000 corps troops.

Strength and Organization of Corps Engineer Troops

In training areas and under stabilized conditions, the divisions are in direct contact with the railheads and other installations of the services of supply. Railway, water supply, and general construction projects can be handled by the services of supply, and each division can handle its own road problems.

Under these circumstances there is no urgent need for corps or army engineer troops except for minor utilities work around headquarters which can as well be done by detachments of divisional troops. The services of supply will have need for every available engineer.

It is not to be expected that corps and army troops will be assigned and held idle while they are urgently needed for emergency work in the services of supply.

We must assume that in future, as well as in the recent operations, corps and army troops will not be actually concentrated in their respective areas until immediately prior to an operation.

Recognizing these conditions, what can be done to render the work of the corps and army troops effective immediately upon their arrival in the forward areas? The obvious answer is that we must know what work these troops will have to do, and must have ready an office organization competent to direct the efforts of the troops when they arrive.

This means that the offices of the corps and army engineers must be organized as an integral part of their respective headquarters and must not be allowed simply to grow up as the troops arrive. The latter course brings inevitable inefficiency in the early stages of the operation and cripples the arriving units which will be robbed of some of their best officers to provide personnel for the headquarters offices.

As to the numbers and classes of troops which should be assigned to the corps and army engineers, it must not be assumed that our recent experience carries very much weight. On November 11, 1918, the Chief Engineer of the 1st Army commanded over 50,000 men and each of his corps engineers commanded, say, 5,000; but if hostilities had ceased a month earlier or a month later the figures would have been very different.

As the divisions move forward in an offensive, they open a gap between themselves and the organized establishments in the rear areas which must be bridged by greatly expanded engineer activities. The three spans in the bridge are the corps engineers, the army engineers, and the advance section of the services of supply. At least one of these organizations must be capable of great and rapid expansion. Logically, the greatest expansion should fall upon the services of supply, although in the recent operations it fell upon the army engineers. At any rate, it may be assumed that the corps engineer will control from two to four regiments including engineer and labor troops, which assumption may serve as a basis upon which to organize the corps engineer's office.

The corps engineer should properly be stationed with his corps headquarters, while the several corps regiments will as a rule be working miles away. The provision requiring that the corps engineer shall be the colonel or commander of the corps engineer regiment is wrong, and has the practical effect of depriving the regiment in question of its colonel.

Work to be Done

Our service included stationary operations, a number of advances and the conditions in training areas. Since we took no part in a retreat, we can only specu-

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late as to what duties would have fallen to the Corps Engineers in a retreat.

Engineer supply and road work (including fixed and floating bridges) constitute the great bulk of the corps engineer's work. The office organization must therefore be built around a road section and a supply section. In stationary warfare or in a retreat, defensive lines and military demolitions may become very important. Mining and counter-mining are not pressing matters, and can be developed when the necessity actually arises. Motor and animal drawn transportation are ever present problems of the greatest importance, not only on account of the large quantities of materials which must be moved but also to make possible the intensive engineer reconnaissance and the rapid communication which are vital to the success of engineer operations.

Standard and light railway construction and operation, general construction, water supply installations, electrical and mechanical work, lumbering and forestry operations, camouflage, drafting, photography, administration and records are of importance to higher engineer officers, but touch the corps engineer only lightly or incidentally. The burden of his thought turns upon road work, supply and transportation.

Neither the road work nor the supply problems can be successfully handled without an efficient system of engineer reconnaissance and communication. This system must give the corps engineer early and accurate information as to the capacity and condition of roads and bridges, damage done by the enemy, materials required for repairs, location of fords, character of banks of streams, location and capacity of quarries, location of timber and other engineer materials, estimates of labor and transportation, location and contents of captured dumps, and information as to what the Division Engineers are doing and propose to do. Combining this information with the known plans of the corps commander, the corps engineer can assign his available supplies and troops to the best advantage.

Nor should the corps engineer fail to make systematic reports to the corps staff as to road and bridge conditions. The staff is responsible for traffic routing and regulation, and if it acts in ignorance of true road conditions disaster to the general operation and in particular to the corps engineer's program will be the sure result.

While traffic control is the duty of the military police, acting under the staff, still the fact remains that the engineers are the ones who will be found in force at the critical points where trouble is most likely to occur. The corps engineer should therefore arrange with the staff to have all road officers and non-commissioned officers vested with the power of military police in the matter of clearing up traffic jams. He should also see that these powers are recognized throughout the corps.

The question of camp utilities is, in itself, a small matter, but is apt to cause trouble. In time of war the Corps of Engineers handles all construction and maintenance work in the theatre of operations. The corps engineer officer will, especially in periods of inaction, be called upon to do a great variety of small jobs around headquarters, such as running lighting plants and pumps, erecting bath houses and latrines, making board walks and delousers, etc. The headquarters troop is supposed to handle this utilities work, but as a matter of experience it has neither the necessary men nor material. If the corps engineer resists these demands he is branded as an obstructionist. It is therefore best to recognize that these things must be done and to organize a small utilities section to handle them in a businesslike way. It is even well to take the initiative in doing small jobs which will contribute to the general comfort around headquarters.

Training

The corps engineer is responsible for the training and efficiency of the engineer troops of the corps. He should coördinate training in the divisional regiments by inspections and suggestions but must not attempt to prescribe specific schedules for these regiments. To do this would surely cause trouble with division commanders and would relieve division engineers of responsibility for the efficiency of their regiments.

Uniformity in the training and use of divisional engineers is desirable but hard to attain. Division commanders, seeing the emergencies in the fighting line, are prone to throw in their engineers regardless of conditions in rear. Higher commanders and staff officers, seeing the emergency conditions in rear, are impressed with the necessity of conserving the engineers to meet these conditions. They therefore in their training instructions, at maneuvers, etc., stress the view that engineers should be thrown into the line only in real emergencies. The more tractable division commanders heed this advice while the headstrong disregard it. Uniformity can come only with the authoritative enunciation of proper doctrine and as a result of uniform education of our higher commanders and staff officers.

As a member of the corps staff, the corps engineer will constantly be called upon to act as umpire at division maneuvers. To perform this duty well, he must be familiar and in sympathy with the methods of conducting these maneuvers and the manner of thought of his associates in the work. In other words, he should have the same tactical training as our higher staff officers. He should be a graduate of and maintain familiarity with the methods of the General Service and Staff Schools of the Army. These

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methods are used in our training and consequently in our operations.

Relations with the Corps Staff

As at present organized, the corps has a Chief of Staff with three principal assistants, known respectively as G-1 (Administrative), G-2 (Intelligence), and G-3 (Operations).

The corps engineer is associated with G-3 in matters of training and military operations, with G-2 in matters of military intelligence, but especially with G-1, who is charged with the duty of coördinating the work of all staff and supply services of the corps. The maintaining of proper relations with G-1 is an important consideration for the corps engineer. The officer selected to be G-1 of a corps will probably be a strong man more inclined by disposition and training to command than to merely coördinate. If he in fact assumes command of the technical auxiliary services, his action may be countenanced or even encouraged by the chief of staff and the corps commander. Under these conditions the corps engineer finds himself seriously handicapped by receiving orders from G-1, issued in the name of the corps commander and often arising in a misapprehension on the part of G-1 of the true engineering situation or requirements and in ignorance of the capacities and limitations of available troops and supplies. Theoretically, with a general staff properly trained and administered such situations will not exist, but in fact many corps engineers have in the past received orders to perform absurd, unnecessary, impossible tasks.

In the interest of efficiency, the corps engineer must do his utmost to maintain proper relations with G-1. He must keep him informed at all times of the engineering situation and of engineer plans. He must, insofar as practicable, make himself personally agreeable to G-1, avoiding especially all written controversies. He must be in actual command of the engineering situation by knowing engineering conditions better and earlier than any other man in the corps. He must formulate and propose good plans before poor ones are thrust upon him. G-1 will generally approve any reasonable engineer plan, provided it is presented before he has been forced to formulate a plan of his own. When G-1 finds that the corps engineer is beforehand with his work and his plans, he will refrain from interference in the details of the engineer work, and his notes to the corps engineer upon unforeseen problems will come in the form of requests for recommendations or proper action rather than as arbitrary orders.

As an example, the corps and army have many staff officers who ride over the area and report to headquarters upon any and all subjects. Suppose a report comes in that a road is bad at a certain point. G-1 may remember that the corps engineer has spoken to him about that bad place and has said that it would be repaired at once or perhaps that it could not be handled at present. He therefore throws away the report. But suppose he knows nothing of the matter. He then checks the report to the corps engineer for his information or for proper action. Suppose now that the corps engineer knows this matter to be of no immediate importance. It is then wise for him to so inform G-1, otherwise in a few days he will probably get a second report directing that the road be repaired within twenty-four hours and report made upon completion. Such occurrences are most annoying and may delay important work. They can be avoided if the corps engineer takes the initiative in reaching a working understanding with G-1.

As another example, take the lumber situation. The demand is always greater than the supply. Division commanders and other services requisition for lumber upon the corps, and G-1 in the absence of knowledge of the situation may issue orders to the detriment of more important work. However, if the corps engineer has talked over the lumber situation with G-1, explaining the shortage, and what is being done to remedy it, or if he has made an agreement with G-1 that the two shall resist all calls for lumber except for certain urgent uses, then the lumber situation remains within the corps engineer's control.

By means similar to the above, any but the most refractory G-1, should be brought to see the advantage of coöperating with the corps engineer rather than commanding him.

In important cases where the views of G-1 and the corps engineer can not be reconciled, the question should be taken to the chief of staff.

To sum up, the corps engineer must not only do his work promptly and well, but must also keep the staff informed as to what he is doing and proposes to do.

In this brief article, no attempt has been made to describe engineering methods or the details of execution. These are questions which relate more particularly to the duties of officers in immediate command of engineer troops and in actual charge of work.

For the corps engineer the questions of office organization, relations with staff and other services, general military information, foresight, and a well developed sense of proportion are of far more importance than personal skill in the actual execution of engineering work.

Discussion

Brig. Gen. Campbell King
Formerly Chief of Staff, 1st Division and 3d Corps A. E. F.

Relations between Division, Corps and Army Engineer

The principles set forth in Colonel Jones' article in regard to the relations between division, corps and army engineers are concurred in so far as my experience as a division and corps chief of staff is concerned. My observation was

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that in active operations the engineer of the higher unit seldom encroached upon the domain of the lower unit, but the latter, owing to the exigency of the case, was often required to extend its activities back into the area normally assigned to the next higher unit.

Organization and Strength of Corps Engineer Troops

While there is a certain advantage in the matter of giving orders, in having the corps engineer directly in command of the engineer regiment, as a matter of fact in my experience, he rarely has actually commanded the regiment, but only nominally occupied this position as his duties usually required him to be detached from the regiment. The actual regimental commander is really the senior engineer officer on duty with the regiment and I believe for this reason that the principle set forth by Colonel Jones, in regard to the direct command of the regiment not being in the corps engineer, is correct.

Work to be Done

While there are many other duties that fall to the corps engineer, engineer supplies and road work certainly constitute the main burden of engineer work. It is believed that the suggestion that powers of military police be conferred upon engineer road officers and non-commissioned officers on road work at critical points is very useful. This practice was followed in the First Division when I was its Chief of Staff.

The further suggestion as to a utility section of engineers around corps headquarters is believed to be sound and conforms to my experience in this matter.

Training

The training of engineers in the divisions should be coordinated as is all other training, under the general supervision of the G-3 of the corps upon consultation with and acting through the agency of the corps engineer. It is believed that the consequent uniformity in training can thus be secured without trespassing upon the responsibility of the divisions and without any friction resulting therefrom.

The remarks as to the tendency of division commanders to use engineer troops too frequently as combat units is very true according to my experience and must be carefully restricted to urgent emergencies.

Relations with the Corps Staff

The relations of the corps engineer to G-1, G-2 and G-3 as set forth by Colonel Jones are thoroughly concurred in by me. Under certain conditions the duties of the engineer assume such a great importance in their relation to the general work of the division that I found it expedient in the First Division to have him attend the daily conferences held by the Chief of Staff with the heads of the General Staff sections. Ordinarily this was not necessary. However, neither in the first division nor in the third corps were the difficulties suggested by Colonel Jones encountered in the relationship between the engineer officers and the G-1's. It is believed that the reasoning which assumes an inefficient, incompetent G-1 as an objection to the principles governing the relations established between the engineer officer and G-1 is hardly correct because such an assumption would make any relation with any general staff officer unsatisfactory. No such difficulties ever occurred either in the first division or the third corps.

The remarks about the division or corps engineer officer being beforehand with his work and looking well towards the future cannot be emphasized too strongly as a prime factor in making for the efficiency of the engineer service and the general betterment of the staff work.

Line of conduct set forth in Col. Jones' paper to govern the relationship between staff officers is a good exposition of the principles which should control in all staff work, and is essential to that team work which is necessary to produce high efficiency.

In conclusion, I would say that I consider Col. Jones' paper a particularly clear and lucid statement of the duties of a corps engineer and those which, based on my experience as a chief of staff, I believe to be logical and correct.

Brig. Gen. Wilson B. Burtt

Formerly Chief of Staff, 5th Corps, A. E. F.

Corps Areas

The point should be borne in mind that the difficulties of the engineer increase as the forces move forward. It happened in our own experience that the corps area was much lengthened by the advances made. The army and service of supply troops were not available or their forces were not so mobile as to immediately take over the back areas of the corps and permit the corps engineer to give most of his supervision to the areas nearest the divisions.

Reconnaissances

The reconnaissances of roads, etc., are of vital importance to the commander, staff and engineer. They should be made by the engineer on his own initiative. These reconnaissances should extend to the front line and as far beyond as conditions permit. They must be kept up to date as the army moves forward. It seems almost unnecessary to say so, but the material must be on hand, the assignment of labor made, and everything put in order so that repair and construction can begin at zero hour. In no other way can we be assured of even slight progress. All advances will come to an end finally, through the wearing down and "petering out" of the fighting forces. This should not be hastened by failure to provide all the necessary labor and material for the repair and construction of arteries of supply.

Command of Engineer Troops

I do not agree with the idea that the commander of the engineer troops should *not* be the corps engineer. He should be the commander of the troops. His subordinates should handle the regiments or units. The question of rank does not enter. The man in charge of the work should have control of the labor which does the work.

Relations with the Corps Staff

It cannot be emphasized too strongly, that if the corps engineer is thoroughly posted in his duties, has had ample outdoor work with troops, and thoroughly understands his responsibilities, and his relation to the commander and staff, no friction between the corps engineer and the assistants to the chief of staff can arise which are not easily disposed of. They will welcome a strong resourceful man in any capacity, and it can be confidently predicted that they will be glad to accept his forehanded recommendations. "He must formulate and propose good plans" and no others will be "thrust upon him."

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Brig. Gen. Stuart Heintzelman

Formerly Chief of Staff, 2d Army, A. E. F.

I have read Colonel Jones' paper with great interest, and my own opinion is in general accord therewith, especially as to "Relations with the Corps Staff." There are three points of difference of opinion probably more apparent than real.

First. In the summing up of the paragraph headed "Relations between division, corps and army engineers" the phrases "To meet both requirements," "To forestall the issue of division orders which will run counter to the corps engineer's plans," and, later, "Arrangements made between army and corps engineers, etc.," give an impression that there are two wills involved. On the contrary, there is only one. The corps commander orders, upon the advice of his engineer officer through G-1, what the division is to do in the way of engineer work. Except as thus prescribed or limited, the division commander's will is supreme. The corps engineer officer can urge his interpretation of these orders on the division engineer, but he cannot give any orders except to his own corps engineer troops.

If the division staff refuse to accept the corps engineer's interpretation of the corps commander's orders, he, as a staff officer of the corps commander, reports the whole matter to him through G-1, who issues the necessary orders to the *division commander.* Any other conception of this relationship will cause increasing friction and divided responsibility.

Second. With reference to bridging the gap opened between the troops and the rear areas by an advance, the greatest necessity for rapid expansion will always fall on the army engineers rather than on the advanced section, S. O. S., since the army is vitally interested and its success or failure depends on bridging this gap. Hence, all available engineer troops should be given the army and the army have an undivided responsibility. It will be only too glad to turn over the bridge as built, once flow of supplies is assured, but until thus assured the army must control.

Third. The corps engineers must assist in clearing up traffic jams. But it must be clearly kept in mind that the engineer building the road cannot control traffic. For here are two conflicting interests; moving supplies and road building. A third party must decide priority at any given time or place. Frequently these decisions will be so important and so difficult to make that they will require an officer in close touch with the condition of the troops and the plans of the commander.

The most important thing to keep in mind is that all good staff management depends on personnel. Good staff officers will make any system work, or at least amend it so that it is workable. On the other hand, the best system will not operate satisfactorily under the direction of inefficient officers.

Col. Hj. Erickson

Formerly Commanding 1st Brigade, and Chief of Staff 8th Corps, A. E. F.

With reference to Colonel Jones' article on "Duties of a corps engineer" the following remarks are submitted:

It is intimated that under certain circumstances a corps engineer may deal directly with the chief of staff of a division. In practice, when the engineer work of a division does not co-ordinate with the scheme of work for the entire corps, the corps engineer would take the matter up with the corps chief of staff who, in the name of the corps commander, would cause orders to be issued which would remedy the matter.

Colonel Jones believes that the division engineer should try to mold the divisional orders so as to coincide with his own pre-determined plans whereas in practice he would be informed by G-1 what would be required from him, and his plans would be made to meet those demands. The part of the G-1 annex to the divisional orders referring to "Works" would of course be in accord with the will of the corps commander.

In a rapid forward movement it seems that the work of both the division and corps engineers would be of a temporary character and only just sufficient to aid the advance of their organizations. As the army would be interested in the advance as a whole, it is believed that the main permanent work, such as railroad, tunnels, complete bridges, etc., would be carried out by the army engineers and that consequently, for a short period, corps and army engineers would be working side by side at their respective jobs. However, this would be only for a very short time. If the advance continues, the temporary work of the division and corps engineers would be elaborated by the army engineers. In other words, there will be a constant forward flow of work following the advancing divisions, the rear limits of the division and corps zones of work will be more or less overlapping until the movement stabilizes. It seems therefore that the strength of the army engineers, whose work is of a more permanent character and whose scheme of work is broader, will exceed that of the corps engineers.

It is never advisable to divide responsibility for work in a campaign, and for that reason if no other, and there were others, traffic control should be strictly under the military police. It is true that in a number of instances during the campaign of 1918, engineers assisted in traffic control in the American zone of advance. However, this was a makeshift to assist an organization new to the American military establishment and will not be called for in our future campaigns. The engineers have their well defined and important work to perform and their efforts should not be reduced by performing police duty. They assist, of course, indirectly in reducing traffic jams by repairing bridges, constructing "run arounds" when necessary, etc.

Col. Wm. J. Barden

Engineers; formerly Corps Engineer, 6th Corps A. E. F.

Colonel Jones' article is interesting and instructive. It is, of course, based on experience with the American Expeditionary Forces in France in the greatest war, not only in which our country has ever been engaged but the most stupendous one in history. Lessons derived from our experience therein should therefore be the best guide for our future organization and policy, but in considering these lessons it seems that sight should not be lost of two important factors: first that our next war may be fought under entirely different conditions and second that our participation in this war was too short as compared with that of the other nations engaged to justify us in accepting without very thorough examination the conclusions apparently to be drawn from our experience. While the 1st Corps was organized to take effect January 20, 1918, the 1st Army was not organized until August 10th so that there were only four months before the armistice in which the army corps functioned during active operations in their normal relation to divisions and armies.

I do not recall having seen any statement of the reasons for reintroducing the corps organization into our system—possibly it was to harmonize our organizations with that of the French. The corps had been definitely and appar-

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ently advisedly abandoned in our regulations which prescribed the organization of divisions into "field armies' and the latter into "armies." This may be considered as practically the same as the "corps" and "army" as organ ized in the A. E. F., except that a field army or army involves the idea of a more complete and complex organization than that of a corps. The corps is primarily an organization for training and fighting a number of divisions and is only incidentally concerned with supply and administrative details. The original plans apparently contemplated the definite assignment of six divisions permanently to a corps—four combat, one replacement and school, and one base and training (G. O. 9 Jan. 15, 1918, G. H. Q.—A. E. F., and corps tables of organization) but in practice, divisions were changed from corps to corps so frequently that the smaller organizations of a division often did not know to what corps they belonged. In combat therefore practically the sole purpose of the corps organization was tactical; to fight most effectively the divisions temporarily assigned it. Nevertheless, the corps staffs were elaborately organized, heavily officered units. One corps at one time had as many as 140 officers at headquarters and even as late as April 30, 1919, when it was about to be broken up, the 9th corps had some 60 officers on duty in the staff These officers were largely from the line and competent troop commanders, many of them regular officers whose services with troops were certainly greatly to be desired in view of the serious shortage of trained troop leaders. It seems that serious consideration might be given to the possibility of omitting the corps organization and reducing somewhat the size of the field army. If this could be done it would considerably reduce the number of officers required for over-head.

If the corps is to remain as a part of our system the question of the assignment to it of engineer troops should be more definitely determined. In my opinion, the corps engineer regiment should be a pioneer regiment similar in all respects to the divisional regiment except as regards the train. The latter should be more complete especially as to the bridging equipment. Its transportation could probably all be motorized and should include tractors and dump wagons or dump trucks for road work, and a portable pile driver and light derrick for heavy bridge work. If streams of such size as to require ponton bridges are likely to be encountered one or more divisions of bridge equipage should be assigned it. An ample amount of the canvas type, portable foot bridge should form a part of its permanent equipment. Colonel Jones is right in his statement that this regiment should have its own colonel. The corps engineer in active operation will have his hands too full of other work to exercise actual command of the regiment. It is also of course essential, as he points out, that the office of the corps engineer should be promptly organized with its full complement of authorized commissioned personnel and such enlisted personnel as is likely to be needed, but I cannot agree with his assertion that it will probably be necessary to wait the actual entrance into hostilities to secure the corps engineer regiment. That should be promptly and permanently assigned and join the corps, or the corps engineer will be likely to find it missing when combat begins. In training areas it will probably need some training itself, and in any event either there or under other stabilized conditions there will be no difficulty in finding useful employment for it. If necessary it can do work for the army or services of supply but should never be withdrawn from the active control of the corps engineer.

If the pioneer infantry regiments are to be retained, one of them should also be permanently assigned to the corps: otherwise, and probably preferably, one or two labor battalions. Additional engineer organizations may be assigned from the army temporarily, as may be required.

The duties and relations of army, corps and divisional engineer officers and troops were prescribed in G. O. 98, G. H. Q. A. E. F. June 18, 1918, and in G. H. Q. pamphlet approved by the Commander in Chief, August 30, 1918, and republished in Engineer Field Notes No. 44. The most important of the engineer functions is unquestionably that of providing the means of communication sufficient to secure the passage and supply of all troops and material. This of course includes roads and bridges, railways and light railways. All kinds of engineer troops, divisional, corps, army and S. O. S. will be engaged on this work and it is not always nor even generally practicable to make definite division of areas within which each will work. They will necessarily overlap. The corps troops may have to assist the division engineers on road and bridge work in the division areas, and the army road troops will almost always be working in corps areas. The army railway and light railway troops will work as far forward as possible, the former almost to the front lines. I do not believe it to be practicable to hold the corps engineer responsible for all work on his corps area nor to give him troops and equipment sufficient to accomplish this work. It is of too great variety and requires too many kinds of engineer troops to make it feasible to allot to each corps troops of all classes needed. The number of different kinds of engineer regiments or organizations should be reduced to the lowest possible limits:—for example, water supply, electrical and mechanical and shop and supply regiments should be combined into one class, and possibly other reductions can be profitably made—but even so these special troops should belong to the army rather than to the corps. It may be necessary occasionally to temporarily assign portions of them to the corps. But in general they can be better supplied and cared for and more constantly usefully employed by leaving them under the army engineer, and in the 2nd Army satisfactory results were obtained by instructions to them from him to do such work as was requested by the corps engineer so far as this did not conflict with his general orders.

Colonel Jones' discussion of the relations of the engineer to the general staff section of the corps staff will be of particular interest to officers of our corps who served as division or corps engineers. He seems, however, to have rather dodged the issue as to whether G-1 had been given proper authority by orders and regulations to assume command of the technical auxiliary service and to issue orders in the name of the commanding general. The average G-1 certainly considered that he had such authority and I think an analysis of G. O. 31, G. H. Q. A. E. F., Feb. 15, 1918, will show that this was correct. Hardly any one can now be found who will question the necessity of a general staff, nor will any troop commander or technical staff officer object to receiving orders from the chief of staff in the name of the commanding general. The delegation of such power to the assistants to the chief of staff, however, and its exercise by them, undoubtedly caused occasional irritation both to line commanders and to the technical staff. In the case of the latter the matter was further aggravated by a tendency on the part of G-1 to do more than "co-ordinate" the work of the different technical services. The verb "co-ordinate" is defined in the dictionary as "to regulate and combine so as to produce harmonious action: to harmonize." This would seem to be the proper function of the general staff as regards the technical services and if its activities were limited thereto, even if exercised by G-1, there could be little ground for complaint.

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Col. George B. Pillsbury

Engineers; formerly Corps Engineer, 2d Corps A. E. F.

I am in complete accordance with views expressed by Colonel Jones in his article, and desire merely to correct a misunderstanding, for which I fear that I may be myself responsible, concerning the functions and duties of the corps engineer of our corps which served in the British 4th Army.

The British organization, as I understand it, made no provision for corps engineer troops. As a result of their war experience, however, they arrived at an organization that I believe we were rapidly approaching in the American Army, under which the army engineer troops were assigned to duty under the corps.

Each corps had a definite sector, and within this sector the corps engineer was responsible for:

(*a*) All roads in advance of a line known as the D. G. T. line. An organization analogous to our Advance Section of the Services of Supply took over the roads behind this line. The line is so drawn that the emergency work, required for the immediate prosecution of military operations, falls to the corps engineer; the systematic repair of the roads behind the area of congested traffic to roads.

(*b*) Bridges in the corps area, including those in rear of the D. G. T. line. I presume that the reason for this lies in the desirability that the control of all available bridge material be exercised by those responsible for front line operations.

(*c*) Water supply in the corps area.

(*d*) Engineer supplies for the corps.

All work on light and standard gauge railroads was wholly outside of the province of the corps engineers. Army railroad troops would accordingly be working alongside troops under the corps engineers; and, when necessity therefor arose, troops would be diverted from the corps to report to the army railroad engineer.

The chief engineer of the field army did not have control of the roads in rear of the D. G. T. line, nor of light or standard gauge railroad construction, these being under the quartermaster branch. Outside of maintaining water supply points, bridges, training grounds, etc., in the army area, which lay behind the corps area, he controlled the supply of material and troops to the corps engineers, kept them supplied with engineer information concerning the territory over which the advance would take place, and maintained a general supervision over their work.

This was the system in the British 4th Army. In some other British field armies the troops directly under the army engineer took over water supply and bridging work well up into the corps areas. Such practice, from my limited observation, did not lead to the efficient execution of the duties observable in the 4th Army.

It will be seen, therefore, that the British practice, as concerns the functions of the corps engineer, was not substantially different from the American practice as described in this article. The difference lay in the fact that in the British service, the duties and sphere of action were very definitely defined, and a well ordered procedure established for the execution of these duties. Thus, on taking over the sector, the new corps engineer was furnished with a complete "turn-over report," giving the precise status of the work in hand; the corps engineer troops were transferred with the corps area, and continued their operations, which, however, were thereafter conducted in immediate and complete accord with the plans of the corps commander, being directed by a member of his staff, the corps engineer.

I believe that the American practice of placing the construction of light and standard gauge railroads under the engineers, instead of under the supply branch of the staff, is the preferable one, as it permits of a better utilization of all construction agencies.

As for extending the scope of activity of the corps engineer to include light and standard railroad construction, it is of course evident that these lines must follow a comprehensive plan for the supply of the army as a whole, or even for the army group as a whole. Responsible control by the corps is therefore impossible. On the other hand, there should be close co-operation between the rail construction forces and the corps engineer forces in such matters as water supply, unloading points, labor, etc. If the corps engineer was notified of all rail construction operations in his territory, and if the officer in charge of such construction was instructed to confer with him, this co-operation should be assured.

Another point may be emphasized. The corps engineer executes his work by means of organized troops. Efficiency and good organization require that the commanders of these units be in responsible subordinate charge of the work which these units are performing. The corps engineer's road officer should be the senior officer on duty with the troops on road work; his water supply officer the commander of the troops who are engaged on water supply work, etc. The corps engineer's office staff, as such, should be limited to an executive officer, a supply, and a junior officer who is charged with looking out for the facilities necessary and desirable at corps headquarters.

Inefficiency will inevitably result if a junior officer on the corps engineer's staff has charge of work which is being executed by troops whose commander is a senior officer. If the commander of the troops is not qualified to execute the work, he should be replaced.

Col. J. R. Slattery

Engineers; formerly Corps Engineer, 7th Corps A. E. F.

Colonel Jones outlines clearly the relation that exists between the corps and division engineers. At times considerable difficulty in securing the best engineering results are likely to arise from this relation. The writer found the division engineers of his corps at all times eager to co-operate with him in making the engineer plan for the corps just as complete and well co-ordinated as if it were laid down in detail by the corps commander himself, and there were no division commanders to be considered. This would probably be the usual case.

As an example of the difficulties that may arise, the following experience may be of interest. In one of the divisions the division engineer did not have the entire confidence of the chief of staff of the division. This chief of staff forbade his division engineer to give any orders to the German road-masters in regard to road work under way, insisting that all such orders be given by the officer in charge of civil affairs. There resulted a situation which seriously interfered with the progress of the road work and greatly annoyed the German road officials through whom the work was being carried out. The corps engineer immediately took the matter up with the chief of staff of that division, pointing out the methods in use in the corps and other divisions, but was unable to persuade this chief of staff to change his decision and was compelled to bring the matter to the attention of the chief of staff of the corps.

Continued on Page 145

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Multiple Production of Relief Maps

By

Louis M. Manheimer
Captain, Engineers
and

Frank T. Fuller
Lieutenant, Engineers

At the very beginning of the World War it was recognized that with an army composed so largely of officers drawn from civil life, it would be of great importance to have maps which would enable officers with little or no training in map reading to visualize the terrain. It is well known that this faculty is a rare one, and that map reading is, by many, mastered only after years of training.

The following is quoted from a service manual:

So important is the influence of the *lay of the land* upon *military operations* that every officer must thoroughly acquaint himself at the earliest practical moment with the topography of the area within which his responsibilities lie.

A mere knowledge of the main roads, of the direction and distances to nearby towns is by no means sufficient. He must know where the plains are, where the hills rise, how the streams run. *He must have a mental picture, a birls-eye view,* impressed on his brain, of the main *physical and military features of his territory.*

It was to meet this need and supply a miniature of the battlefield, true to scale, in such form as to be available for the use of officers down to the company commander, that the experiments in relief mapping were undertaken.

In addition to this use it is common knowledge that relief maps played an important rôle in the World War as media through which were obtained technical data in connection with visibility, fields of fire, defilade, masks, location of gun emplacements, and the like.

A study was made and experiments undertaken in an attempt to devise a method whereby a large number of durable and portable reproductions in relief of each map could be made in a short period of time and at reasonable cost. At the time this was begun there was no known method for making such maps except in single copies by painting, drawing or pasting the details upon a cast of plaster of Paris or some such material. Although maps of that kind are cumbersome, fragile, and often inaccurate, they have a great advantage over flat maps for certain purposes.

The work of the Corps of Engineers upon this problem can hardly be said to have passed out of the experimental stage, but as a result of extended study a process has been evolved whereby are made relief maps, formed solely of paper, which are true representations of the terrain and which can be produced in quantity by such talent as may usually be found in an engineer organization, at reasonable expenditure of time and money.

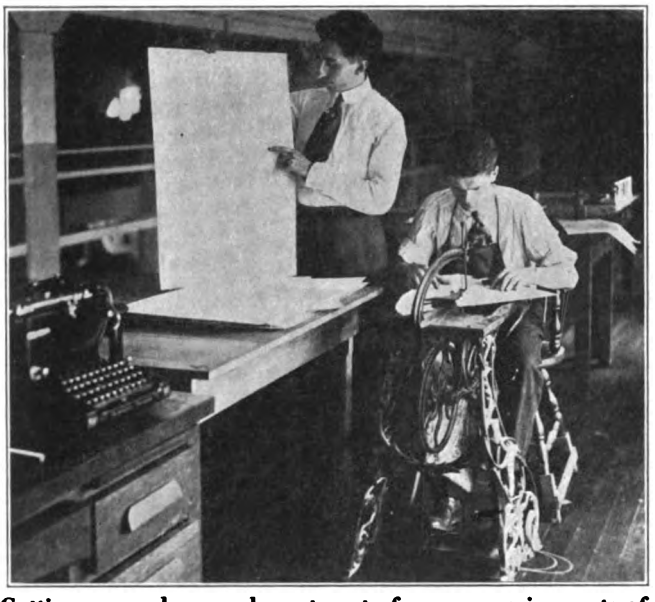
Briefly, this is accomplished by forming up a model of wax and cardboard from which a metal die and counter-die (male and female) are cast. Paper which has been softened is then embossed between the two dies under pressure and at a temperature of approximately 200° F. Upon this blank paper relief map the topographic and military features are projected photographically or drawn by pantograph. This original relief map is then softened and flattened out again, and a flat distorted map thus obtained which is reproduced in quantity in the proper colors, by lithography or other methods. The printed maps are then formed up between the same dies, at the same register as the original map, making accurate reproductions of the terrain in relief.

The above brief description outlines the general principles upon which the process is based, but the actual construction of the maps is quite complex and has required a great deal of study to perfect. The process is more completely described as follows:

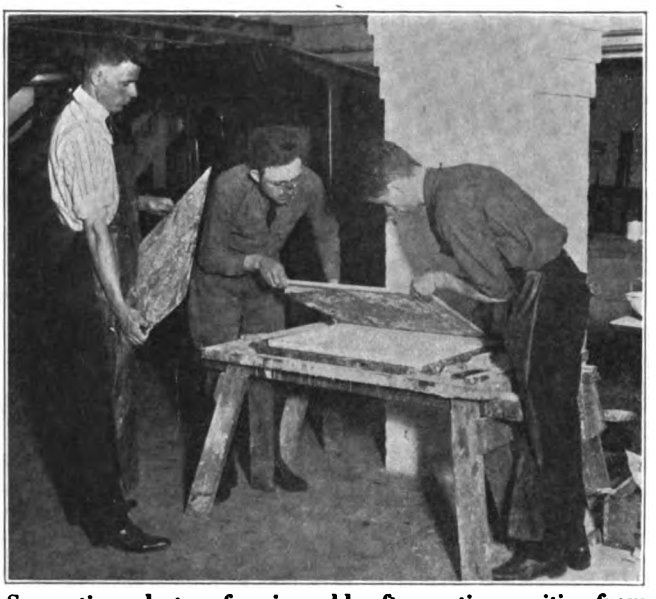
(*a*) A cardboard wax model is formed from the ordinary topographic contoured map. The model is made by lithographing, and printing, or drawing the contours of the map which is to be copied in relief, upon cardboard whose thickness represents a contour interval at the determined vertical scale, which is, of course, exaggerated relative to the horizontal. From the original map each contour is cut out with a scroll or jig saw.

Starting with a sheet of cardboard the size of the printed map, the irregular curve representing the lowest contour is sawed out and pasted into the position indicated upon the base map. Then the contour above the lowest

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Cutting maps along each contour to form successive parts of original model



Separating plaster-of-paris molds after casting positive from negative

is pasted upon the first, its position being easily seen as it is printed or drawn upon the map from which the lower contour was taken. In this manner each layer is built up on the one below until the highest full contour elevation has been reached.

We now have a solid mass of cardboard of the correct height for the relief map and true to scale. The contour intervals are like a flight of steps, the top edges of which are in theoretically correct position vertically and horizontally. It remains to slope off the portion of the map between the tops of these contours so as to create the natural ground forms in place of the steps. To do this,



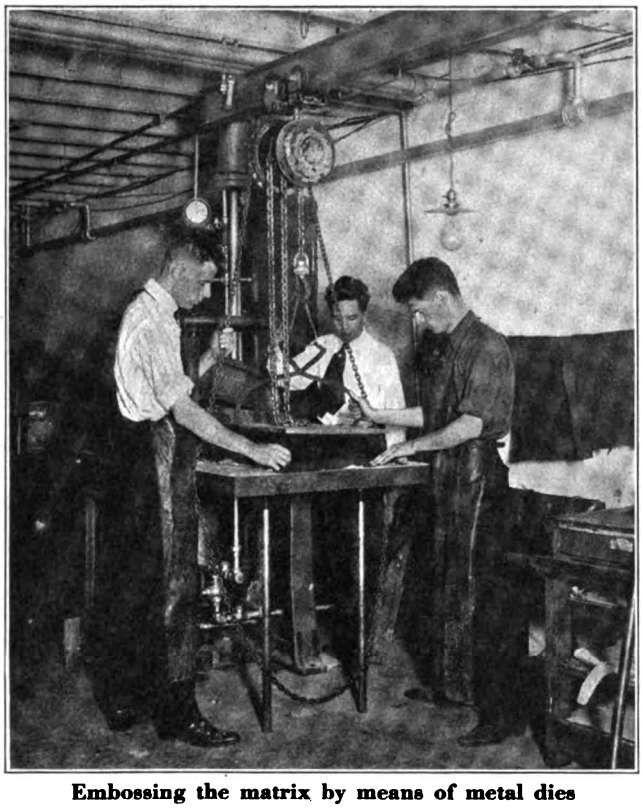
Finishing model by scraping away surplus wax

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wax is mixed with balsam of fir or Canada balsam, which is heated slightly until it is a creamy liquid. It is painted on to the paper model with a brush to such thickness as to fill in all the steps and to round off the tops of the hills and ridges above the upper layer of cardboard. The wax is allowed to cool and harden. The surplus is then cut away with dull tools. The result is a wax and paper model which is a reproduction of the ground as shown by the flat contour map, with an exaggerated vertical scale.

(*b*) From the original model thus produced a mold of plaster of Paris is cast by pouring a wet mixture on to the wax relief model, from which a counter-mold is in turn cast in like manner.

(*c*) When each plaster mold becomes dry it is placed in a metal molding or casting box which has previously been heated. Molten linotype metal, at a temperature of approximately 800° F. is now poured into the mold against the plaster model and a metal die and counter-die are thus cast.



Embossing the matrix by means of metal dies

(*d*) The next step is to form up the paper matrix. To do this several sheets of paper are first pasted together with a cold mixed dextrine paste and these, while still wet with the paste, are placed on the concave die. Two woolen blankets are laid over the matrix to absorb the moisture and then the convex die is inserted. This combination is formed on the apron of an ordinary stereotyper's matrix press and when complete is slid into the press which previously has been heated. The hand screw of the matrix press is now promptly turned down upon the dies, bringing them firmly together. The matrix is left in the press about 6 minutes, during which time it becomes baked into a hard substance

(*e*) The surface of the paper is next sized and an emulsion, which is a very rapid bromide-silver solution, is sprayed upon the surface in an even layer by means of an air brush or atomizer.

(*f*) The original flat map is photographed in a copying camera in the usual manner. The negative thus obtained is placed in a projecting machine or enlarging camera and the sensitized matrix is hung on the easel. The negative and matrix are adjusted by turning appropriate screws until exact register and focus are obtained. The light is projected through a piece of orange celluloid which protects the sensitized matrix from exposure until the adjustments are made.

(*g*) This master map thus made by projection, is next placed in a bath of water and softened. When quite soft it is flattened out upon a piece of stiff cardboard, placed in a cold press and allowed to dry under pressure. In flattening the map, care is taken to avoid wrinkles.

The embossing of the map is accomplished by two separate processes in treating the paper. First is the permanent stretch in which the fibers are actually separated one from another; and the other is the temporary deformation in which the paper moves or slides into appropriate position. This is best understood by thinking of a high, rounded, lone hill; to accomplish a conformation to this the fibers shift along one another and the paper becomes thinner. Whereas in accommodating the paper to a high embankment such as would occur along the right-of-way of a railroad tangent, there is a slipping of the paper into the ravine which does not cause any deformation of the paper. So that when the matrix is flattened out the paper is larger than the model, the amount of the sliding of the paper, and is puffed up with the permanent stretch. In order to flatten out the permanent stretch, a paper is used which is composed of especially long fibers and which can be softened almost to the consistency of pulp. The fibers are virtually shifted back into their original position and with them the lines on the map.

(*h*) When the flattened map has become dry, separate tracings of each color are made. These tracings collectively show the entire map. The tracings are then printed directly to metal by a well known lithographic process and maps in the desired colors are run off on the press upon the same quality of paper employed in making the paper matrix (*d*). We now have, it will be seen, a number of distorted flat maps in color

(*i*) The next step is the embossing of the flat, distorted maps. On the four corners of the concave metal die are four dowels or tits which fit into corresponding holes in the convex die. On the corners of the printed maps are corresponding holes which are fitted over the dowels on the die to insure proper register between the ground forms of the die and the corresponding contours representing these forms on the map.

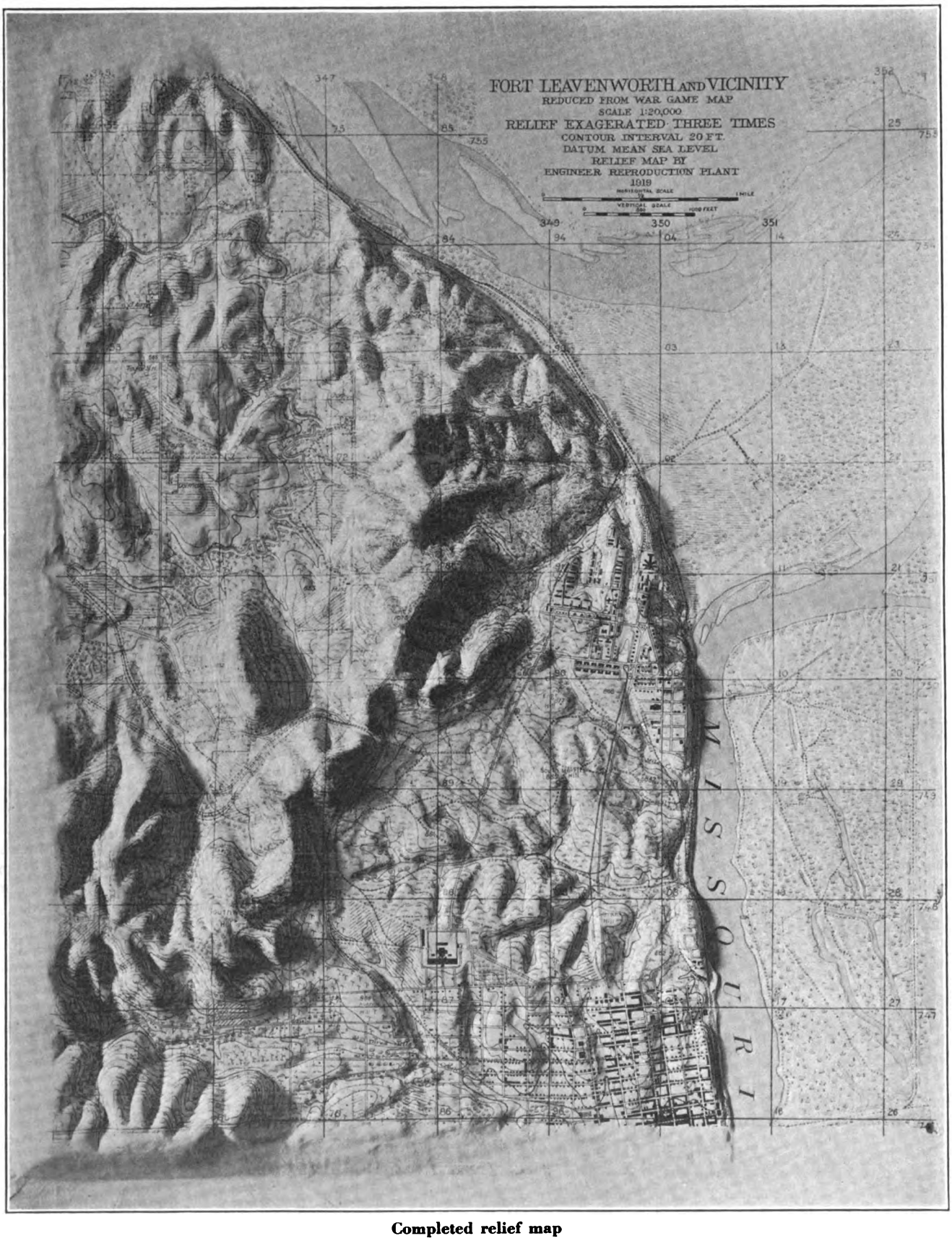
The register may not be perfectly correct at the first trial, that is to say, the contours may not fall in the proper position with reference to the hill and valley forms they represent. The amount and direction of the parallax is determined by inspection and corrected by shifting the register points on the printed map.

The secret of success in this embossing process is in exactly duplicating with the printed maps all that was done with the original blank matrix.

(*j*) The finished matrices are mounted upon beaverboard, but no washing takes place and as no chemical or water reaches the map it is not necessary to apply the paraffin to the edge or to paint with varnish. However, it is deemed expedient to varnish the maps, the better to preserve them.

Maps made by this process have been compared with the relief maps of the western battle front in France, made by the French and by the British, and it is at

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Completed relief map

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least conservative to say that our work compares very favorably with theirs, besides having the additional advantage of being lighter in weight and far less fragile and therefore more portable and convenient to use. As far as known a paper relief map, which is a true representation of the terrain and which can be reproduced in quantity, has never before been made. The French and British maps are made by pasting upon a relief foundation flat maps which are printed upon thin India paper. These are not true maps in relief, and are patched and touched up with pen and brush to correct evident inaccuracies.

If the relief map produced by this process be lighted by parallel rays from one side or one corner, so as to produce the shadows of the hill forms, and then photographed, a flat print conveying a very good indication of the ground forms is produced. The appearance of such a map is indicated in the accompanying plate. While inferior to the actual relief map it conveys a far better idea of the topography than an unshaded, flat contour map. Experiments looking to the production of such a map *in color* are now in process. One method under experiment is to print the shadows as photographed from the blank relief map in sepia upon a regular contoured map. If a map of this character can be successfully produced in color it will be most useful, possessing all the advantages of the ordinary flat map as to speed and economy in production, portability, and general utility, while possessing to a considerable degree the advantage of the relief map in visualizing ground forms.

An estimate of cost and time required for reproduction of relief maps by this process, based upon the Camp Humphreys map (size 15 by 18 inches, on a scale of 1:4224), indicates that maps can be made in four colors and in quantities greater than 200, for approximately $1.30 each, the cost greatly decreasing with larger production, as the making of the original models, dies, and lithographic plates, which is a considerable item of the total cost, is the same whether one map or several thousand be produced. The cost and time required for production vary greatly with the nature of the topography, and the estimate given above cannot be regarded as applicable to all cases. It is certain that by a subdivision of the work among a large number of men the time required could be greatly reduced, so that in an emergency maps could be issued in 48 hours. Ordinarily it requires about ten days for the first 100 copies and 100 copies per day can be produced by a single unit thereafter.

It has been recommended that maps be prepared by this process of the training areas and important land defense areas, and that this work be carried on in such manner that engineer troops will be trained to take charge of relief map-making.

This process was conceived and developed for the Corps of Engineers at Washington Barracks, D. C., under direction of the Board on Engineer Equipment of Troops, by Louis B. Manheimer, then Captain of Engineers. The work is at present being carried on as one of the activities of the Engineer Reproduction Plant, under the direction of Major H. R. Richards, Officer in Charge, Engineer Reproduction Plant. The plant is at present engaged in producing relief maps of Fort Leavenworth, Fort Sill, Camp Humphreys, and the island of Oahu, H. I.

Board on Surveys and Maps

The President, on December 30, 1919, issued the following:

In order to co-ordinate the activities of the various map-making agencies of the Executive Departments of the Government, to standardize results, and to avoid unnecessary duplication of work, I hereby constitute a Board of Surveys and Maps, to be composed of one representative of each of the following organizations:

1. Corps of Engineers, U. S. Army.
2. U. S. Coast and Geodetic Survey.
3. U. S. Geological Survey.
4. U. S. General Land Office.
5. Topography Branch, Post Office Department.
6. Bureau of Soils, Department of Agriculture.
7. U. S. Reclamation Service.
8. Bureau of Public Roads.
9. Bureau of Indian Affairs.
10. Mississippi River Commission.
11. U. S. Lake Survey.
12. International (Canadian) Boundary Commission.
13. Forest Service.
14. U. S. Hydrographic Office.

The individual members of this Board shall be appointed by the chiefs of the various organizations named and shall serve without additional compensation.

The Board is directed to make recommendations to the several Departments or to the President for the purpose of co-ordinating all map-making and surveying activities of the Government and to settle all questions at issue between Executive Departments relating to surveys and maps in so far as their decisions do not conflict with existing laws.

This Board shall perfect a permanent organization and shall hold meetings at stated intervals, to which representatives of the map-using public shall be invited for the purpose of conference and advice.

This Board shall establish a central information office in the U. S. Geological Survey for the purpose of collecting, classifying and furnishing to the public information concerning all map and survey data available in the several Government Departments and from other sources.

All Government Departments will make full use of the above Board as an advisory body and will furnish all available information and data called for by the board.

So much of the Executive Order of August 10, 1906, as grants additional advisory powers to the United States Geographic Board is hereby rescinded and these additional powers are transferred to the Board of Surveys and Maps."

The Board has been organized and is now ready to function. O. C. Merrill, Chief Engineer of the Forest Service, was elected chairman of the Board. A committee is now engaged in drawing up a set of by-laws and rules of procedure.

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Military Committee of Engineering Council Announces Military Policy and Indorses Universal Training

NOTE: In Dec., 1919, Engineering Council created a Military Affairs Committee to consider the relation of engineers to the future military establishment and activities of the United States. The membership comprises civilians as well as ex-officers of many of the services of the Army and Navy, men of all the important branches of the profession of engineering. Under date of Feb. 26 this committee submitted the following communication to Engineering Council:

1. We believe it of vital national importance that sound military legislation should be enacted during the present session of Congress.

2. Effective provision for national defense with an adequate organized trained Army and Navy, sufficient to discharge our national and international obligations, is essential to security and stability, which must be present if our country is to go forward in constructive activity and achieve its possibilities as a nation.

3. The training of the entire youth of the nation and the establishment of organized reserves are indispensable provisions for national defense. With an adequate organized citizen force, so that a minimum of professional soldiers is required, that maximum protection is afforded with a minimum of expense.

4. The careful selection and training of personnel and their assignment, when reservists, to organized reserved units are vitally important to the efficiency of the technical services of the Army and Navy, and therefore essential to the proper preparedness of the individuals of the engineering and allied professions and trades for the discharge of their constitutional obligations in national military service.

5. The full utilization of specially and technically qualified men and specialized industries has proved impossible where an organization was built up only after war had become imminent or had been declared.

6. The status of the membership of the National Engineering Societies with respect to all military matters, on which to base their plans for individual and collective preparedness, must remain indefinite until a military policy and principles of a military organization shall have been determined.

7. We believe national security and stability can be assured only by application of the foregoing principles, in particular the principal of universal military training and the creation of organized reserves, above all in the technical branches.

We therefore recommend to Engineering Council that the President and Vice-President of the United States, the Secretary of War, the Secretary of the Navy, the Speaker of the House and the Chairman and Members of the Military and Naval Committees of the Senate and the House be urged to incorporate the foregoing principles into any bills passed by either body for army or navy organization, and particularly the principle of universl training.

We also recommend that each member of the Founder Societies (American societies of Civil, Mining, Metallurgical, Mechanical and Electrical engineers) be urged to study carefully the foregoing principles of military policy, and in case, in the light of such study, he endorses said principles to give his active support through letters to his Senators and Congressmen, or otherwise, to their incorporation in pending legislation.

MILITARY AFFAIRS COMMITTEE

Col. Wm. Barclay Parsons, *Chairman,*
Mr. Paul G. Brown, *Vice-Chairman,*
Lt. Col. George D. Snyder, *Secretary,*

Col. Roger D. Black,	Mr. George Gibbs,
Mr. Harold W. Buck,	Maj. Fred J. Miller,
Col. Lincoln Bush,	Mr. Spencer Miller,
Col. John J. Carty,	Col. F. A. Snyder,
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Col. B. W. Dunn,	Col. G. R. Solomon,
Maj. Arthur S. Dwight,	Col. W. A. Starrett,
Capt. Alfred B. Fry,	Mr. Leonard Waldo.

The Field Lithograph Equipment

In the very excellent and comprehensible article in "The Military Engineer," Jan.-Feb., 1920, entitled "Engineer Duties in the Field in War," by Colonel Ralston, and in some of the discussions in connection with this paper, it appears that there is a concurrence on the elimination of the lithograph outfit from the equipment of divisional engineers.

In view of the array of opinions by those who were actually in command of engineer troops in the field, the writer hesitates to express ideas contrary to their conclusions. However, he did have the opportunity to study the needs of divisional engineers in the training camps, and was in command of an engineer regiment during its year of training in the United States.

As a result of his observation, it would seem to him inadvisable to take away from divisional engineers their power to furnish local maps for the training of troops, as under ordinary circumstances there will be no other even fairly well-equipped map reproduction service available, and the hectograph and the blue print or brown print processes are not satisfactory for turning out maps promptly and in sufficient number.

I feel that I can state positively that the work of the division with which I was on duty would have been materially interfered with if my regiment had not been equipped to turn out lithographed maps. We did suffer, as probably most regiments did, from the disadvantage of not having trained officers or enlisted personnel familiar with the lithographing process. It is rather an antiquated process, and therefore we were unable to obtain assistance from trained commercial lithographers in the nearby city. If a system of instruction had been instituted, under which men who understood the equipment could have spent a week with each of the regiments giving special instruction, much of the delay with which we had to contend would have been avoided, and we would have been able to supply maps to the division much earlier than we could under existing conditions. It was largely a case of experimentation, but after considerable time and after the modification of one or two of the elements of the equipment, mainly the zinc plates, we were able to turn out very creditable work.

It appears to the undersigned that the decision to eliminate this equipment from the divisional engineer regiment is based largely on the conditions that existed in France, where the forces were fairly well concentrated and where the central mapping plant or the movable mapping units could readily supply all outlying organizations. I feel that this would not be the case in the training camps and would probably not be the case in almost any extended operations with which we might be connected in our own country or in the defense of our borders. I would urge that the elimination of this equipment be made only after a thorough study, and after assurances can be given that local maps can be promptly turned out by some central agency.—F. C. BOGGS, Colonel, General Staff (Engrs.).

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Concrete Caissons for Breakwater Construction

Milwaukee, Wis., District

By

J. A. B. Tompkins

Principal Assistant Engineer

WHILE concrete caissons have been used for in foreign countries since 1905, so far as is breakwater and other harbor construction known the first to be used in the United States for such purposes were built in 1908. These caissons were built by the Government, not by contract, at a plant established for that purpose at Kewaunee, Wis., and were used in breakwater construction at Algoma and Manitowoc, Wis. They were 24 feet long, 15 feet wide, and 12 feet 4 inches high, with walls 12 inches thick, and were designed and constructed under the direction of Col. W. V. Judson, Corps of Engineers, U. S. A., in accordance with a patent obtained by him in 1901, and dedicated by him to the United States.

A very complete description of these caissons is given in a paper read by Colonel Judson before the Western Society of Engineers in May, 1909, published in Vol. XIV, No. 4, of the *Journal of the Society*. In this same paper appear many studies, including drawings, of other caissons than those employed at Algoma and Manitowoc, including caissons 54 inches long and rectangular in cross-section, subsequently employed on pile foundations in the South Pier at Milwaukee; and caissons, trapezoidal in cross-section, 40 feet long, 16 feet wide at the top and of various widths from 22 feet to 27 feet at the bottom, for use on rubble foundation in localities of different degrees of exposure. An historical summary of foreign and domestic development of concrete caissons, prepared by Mr. Harrison S. Taft, was published in Vol. VII, PROFESSIONAL MEMOIRS.

Caisson construction has now been carried on in the Milwaukee, Wis., district for twelve years, during which time 144 caissons, exclusive of 15 now under construction for Indiana Harbor, Ind., have been built. The general design, methods of construction, etc., have been greatly modified since building the first caissons in 1908. The design and construction are now fairly well standardized. This paper describes in detail the standard concrete caisson adopted in this district.

Design

Prior to 1916 all caissons were rectangular in cross-section, the width being generally about 3 feet more than the height. Since then a trapezoidal cross-section has been adopted, with uniform top width 10 feet for all heights, the side walls having a slope of 3 vertical to 1 horizontal; the bottom width is therefore two-thirds the height of caisson plus 10 feet. The standard caisson is 54 feet long with vertical interior cross walls, dividing it into four compartments.

This section is more economical, both in materials and cost of forms, than is a rectangular section having equal stability, the quantities of materials being approximately as 1 to 1.3. Caissons vary in height by 3 feet, so that by adding or removing 3-foot sections at the bottom of forms, various heights can be built from a single form. As the cost of forms is considerable, approximately $7,500 at the present time, the advantage of a form adjustable to various heights is very great, especially when, as frequently happens, two or three different heights of caisson are to be used on one job. This cannot be done with the rectangular section, the width of which changes with the height, if necessary stability is to be economically obtained. Four sizes of caissons have been designed, all of which, except the smallest, have been used in breakwater construction. The draft of caissons of the same size will vary slightly, owing to slight variations in thickness of walls and bottom. The sizes and approximate draft and freeboard when floating are as follows:

Height	Bottom width	Draft	Freeboard
21 ft. 3 in.	24 ft.	16 ft. 3 in.	5 ft. 0 in.
18 ft. 3 in.	22 ft.	14 ft. 1 in.	4 ft. 2 in.
15 ft. 3 in.	20 ft.	11 ft. 7 in.	3 ft. 8 in.
12 ft. 3 in.	18 ft.	9 ft. 2 in.	3 ft. 1 in.

The thickness of plank, 3 inches, is added to all heights.

While the resistance of caisson or crib to overturning can be computed, the forces which tend to overturn the structure are unknown as to magnitude, point of application, and direction. The necessary stability of a caisson is determined by comparison with cribs which have successfully withstood the severest storms for many years. Timber cribs, 24 feet wide, 100 feet long, filled with stone and resting on a rubble foundation, the top of which was about 20 feet below the water surface, and which formed part of

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the Milwaukee breakwater, were carried away. These cribs were replaced by others of the same length and height, but 30 feet wide, which have successfully withstood all storms for at least 25 years. Practically the same horizontally applied force per linear foot is required to overturn a concrete caisson of trapezoidal cross-section, having a bottom width of 24 feet, a top width of 10 feet, and a height of 21 feet 3 inches, as for a timber crib 30 feet wide, 20 feet 6 inches high, the caisson and crib in each case being provided with standard superstructure. Fig. 1 is cross-section of this caisson.

In computing reinforcement, walls are considered as restrained beams, taken in widths of about 2 feet vertically. The bending moment is computed from the formula $\frac{W1^2}{12}$, 1 being the distance between fillets. The generally accepted straight line formula for determining stresses in steel and concrete is used. As caissons are launched when the concrete is about ten days old, the ratio of moduli of elasticity of steel to concrete, is taken at 24, instead of the more usual ratios of 10 or 15. Walls are reinforced equally on both sides, the steel being generally placed 2 inches from the surface. While theoretically this is not an economical distribution of steel, it is found in practice to be more economical than to care for the negative bending moments, which develop at the ends of the walls and near the cross walls, by bending the bars, or using shorter bars; furthermore, as caissons are frequently filled with sand, there will be an outward pressure which, while materially less than hydrostatic pressure, must be cared for.

Steel reinforcing bars are standard deformed sections. For 10-day concrete, bonding stresses of 250 pounds per square inch are allowed, and for 30-day concrete, 375 pounds per square inch. On account of negative bending moment occurring near ends of the restrained beams, a minimum bonding length of 20 inches is taken. Diagonal tension stresses of 50 pounds per square inch for 10-day concrete, and 65 pounds for 30-day concrete, are allowed. High carbon steel, having a minimum elastic limit of 50,000 pounds is used, allowing 20,000 pounds per square inch on 10-day concrete for launching submergence, and 30,000 pounds per square inch on 30-day concrete for complete submergence while towing, increased bonding strength of the older concrete permitting the development of the greater steel stress. Steel is proportioned according to which of these considerations requires the greater reinforcement. To allow for "list," the submergence at launching is taken as 1 foot greater than the floating draft of the caisson.

The foregoing stresses are much higher than those commonly allowed. The steel, however, is not subjected to them after the caisson has been placed and filled, forming part of the completed breakwater. For this reason and as a failure before placing in breakwater would not cause loss of life or personal injury, a low factor of safety is considered permissible. Furthermore, no allowance is made in the computation of stresses for the vertical steel, which serves as a "warp," its size and spacing depending upon the strength needed to support the horizontal steel without appreciable buckling. It actually takes up some of the stress, and materially increases the general factor of safety. During the twelve years in which caisson construction has been carried on, there has been no failure on account of the high stresses allowed.

Construction Plant

Caissons are built by hired labor at the government plant located along the inner side of the breakwater in Milwaukee Bay. It consists of a wharf, launching ways, and necessary equipment of buildings, tools, and machinery. The plant is at a disadvantage in having no rail or highway connection and being accessible only by water. The floating plant used for transporting materials and supplies, mooring and towing caissons, etc., consists of one 36-foot gasoline launch, one 50-foot steam tug, and one 60-foot flat scow of about 100 tons carrying capacity.

The wharf is pile and timber construction, 90 feet wide by 328 feet long, having material sheds, stone and sand bins, and office building. The cement shed has a storage capacity of 1,200 barrels. Cement is usually delivered in the warehouse from lake vessel. A shed 30 feet by 60 feet is used for storage of reinforcing steel and miscellaneous tools and equipment. Stone and sand bins having a capacity of about 315 cubic yards of stone and 155 cubic yards of sand are located along the edge of the wharf where they are accessible to vessels. The bins are built up on posts and blocking so that stone and sand can be delivered to the mixer by gravity, avoiding the use of derrick and skips. A water tank, capacity about 900 gallons, serves the concrete mixer and other purposes. It is filled by a pump under the stone bins.

There are two sets of launching ways, each about 50 feet by 185 feet, built of timber piling and 4 runs stringers. The ways are on a slope of 1 vertical to 8 horizontal, and extend into the water to a depth of 20 feet over the outer ends of the stringers. The upper surfaces of the four stringers in a set of ways should be as nearly in the same plane as possible. The greater part of the ways is under water, and it is practically impossible so to cut the piles and frame the caps and stringers as to secure the necessary plane surface. It is found to be easier to place shims on the stringers, their thickness being determined from levels. By this means a surface can be secured which will be less than ½ inch out of plane. Without shims, variations of 6 inches occurred.

Caisson forms are of wood, lined with No. 24 sheet

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steel. The outside form is in eight pieces, two end pieces, and three pieces for each side. There are four cores to a form by which the cross walls and compartments are molded. Each core form is in six pieces, the trapezoidal ends being in two pieces separated by a removable wedge which permits the withdrawal of the form from the molded caisson. The form is held together longitudinally and transversely by steel rods

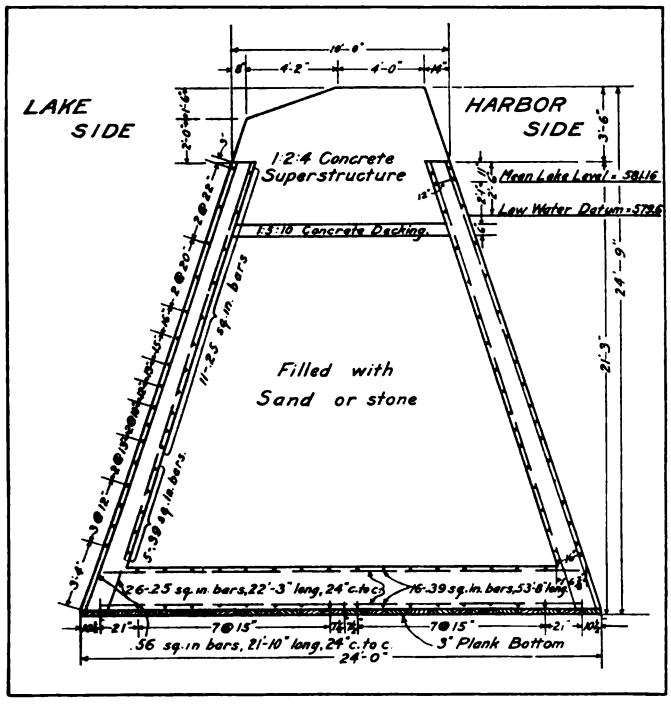


Fig. 1. Standard cross-section

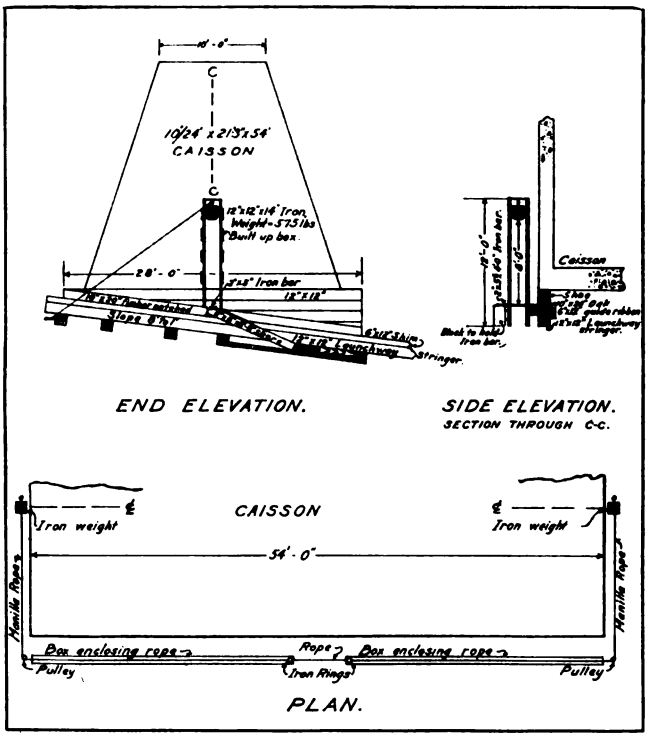


Fig. 2. Release for launching

and cables passing above and below the form and through heavy trussed timber "strong backs." No rods or bolts extend into or through the caisson walls.

Forms are handled, concrete delivered to same, and other heavy lifting work done by a locomotive crane of about 20 tons capacity on a standard-gauge track running longitudinally along the wharf. A concrete mixer, 1 cubic yard capacity, equipped with mechanical side loader, is mounted on a truck and moves on the same track as the crane. A turnout is provided at the outer end of the wharf, so that the relative positions of the crane and mixer can be reversed whenever necessary. Narrow-gauge industrial tracks extend in front of the stone bins and lead from the cement shed. Stone, sand and cement are delivered to the mixer by push cars on these tracks.

Plans are now in preparation for enlarging this plant. It is proposed to lengthen the wharf about 64 feet, to practically double the capacity of the stone bins, and to build an additional set of launching ways. With the enlarged plant, and two shifts working 16 hours per day, it is expected to double the present seasonal output of fifteen caissons.

Construction Methods

The foundation, upon which caissons are built, is at the upper end of the launching ways. It consists of 12 by 12 inch timbers, spaced about 4 feet center to center, and supported by blocking and 2 by 6 inch locomotive jacks. The blocking is placed under the longitudinal edges of the caisson to be molded, the remainder of the foundation being supported entirely by the jacks. Three-inch planks are then laid longitudinally with the caisson on the foundation timbers, thereby forming a level floor on which the caisson bottom is molded. The plank floor is covered with a cheap grade of tar paper so as to make it sufficiently water-tight while depositing the wet concrete thereon. Six-inch wire spikes are then driven at 2-foot intervals along each plank, projecting about 4 inches above the floor, by means of which the plank floor is anchored to the caisson bottom and remains a part of it. The plank floor attached to the caisson affords a means of releasing the completed caisson when launching.

The bottom reinforcing steel is then placed in position followed by the core forms. These latter are supported on 6 by 12 inch timber sills, which in turn rest on steel knees set on the plank flooring. These knees are imbedded in the concrete and remain a part of the caisson. Fig. 2 illustrates the placing of core forms, and shows the method by which the two parts of the trapezoidal end-piece are held together. Note the 6 by 12 inch sills and the steel knees supporting them.

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Reinforcing steel for the walls of the caisson is assembled in horizontal position on the wharf, and placed in the form in separate units by locomotive crane. A 6 by 6 inch timber provided with bolt grips and eye bolts for hoisting chains, is attached to the steel unit assembled on the wharf, and by means of which the unit is hoisted into place without distortion. Figure 5 shows the steel being assembled and woven into a reinforcing unit for the side wall of a caisson. On the extreme right of the picture, a portion of the stone and sand bins may be seen. The caisson in left foreground has been molded, and the core forms have been removed and placed for the next caisson. The outside form is still in place. Bars, whose deformation is such as will effectively prevent slipping of the wire ties, are especially desirable for the verticals. It is necessary for men to climb the steel units when securing the intersections at the end walls and cross walls; also, concrete falling on the horizontal bars, when dumped into the walls from the tops, will cause slip, unless the bars are firmly secured to the verticals. Spreaders, to hold the two steel webs at proper distance apart, are used in all walls. Figure 6 shows an assembled unit being placed by the locomotive crane. The blocking and 12 by 12 foundation timbers on which the caisson is built may be plainly seen.

When the reinforcing steel has been secured in position, the outside form is erected, after which the entire assembled form is locked by timber strongbacks and tie rods. In setting up or removing forms, each section is handled by the locomotive crane. In continuous operation, the form as removed from the finished caisson is transferred directly to the site of the next caisson to be built and erected. Strongbacks consist of 12-inch by 18-inch timbers, each timber trussed with two 1¼-inch steel rods. For caissons 21 feet 3 inches high, a 4-foot depth of truss is used. These strongbacks are placed in pairs along the two sides of the form, and are fastened together, top and bottom by 1½-inch steel rods, passing above and below the form. Five pairs of strong-backs are used along the sides of the form. The ends of the form are similarly held in position, except that an A-frame strong-back, instead of a single timber, is used. Figure 7 shows a form assembled and locked, ready for pouring concrete. Note the heavy locking of the form, which has been found by experience to be necessary, the wet concrete exerting a very great pressure against the sides and ends. Formerly 12 by 16 timbers, without trussing, were used, but it was found that deflections of as much as 1½ inches occurred when molding caissons of less height than those now built.

The proportions of the concrete are 1:2:4. The coarse aggregate is crushed limestone, ranging in size from ¾ inch to ¼ inch. Crusher screenings which will pass a ¼-inch screen are used as the fine aggregate, except for the upper 5 feet of the caisson, where well-graded sand is used. The use of crusher screenings is not advocated. They are only used on account of the cost and difficulty of getting sand placed in the gravity bins. Crusher screenings are delivered by the same vessel as the crushed stone. This vessel has an elevating device whereby the materials are discharged directly into the bins. The use of crusher screenings is now limited to that portion of the caisson which is at least 3 feet below the water surface when in place, and where there is no danger of the freezing of the water absorbed in the concrete, which is believed to be the chief cause of disintegration. Stone and sand are delivered by gravity from the bins into side dump cars, which in turn dump into the mechanical side charger of the mixer. Cement is dumped into the charger at the same time.

On account of the height and narrowness of the walls a very wet mixture is necessary in order that the concrete may flow around the steel and thoroughly imbed it, as it is impossible to tamp the concrete in the walls in the ordinary manner. The concrete is puddled from the top of the form with special steel spades. Puddling is done only between the two tiers of steel. On account of the slope of the side walls, it is impracticable (from above) to puddle the concrete thoroughly at the bottom of the walls and especially at the corners where they join the vertical end walls. Openings of 2 by 3 feet are left in the outside forms at each corner and at the middle of each compartment of the caisson, about 4 feet above the bottom. The lower part of the walls is puddled through these openings. After the concrete is brought up to the openings, they are closed with shutters. One of these openings with shutters in place can be seen in Fig. 7.

Concrete is mixed in a mechanical batch mixer, capacity one cubic yard. Each batch is given at least twelve turns after the last of the materials are discharged into the mixer. Concrete is delivered by the locomotive crane to the forms, a controllable bottom dump bucket being used. Concrete for the bottom and walls of a caisson is dumped from the top of the form. In dumping in the walls, special care is necessary to prevent concrete from "blowing out" under the sills. Anchor bolts (⅜ by 12 inch), to secure the decking used in towing, are set by template, about 3 feet center to center, in the top of the caisson walls. The tops of all outside walls are troweled off smooth, so as to provide a close joint between the concrete and the decking. After the form is removed, all outside faces are given a waterproofing coat of cement grout, consisting of 1 part cement and 2 parts sand, which is applied with a brush. No difficulty has been experienced in making caissons water-tight, and no precautions, other than those stated, are ordi-

Continued on page 169

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Army Construction and the Corps of Engineers

By

G. A. Youngberg and C. O. Sherrill

Colonels of Engineers

ONE of the most important matters in connection with Army reorganization, now under consideration by Congress, is the question of the responsibility for "army construction" in time of peace. As discussed in this article, this includes all construction of whatever nature required at army posts, camps, cantonments, depots, terminals, schools and hospitals, excepting only fortifications and auxiliary defensive works which, from the foundation of our government, have been the particular province of the Corps of Engineers.

Three proposals have been made for the execution of this army construction as follows:

1st. That it be done by the Quartermaster Corps;
2nd. That it be done by a new Construction Division to be added to the other branches of the peace-time organization of the army, and
3rd. That it be done by the Corps of Engineers.

The Army reorganization bill recently introduced into the Senate by Senator James W. Wadsworth, Jr., Chairman of the Committee on Military Affairs, provides for a new Construction Service, with one brigadier general as chief, 200 officers of all other grades and 6,000 enlisted men. The corresponding bill recently introduced into the House of Representatives by Mr. Julius Kahn, Chairman of the House Committee on Military Affairs, proposes to place this work in the Quartermaster Corps with a suitable provision for the necessary personnel.

The writers of this article are of the opinion that effective national defense, sound organization of the army, and economy in expenditures for military purposes, all combine in demanding that army construction work, in peace as in war, be placed in the charge of the Corps of Engineers.

General Principles Governing Organization of the Army

The United States maintained an army for but one purpose—"the security of the state" against assault by a foe from without or insurrection from within its borders. Military necessity demands that it shall be organized in such a manner as to efficiently fulfill that purpose and economic necessity demands that it shall be organized on the simplest and most inexpensive lines consistent therewith. The United States, though by far the richest nation in the world, can, nevertheless, ill afford to establish and maintain a defensive force consisting of many departments, duplicating duties, increasing costs through useless overhead expense and decreasing efficiency by division of responsibility. It cannot afford to maintain a Corps of Engineers which shall be useful only in time of war within the theatre of operations, and which shall lie idle at home in time of peace, and maintain at the same time another construction force, also composed of engineers, which shall be useful only within the boundaries of the United States and principally in time of peace.

In devising an organization for the army, we must keep in view the situation as it may exist at the front in time of war, and our military machine must be designed to meet that situation. Its peace organization must be such as to admit of ready expansion to a war footing. We must reduce to the lowest minimum the lack of coördination, the possibility of confusion, needless competition and wasteful work at cross purposes between departments, at the outbreak of hostilities. The machine must be such that it can speed up at the outbreak of war without useless friction, without breaking down and without having to be rebuilt in the face of an enemy. In drafting legislation for an army, it is necessary to keep before us at all times the reason for having an army and the conditions under which it must work. At the same time the army must be such as to render to the United States, even in time of peace, a maximum return on the investment.

These conditions, which conflict to a greater or less extent, can be compromised through the simplification of the army organization, by retaining a minimum number of staff bureaus or departments and by assigning to the army such duties in peace as it can fulfill in direct furtherance of its functions in war.

In the industrial world, the greatest economies are

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effected by utilizing both plant and personnel to their maximum capacity. We do not install factory equipment to run only on Mondays and Tuesdays and duplicate the mechanism for use on Thursdays and Fridays. In our largest ships, as well as in the smallest, the same engines do duty for 24 hours a day throughout the run. We do not engage labor to work on part time with full time pay and overhead costs. We do not elect legislators for service during regular sessions of Congress and other legislators for service during the special sessions of that body. What has been found good practice in civil life will be equally applicable to military procedure.

It is, furthermore, a fundamental principle of good organization that functions or activities of the same general nature should be segregated and administered under a single head. This applies to public and to private undertakings alike, and the army is no exception to the rule.

The Engineer in War

It is true now, as ever, that the foot soldier is the backbone of the army, but it is none the less true that auxiliary troops are necessary to develop his full fighting efficiency. Among these auxiliary troops are the engineers, and from the dawn of recorded history the engineer has played an important part in war. Modern warfare has multiplied his usefulness a hundred fold. There is not an activity at the front, on the lines of communication within the theatre of war, or within the base at home, in which the services of the engineer do not enter in some capacity.

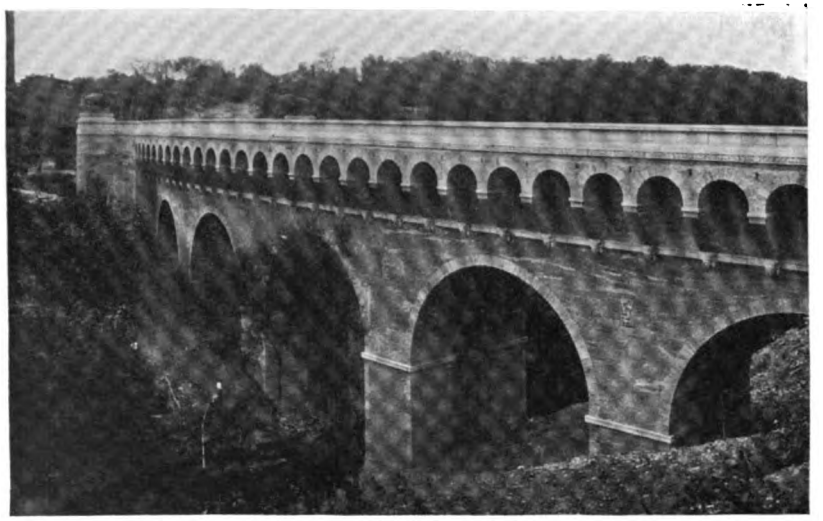
Engineers are as necessary to an army as artillery or medical corps personnel. The United States army has always had its Corps of Engineers and will continue to have such a body until the need for armies shall have passed.

A vast amount of construction is required at the front within the army areas, often under fire of the enemy. This can only be executed by militarized labor, that is, by soldiers subject to all the rules of military discipline who can be supplied and equipped in the same manner and by the same means as the combatant forces. In all the armies of the world, this work is done by the military engineers, and in our service it devolves upon the Corps of Engineers and its various troop units. In general, the structural materials and the troops required for construction work at the front are similar to those required farther back on the lines of communication, or within the area of the services of supply. Moreover, the military situation at the front often requires the immediate shipment of structural material and troops to supplement those on hand, in order to meet some sudden emergency imposed by the action of the enemy, or as required by our own plans of operation against him. Again, during inactive periods at the front, the engineer troops can be safely withdrawn and utilized to advantage in the construction of much needed facilities at the rear. These rapidly fluctuating conditions necessitate the utmost conservation of resources and a flexibility of organization which can be secured only by centralizing the control and responsibility under a single head, that is to say, by pooling the resources in labor and structural materials under a single director, the Chief Engineer of the forces in the field.

It is not possible to carry on any great amount of construction within the theatre of operations by civilian labor, either under contract or working by the day. Civilian administration with its great freedom of action, its powers to give or to withhold, does not harmonize with military operations. Military necessity knows no law other than that of military force and the will of the commander must be at all times supreme. While definite duties may be assigned to definite individuals, decentralization of authority and division of responsibility have no place in military procedure. The assignment of similar duties to separate services within the army necessarily involves such a division and introduces competition for material and for labor, entails a considerable duplication of overhead cost and what is more serious still, a loss of time. It necessitates coördination by the general staff or by the commander-in-chief and distracts them from more important duties. These evil effects can be avoided by segregating such activities under a single bureau, the head of which will then be able to dispose of the total construction resources to the best advantage of the service as a whole. It is the only possible solution of the problems presented by the great shortage of materials and labor and the ever increasing demands occasioned by the tremendous wastage which is the concomitant of modern war.

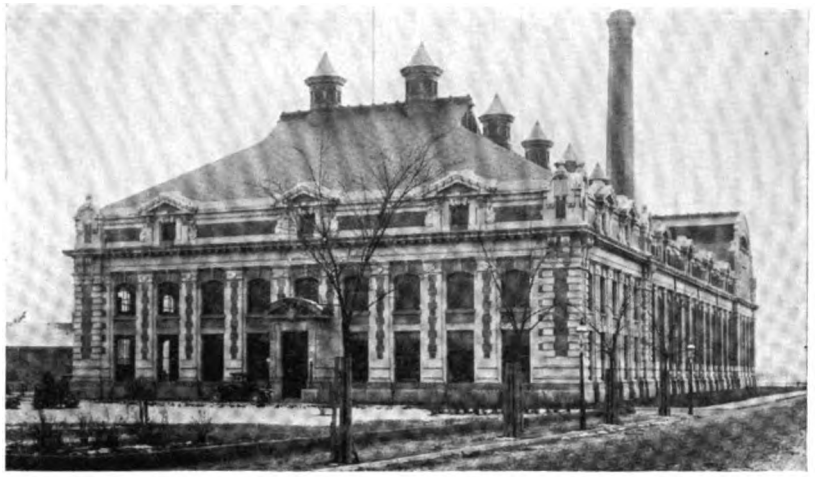
It was demonstrated in the early days of the American Expeditionary Forces that two or more construction forces cannot exist side by side. The aviation service attempted to construct its own aerodromes and shops, bringing to France for that purpose construction squadrons who were really engineers and builders drawn from civil life. The engineers of the A. E. F. were in the field at the same time constructing barracks, hospitals, warehouses and railroad yards. The ordnance department had made contracts with civilian firms in the United States for the construction of certain ordnance shops, and there were other contracts with civilian firms for the construction of certain port facilities. This situation led to serious competition for structural material, and involved a division of labor which was wasteful of money and even worse, of time. It led to many serious conflicts with the French and British, who were also in the field for labor and material. The experience of all armies was

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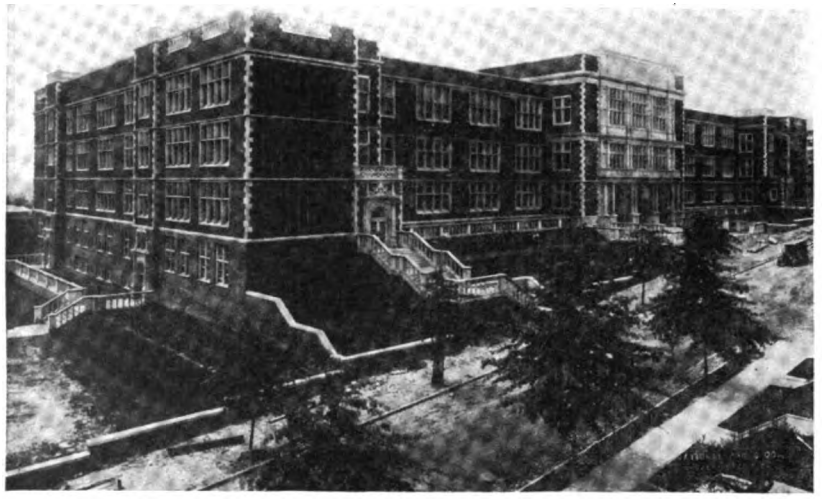
Bridge over Rock Creek, Washington, D. C.

The handsome public structures built under the supervision of the C. of E. have made our National Capital the world's most beautiful city



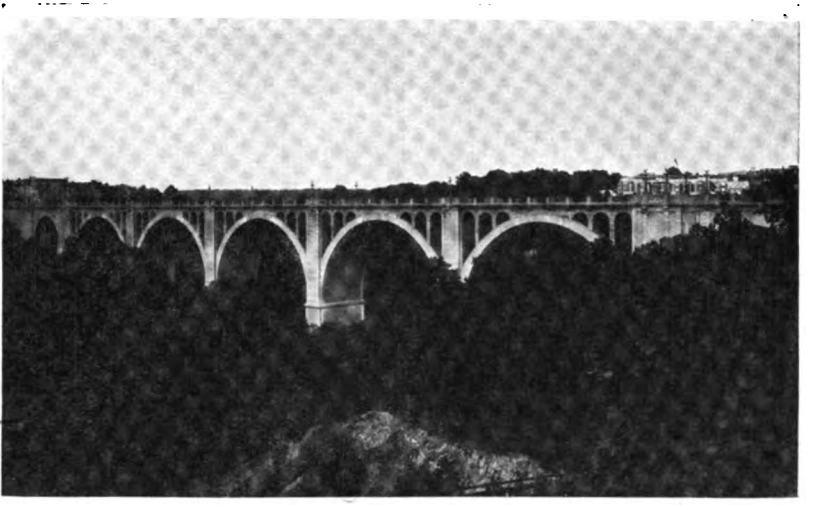
Pumping Station, District of Columbia

A rather ornamental structure designed to meet aesthetic as well as utilitarian demands



Central High School, Washington, D. C.

The Corps of Engineers constructs an infinite variety of buildings, from the most temporary to the most permanent



The famous Connecticut Avenue Bridge, Washington, D. C.

The Corps of Engineers builds every known type of bridge, to serve any purpose or demand

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that only one construction force was possible within their respective theatres of operations, and eventually, even before the consolidation of the tactical command, it became necessary for the allies to pool under a central supervisory control their common resources in labor, lumber and other supplies. The allies as a whole thus duplicated on a larger scale what each had found to be necessary in its own special sector.

The Military Engineer in Peace

The military engineer should be made an effective instrument for war but he should also be utilized to the limit of his useful capacity in time of peace. There is here no conflict of requirements. On the contrary such duty is, in fact, necessary to his efficiency in war. There is a strong family likeness in all engineering and there are very few engineering activities in war which are not analogous to the activities in peace. There is no reason why the military engineer, whose primary function is war, should not also be utilized on peace-time engineering work during the intervals between wars, and it is necessary to his efficiency for war that he be given this experience in peace.

National economy demands that our military engineers, maintained at government expense, shall be employed whenever available on public works which shall be to the benefit of the country. Construction of public works is applied engineering and requires a knowledge of strains and stresses, of the characteristics of material and its proper utilization, the employment of construction plant and equipment, the management of labor, and experience and judgment of a technical engineering and industrial nature directly in line with the whole training and life-time activities of the officers composing the Corps of Engineers.

From the foundation of our government this corps has been charged with the construction of fortification and auxiliary works at military posts, erection of public buildings, monuments and other memorials. Their ability is attested by such structures as the State, War and Navy Building, the Congressional Library, the Government Printing Office, the Army War College, the Municipal Building of the District of Columbia, the Million Dollar Bridge on Connecticut Avenue, the Washington Monument, the Lincoln Memorial and the Key Bridge, the two last named being still in course of construction. With the exception of two or three old buildings now standing at Washington Barracks the school buildings, barracks and officers' quarters at that post were built under the supervision of officers of the Corps of Engineers.



Washington Monument

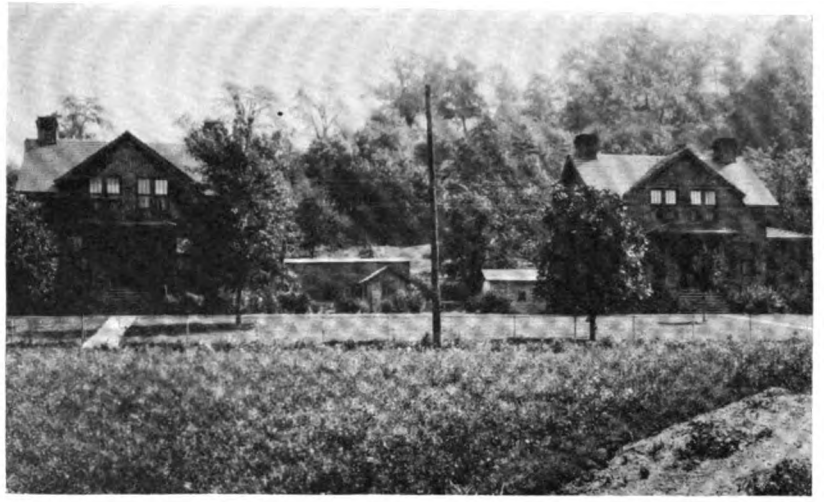
Built, illuminated, and photographed by the Engineers

In addition to the foregoing, the Corps of Engineers is charged by law with the improvement of rivers and harbors throughout the United States. This duty necessitates a knowledge of construction in the building of locks and dams, jetties, levees and other works for the improvement of navigable channels. For the furtherance of these improvements they are required to build storehouses, quarters for lock-keepers, and other structures necessary to the administration of our waterways. The work gives them experience in the principles of construction and trains them in the management of labor in a manner which contributes directly to their usefulness in war, while at the same time it keeps a certain number of them profitably employed on work which must be done.

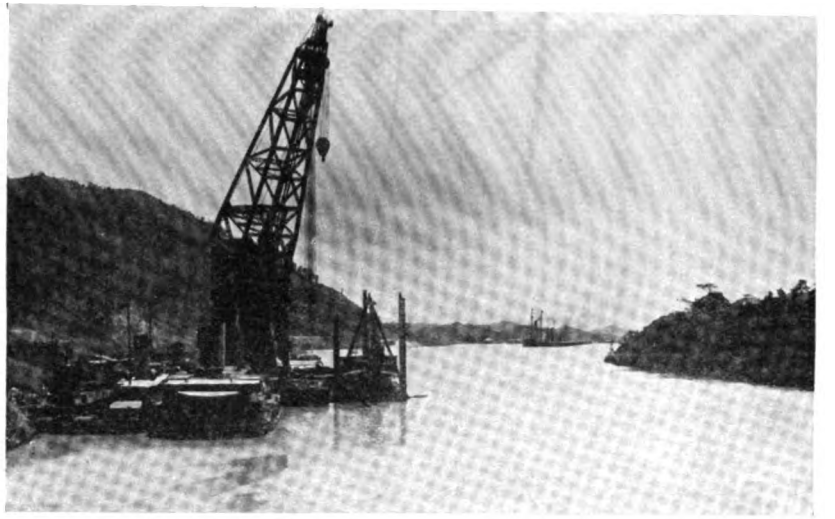
The Corps of Engineers has executed many of the greatest civil works in the world by contract or day-labor, including the following:

The levees, channels and outlets of the Mississippi River; canalization including all locks and dams in the Ohio River and all its tributaries; the great canal and locks at Sault Ste. Marie, through which passes the greatest commerce in the world (over 100,000,000 tons annually); removal of the great rock shoal at Hell Gate, and construction of the great 40-foot deep entrance channel, New York harbor; all breakwaters, jetties and dredging at all American harbors on the seacoast and Great Lakes; all lighthouses on the seacoast, lakes and rivers, including the famous lighthouses on Minots Ledge (Boston Harbor), Spectacle Reef (Lake Huron), and Tillamook Rock (Oregon); the Hudson and Columbia River improvements; the Panama Canal; and thousands of other works of varying magnitude.

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Lock-keepers' Dwellings, Dam 24, Ohio River
Good types of residential architecture, substantially built



View in the Panama Canal — Giant Floating Crane in Culebra Cut
The Panama Canal is the greatest engineering feat of man



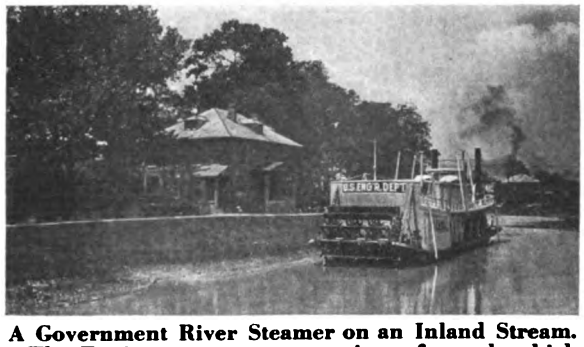
Lock and Dam No. 17, Black Warrior River, Ala.
One of our great inland waterway projects, connecting the coal fields of Alabama with deep water in the Gulf of Mexico



Power House, Lock 9, Ohio River
In addition to public buildings, monuments and residences the Corps of Engineers constructs buildings for every conceivable utilitarian purpose

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It has sometimes been stated that it is undesirable that military engineers should have charge of river and harbor improvements for the reason that when war comes these engineers will pass to the military service, leaving the work disorganized. Recent experience has proven, however, that these fears are without foundation. During the period of the war requirements for the normal systematic development of waterways are curtailed, and the small amount of work remaining is carried on by the available per-



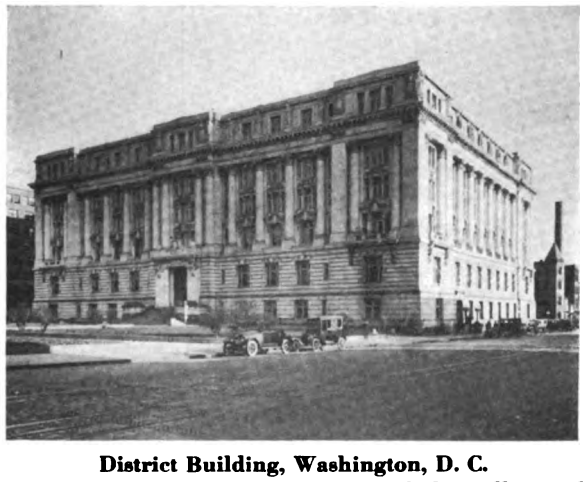
A Government River Steamer on an Inland Stream. The Engineers use a vast variety of vessels which they design, and often build, to meet their needs

sonnel without dislocation of organization. In war we must expect that the best and most active of the employes already in staff departments will enter the military service and the resources of the nation are mobilized for war with a corresponding reduction in ordinary peace time pursuits.

This varied and important construction and operation of engineering utilities would certainly appear to be convincing as to the ability of the Corps of Engineers to execute any task of civil construction that might be placed upon it by Congress, but there is still other and more conclusive evidence of the ability of the Corps of Engineers to do satisfactorily and rapidly the type of construction work that was required by our forces in the United States during the war. It is found in the work actually done by the Engineers for the American Expeditionary Forces in France.* To any one who had opportunity to view the work done within the area of the Services of Supply in France, or to any one who has read of the vast amount of construction work required for the A. E. F., no argument is necessary to prove that the Corps of Engineers is fully able to do construction work similar to that done in the United States during the war. A comparison of the accomplishments of the Corps of Engineers in France and those of the Construction Division of the Army in the United States is given by Colonel Leonard P. Ayres, a civilian statistician commissioned as an officer on the General Staff for the period of the war. His statement is as follows:

> The conduct of the war in France necessitated a construction program comparable in magnitude and number of projects with that in the United States. Less new building was required for shelter and for the manufacture of munitions, but more for the development of port and railroad facilities and for the repair and operation of the complicated equipment of a modern army.
>
> The storage space constructed in France was more than nine-tenths as large as the amount built at home. Hospital capacity constructed in France was twice the new capacity at home.
>
> All construction work in France was performed by the Corps of Engineers under the Services of Supply. The labor force consisted largely of American soldiers and German prisoners, although French and English civilians and Chinese coolies were used wherever available.

To accomplish this work in France, it was necessary to assemble material from Switzerland, England and the Scandinavian countries, as well as from Holland, Belgium and France. The militarized labor was not sufficient, and it was necessary to import laborers from various countries, even from Asia and Africa. This introduced difficulties of supervision, administration and supply not existing in the United States. Due also to the activities of the enemy and his varying successes, changes in plans were numerous, and not infrequently the construction division of the S.



District Building, Washington, D. C. This handsome structure is seen yearly by millions of visitors to the National Capital

O. S. was more or less completely stripped of its material and labor to meet the situation at the front. A study of detailed statistics will demonstrate that the problem confronting the Division of Construction of the Engineer Department abroad was far more difficult than that of the Construction Division in the United States. No contractors with their organization and facilities were available in France, and the work there had to be done by day labor, necessitating an organization from the ground up and the utilization of whatever material or labor could be found. The

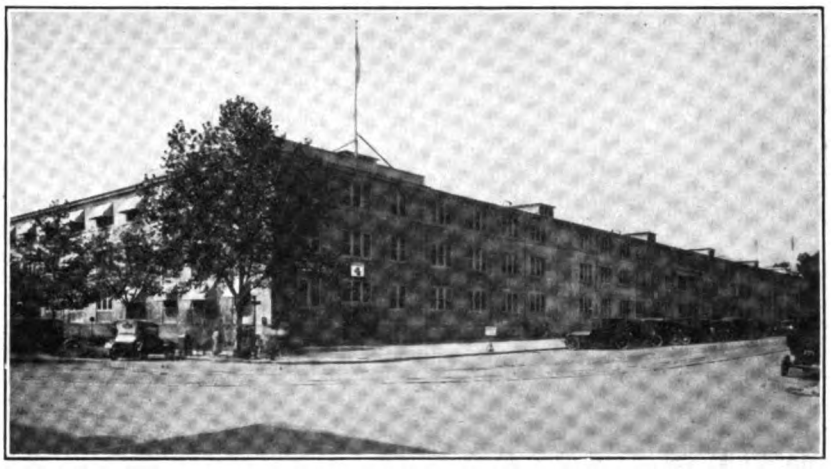
* This work was described in detail in THE MILITARY ENGINEER, No. 61, Jan.-Feb., 1920, under the title "Construction Work of the Engineers in France."

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work at home was an easy task under exceptionally favorable conditions; that abroad a difficult task under very unfavorable conditions.

The construction done by the Corps of Engineers in France was not only of great magnitude but infinite variety. It included works of every conceivable nature. Amongst the more important items may be mentioned:

Oil and gasoline storage,
Port and dock construction,
Forestry and lumbering,
Railroads, standard and light,
Railway shops and terminals,
Storage warehouses,
Veterinary hospitals,
Shelter for troops,
Remount depots,
Lighterage,
Hospitalization,
Water supply,
Sewerage,
Refrigeration,
Bakeries,
Power plants,
Roads,
Bridges,
Quarries,
Cement mills.



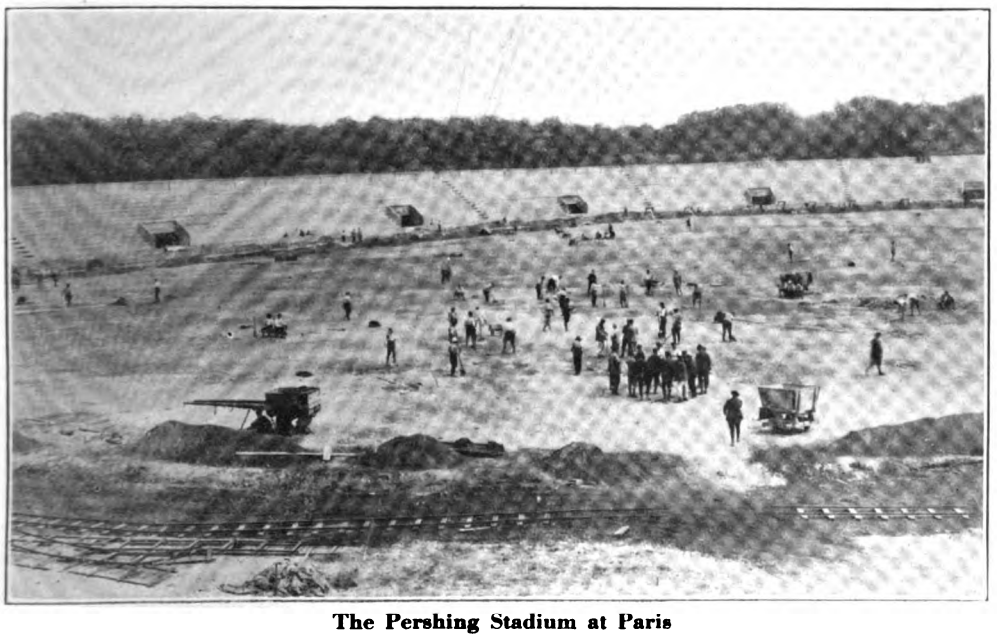
A temporary office building for war use in Washington, erected by the Corps of Engineers. Some of the construction at home during the war, and all of it abroad, was done by the Engineers

These works are in addition to the work of the Engineer Troops operating with the Armies, which maintained lines of communication, built roads and bridges, fought as infantry, conducted camouflage, searchlight, flash and sound ranging, water supply activities, and many other special functions.

The Corps of Engineers Can Do the Construction Work for the Army without Material Change in its Organization

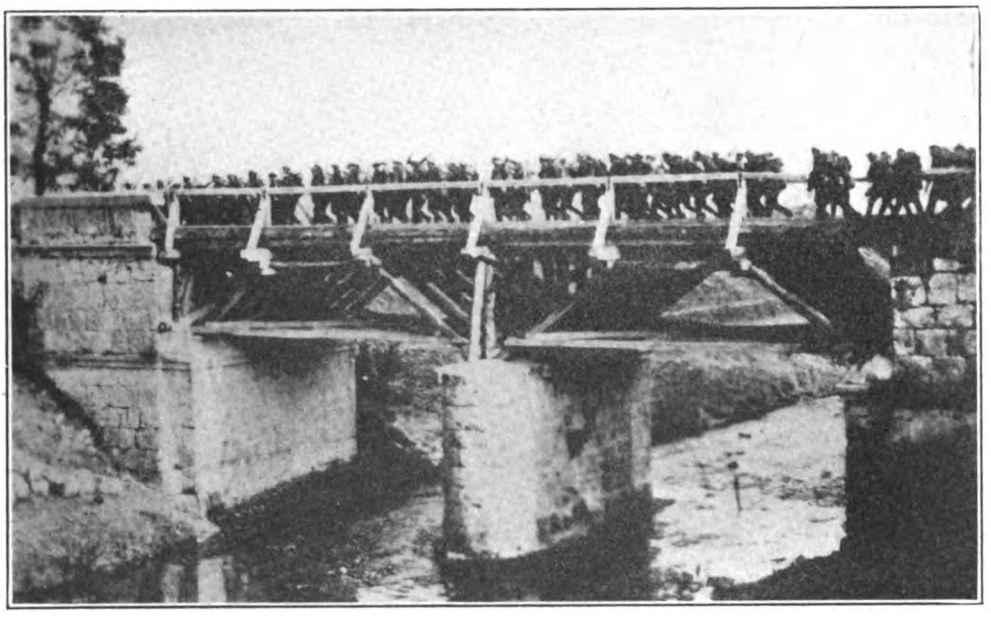
For over 140 years the Corps of Engineers has discharged with signal success every duty laid upon it in war or in peace. The conduct of river and harbor improvements and the construction of various public buildings and other public works in the United States for many decades proves its competency to handle this class of work in peace. The record made by the Division of Construction and Forestry in France, an organization officered and manned by engineers, demonstrates its ability to handle construction work under difficult conditions in time of war. Further proof of the professional ability of the officers of the Corps of Engineers to take over the construction work of the army is therefore not necessary. The question then is as to the organization of the corps. Can it now take over the construction work for the army? The reply is unhesitatingly in the affirmative. Its organization is, in fact, such as to readily facilitate taking charge of these duties with very small additional cost for overhead expense.

For over a hundred years the Corps of Engineers has maintained an organization covering the United States and its outlying possessions. For the execution of river and harbor works the country is divided into a number of large areas called divisions, each comprising a number of United States Engineer districts. Each district is in charge of a trained officer of the Corps of Engineers of the army, who is assisted by technical specialists according to his needs His work is supervised by a Division Engineer, an officer of greater rank, age, and experience in the Corps of Engineers.



The Pershing Stadium at Paris

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A piece of hasty bridge construction by American Engineers in Italy

In addition, at departmental headquarters of the army there are officers of the corps serving as Department Engineers through whom the army departmental commander is able to exercise supervision and control over all engineering matters within his jurisdiction.

All of these officers have such engineer assistants and clerical forces as are required in their work and by a slight reorganization and a small increase in the personnel in subordinate positions they can readily take charge of the work of constructing barracks, quarters, and facilities needed for the army, in addition to their present duties. This organization, already existing and in operation, would save large sums to the United States in the way of superintendence and clerical costs. The officers are there and the principal technical and clerical assistants are there. On the other hand, if construction is to be done by any other department it must practically duplicate throughout the United States the existing organization of the Corps of Engineers. It would have to maintain offices with the necessary technical and clerical staff with a corresponding duplication of costs. To take over this work it would be necessary to add to the Corps of Engineers only a small force of administrative officers for duty at the headquarters of the Corps, at the Departmental Headquarters, and possibly at District Headquarters within the larger departments. It is estimated that for this work about 130 officers and 4,000 enlisted men would be required in addition to the personnel provided for other duties assigned to the Corps of Engineers. This force would be suitably organized and might, for administrative purposes, be given a provisional regimental organization, each unit being assigned to a definite geographical district. Such an arrangement would result in a military organization for military purposes. It would harmonize with the organization of the War Department as a whole and, by reason of their military training, its officers and men, would appreciate, in a proper military sense, the requirements of the army as a fighting force, and their relation to it.

The organization of the construction forces into engineer regiments would be similar to that of the Division of Construction and Forestry in France which achieved its results as a branch of the

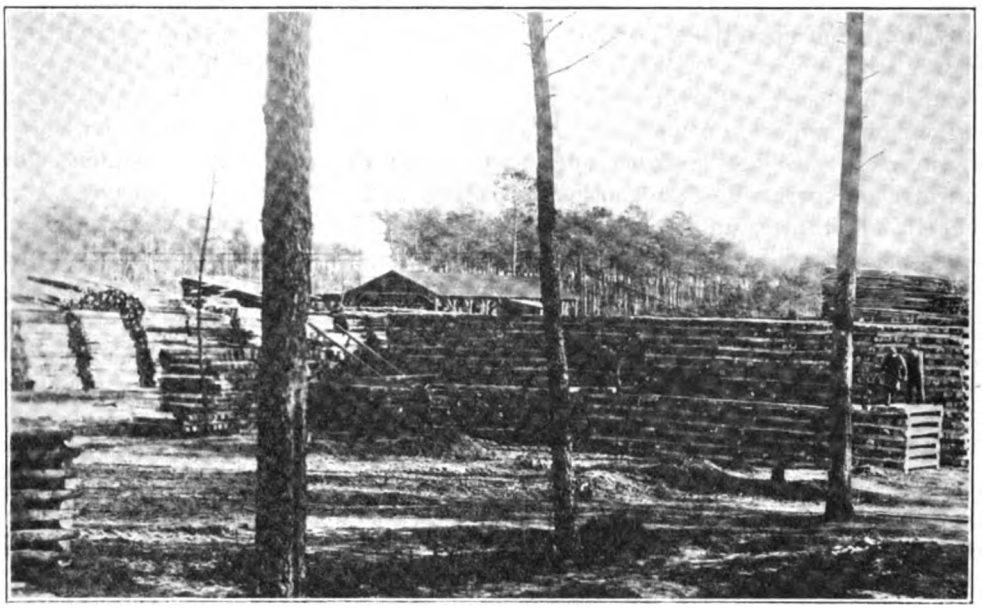


The railroad bridge at Nevers

The "Nevers Cut-off," shortening our main line of communication, was the largest railroad project carried out in France

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Engineering Department of the A. E. F. Such an organization will have conspicuous advantages in case of a national calamity, as of fire, flood, storm or earthquake. Organized within the Corps of Engineers, it can, whenever necessary, take over for construction purposes such number of divisional, corps, and army combat engineer regiments or other special engineer troops, as may be available for the purpose. All of these troops will be under the same control, the Chief of Engineers of the Army, working in direct conjunction with other personnel of the Engineer Department in the same territory. They will be co-ordinated by a single agency and will have a mutual understanding of each others' capacities and limitations. There will be no crossing of staff department lines; no preliminary agreements will be necessary. Time and money will both be saved.



An American Sawmill in the Vosges Mountains

The Forestry Methods of the Americans were so rapid they threatened to denude France of timber

Two Separate Construction Forces in the Army neither Necessary nor Desirable

There is neither need nor room for two separate and independent construction services within the army. There is no need for maintaining in the army a Corps of Engineers for certain classes of work and a separate construction division for other work of the same general class. Construction is an engineering specialty and a construction corps in the army outside of the Corps of Engineers cannot be efficiently maintained by the detail of officers from the infantry, cavalry, and artillery branches of the service unless these officers happen also to be trained engineers. This is seldom the case, and furthermore, to maintain their efficiency as engineers, such officers must practice engineering constantly, and not intermittently. They cannot, at the same time be thoroughly competent as officers of the purely fighting branches of the service and also as officers of the staff departments. Therefore, any construction service formed by the detail of officers from non-engineering branches of the service would have to depend, for its technical advice and assistance, on engineers hired from civil life and the officers detailed from the line would become administrative and disbursing officers only. A construction division so maintained would, therefore, draw its technical personnel from the same sources as the Corps of Engineers now recruits its forces. This would be particularly true in an emergency requiring an expansion of the peace-time force to a war-time basis and the situation is inherently one of unnecessary and harmful competition and duplication.

During the war, the Atlantic Ocean separated the A. E. F. from its base in the United States. No competition for labor and material was apparent on the surface, but, in the last analysis, it existed between the Construction Division, charged with the acquisition of structural material for use in the United States, and the Corps of Engineers, charged with the acquisition of similar material for use in France. It must also have existed in the recruitment of labor, since the contractors doing the work for the Construction Division in the United States required carpenters, masons and other artisans, while the Engineer Service in the A. E. F. required similar personnel to be inducted into the service as soldiers.

These conditions incidentally have not been without an aftermath of evil consequences. Under the draft act many a skilled artisan was inducted into the service and transported overseas to work at his trade under all the discomforts of war and without regard to hours at a cash remuneration of $1.10 per diem, while his brother-craftsman, more fortunate perhaps, remained at home in a civilian capacity with short hours of labor and freedom from military obligations, at eight, ten, twelve dollars per day, and even more.

For reasons previously stated, militarized labor,

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that is to say, engineer troops, must be used within any theatre of operations. Should we ever engage in a war with Mexico or with Canada, or should we by some evil chance suffer invasion and have to fight on our own soil, keen competition would at once arise between a construction force operating within the theatre of operations and another operating within the United States, unless all construction should be administered by a single head. In the beginning, at least, the theatre of operations under the control of the commander of the field forces, would necessarily include some portion of the United States. The boundary between this theatre of operations and the base within the United States would be a mere geographical line, and the two independent construction forces operating within the theatre of operations and in the base areas, respectively, would draw their material and labor from identical sources in the United States. This would introduce much competition and the necessity for much "coördination" by the General Staff or by the Secretary of War. In this case, obvious advantages would accrue from placing control of all construction, including necessary material and labor, under a single head. Since, moreover, the troubles would be most acute at the front in contact with the enemy or in the areas immediately behind the front lines, military necessity requires that the control of structural resources should be vested in that officer or department having charge of construction and military labor at the front, that is to say, the Corps of Engineers. If such action is necessary eventually, and it will be necessary, why not recognize the fact now and organize to meet the situation that will inevitably be encountered?

The provision of a Corps of Engineers for construction service within the theatre of field operations and another construction division for service within the United States is indefensibly illogical and wasteful. It would be just as consistent to maintain a medical department to serve our forces in the theatre of operations in time of war, and require the Public Health Service to serve the army of the United States in time of peace. It would be just as logical to build up and maintain an Ordnance establishment to supply guns and ammunition to the troops abroad and make contracts with private concerns for similar material for the troops at home. It would be just as consistent to provide a navy for naval operations in time of war and to direct that its duties in time of peace should be performed by the U. S. Shipping Board or the Revenue Cutter Service.

Training for the Military Engineer

In common with all other forces, the military engineers must be schooled for their duties in war. The infantry, the artillery, the cavalry can all be trained in peace to a very appreciable degree to fit them for their military work. By means of target practice they are taught to shoot. In the absence of the actualities of war, it is possible to assume certain conditions and through the study of maps and the solution of map problems based on those conditions, officers and men receive instruction for their guidance in war. Through maneuvers, terrain and battle exercises on a suitable topographic field it is possible to gain a measure of training in the movements of war without the heart-breaking costs of tuition exacted by the sterner master—war itself.

The circumstances of daily life with its incidence of disease and its recurrence of accidents, afford the military medical man most helpful experience. For the military engineer the case is quite otherwise. Special measures are necessary for his training, though fortunately, such measures need entail no great extra costs. The daily industrial life of the country provides the means, and all that is necessary is to recognize their existence and to so organize the military engineering service as to take advantage of them.

It must be conceded that the mere study of text books and the reading of engineer literature will not make an engineer. Actual practice is an absolute necessity. Without it an engineer may become a learned man but he will be no more competent to perform his duties than would a surgeon who has studied but has never performed an operation, or a prosecuting attorney graduated from a law school who has never appeared in court. The practice of engineering involves the use of large quantities of material, and the employment of great numbers of laborers. This nation, rich as it is, can not afford to expend public money for material or labor for the mere purpose of training its military engineers. Their work must at all times serve some direct utilitarian purpose. This training can only be obtained in time of peace through the employment of officers on public works; that is, on river and harbor improvements, construction of public buildings, and the civil activities which are similar to those required in war.

This consideration alone, aside from all others, is of sufficient moment to require that all construction work for the army shall be assigned to the military engineers in order that their work in peace may afford the maximum of practice with a maximum of peace-time utility. Such assignment would in no wise preclude the employment to the necessary extent of civilian contractors in the United States in exactly the same manner as was done during the war and for years before the war. In point of fact, the officers of the Corps of Engineers, in connection with their work on fortifications, rivers and harbors, let contracts annually involving millions of dollars, and, in the natural course of their duties, acquire a practical working knowledge of contract law and contracting procedure not exceeded by that of any other branch of the service.

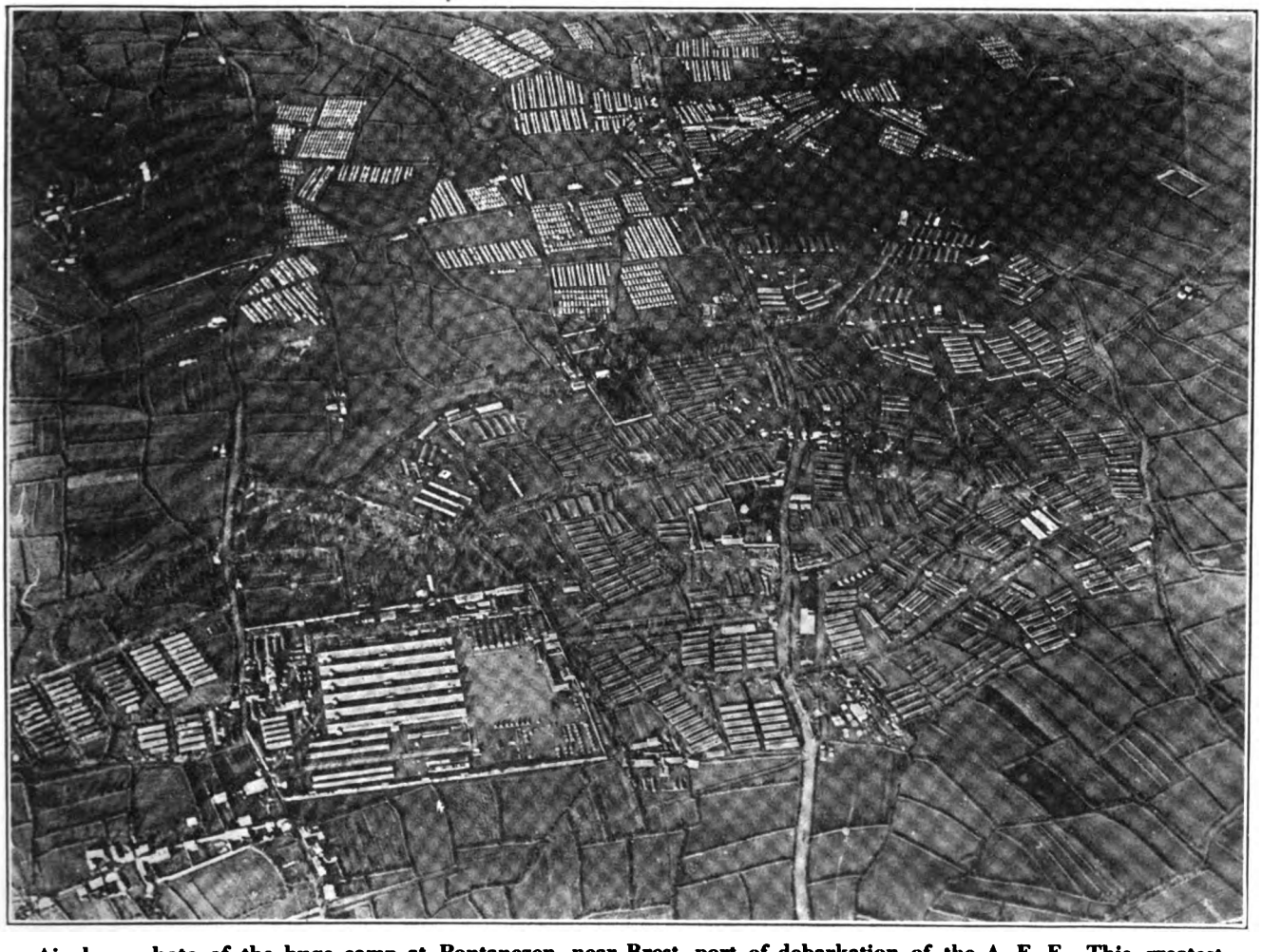
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A Construction Section in the Quartermaster Corps is Illogical

Previous to the World War construction now being executed by an independent construction division was executed by a branch of the Quartermaster Corps. This system originated many years ago, when our Army was scattered in small garrisons throughout the country, especially in the west. The number of these garrisons was so great and the amount of construction work at each was so simple and so limited that it was considered impracticable to use the small number of officers in the Corps of Engineers for this work. It was consequently, as a matter of expediency rather than of logical arrangement, placed in the hands of the Quartermaster Corps, which was charged at that time with a great variety of miscellaneous jobs for the military service. At each of these small posts a local quartermaster, usually detailed from the line, was available for supervision of the simple construction required.

Under the detail system provided in 1901, the direction of construction work was frequently placed under officers not trained in engineering or construction work, who were detailed for more or less limited periods in the Quartermaster Department. They retained administrative control of the work but had to depend in large measure upon civilian employees in subordinate positions for the necessary technical supervision. It is obvious that under such an arrangement the officer in administrative control and responsible for work must have operated under a great handicap, due to lack of practical knowledge of the work upon which he was engaged, and he could rarely have secured the most economical results.

When conditions made necessary the change from the small one-company garrisons of the Indian warfare days to the divisional cantonments of the present, the necessity for close and skilful supervision became much more pressing. Notwithstanding the fact that trained engineers and an engineering organization has always been recognized as necessary for the supervision of large building projects, such as that of our cantonments, such is the power of precedent and so great is the inertia of previously existing organization that the old construction section of the Quartermaster Department was perpetuated only to be projected



Airplane photo of the huge camp at Pontanezen, near Brest, port of debarkation of the A. E. F. This greatest of all camps accommodated 80,000 men, and was a model from a sanitary point of view

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into the present Construction Division, whose status is that of an emergency bureau for the duration of the war.

The very organization of the Construction Division, which it is proposed to officer by detailing from the line officers who may or may not be qualified by engineering training for that duty (usually not), supplemented by engineers from civil life, is strong evidence of the incorrectness of the present policy of having a Construction Division in addition to the Corps of Engineers. To further prove that this kind of work demands engineers for its proper direction, it is only necessary to cite the fact that almost all of the commissioned officers of the Construction Division, during the War, were engineers from civil life; only a very limited number of the officers in administrative control at the top, including the Chief of the Corps, were officers of the regular establishment who had originally been detailed into the Quartermaster Corps.

At present the duties of the Quartermaster Corps consist principally in furnishing subsistence and clothing, forage, camp equipage and miscellaneous supplies. Construction as now practiced is highly specialized and has very little in common with the other duties of the Quartermaster Corps. To function efficiently, a construction section within that Corps would be practically independent of all its other activities and would, in fact, become a separate entity merely acknowledging the Quartermaster General as its titular head. The latter would have to have a special deputy as Chief Constructor who would, in fact, be the real head of the Construction Service. The error inherent in placing construction in the Quartermaster Corps was demonstrated at the outbreak of the war, when it was necessary to completely reorganize this branch and eventually separate it altogether from that Corps. The Corps of Engineers on the other hand, though it had not previously been charged with this class of work for the army, was able to take it up and conducted it with conspicuous success in France.

A Construction Division Outside of the Army

There is on foot a movement to establish a Construction Division, temporarily, as a separate staff department of the Army, with a view to its bodily transfer at no distant date from the War Department to a proposed Department of Public Works. This proposition is predicated on the annihilation of the Department of the Interior and a raid on various other governmental departments to take away from them their duties in connection with construction of public buildings, the making of maps, the administration of the public roads and forests, and the river and harbor improvements.

Of all the ideas included in this proposition for a Department of Public Works, that providing for the transfer of the Construction Division of the War Department to another governmental department is perhaps that which would be provocative of the greatest inefficiency and confusion.

It is a very common, and perhaps in some respects a venial, fault of construction engineers, that they emphasize the importance of the means which they provide, and overlook the ends which they serve. In this idea, brought forward in the interest of the engineering profession, it is therefore not strange that such misconception is manifest. Constructional activities of the army are not undertaken with the end of erecting barracks, storehouses, and other structures, but for the shelter and service of the army. No matter how well and efficiently such buildings may be built, they are useless, and the money spent upon them is wasted if they do not meet the needs of the military service at the time being; not, for instance, the needs of a time in the past. Even within the War Department it has been necessary in the past, and undoubtedly will be necessary in the future, to curb the tendency of officers charged with construction toward planning according to their own lights rather than according to the real needs of the users. Such tendency will be many times magnified if the construction is in charge of a different department. A purely civilian construction division could not handle the construction work for the army until its personnel had acquired a considerable degree of military training. Constant friction, lack of coördination, and resulting red-tape, inefficiency and waste of public funds, would be the inevitable consequence of such an organization. In short, it is an obvious principle that, subject to the control of Congress over appropriations, construction should generally be executed by the department which will use the structures that are built.

Expansion to a War Footing

There are other considerations which make it necessary to vest all construction for the army as well as all other allied engineering activities in the Corps of Engineers. As was clearly exemplified by the World War, it is wholly impossible to maintain in time of peace a force of military engineers sufficient to meet the demands of war. On April 6, 1917, when the existence of a state of war with Germany was formally declared, the engineers available for immediate military service consisted of 256 officers and 2,228 soldiers. In November, 1918, nineteen months later, there were in the Engineering Department of the United States service 10,886 engineer officers and 292,300 soldiers, and this takes no account of a large number of professional engineers who for various reasons became identified with other departments of the Army. In the future, then, as in the past, we must look to the engineering profession in civil life for the vast num-

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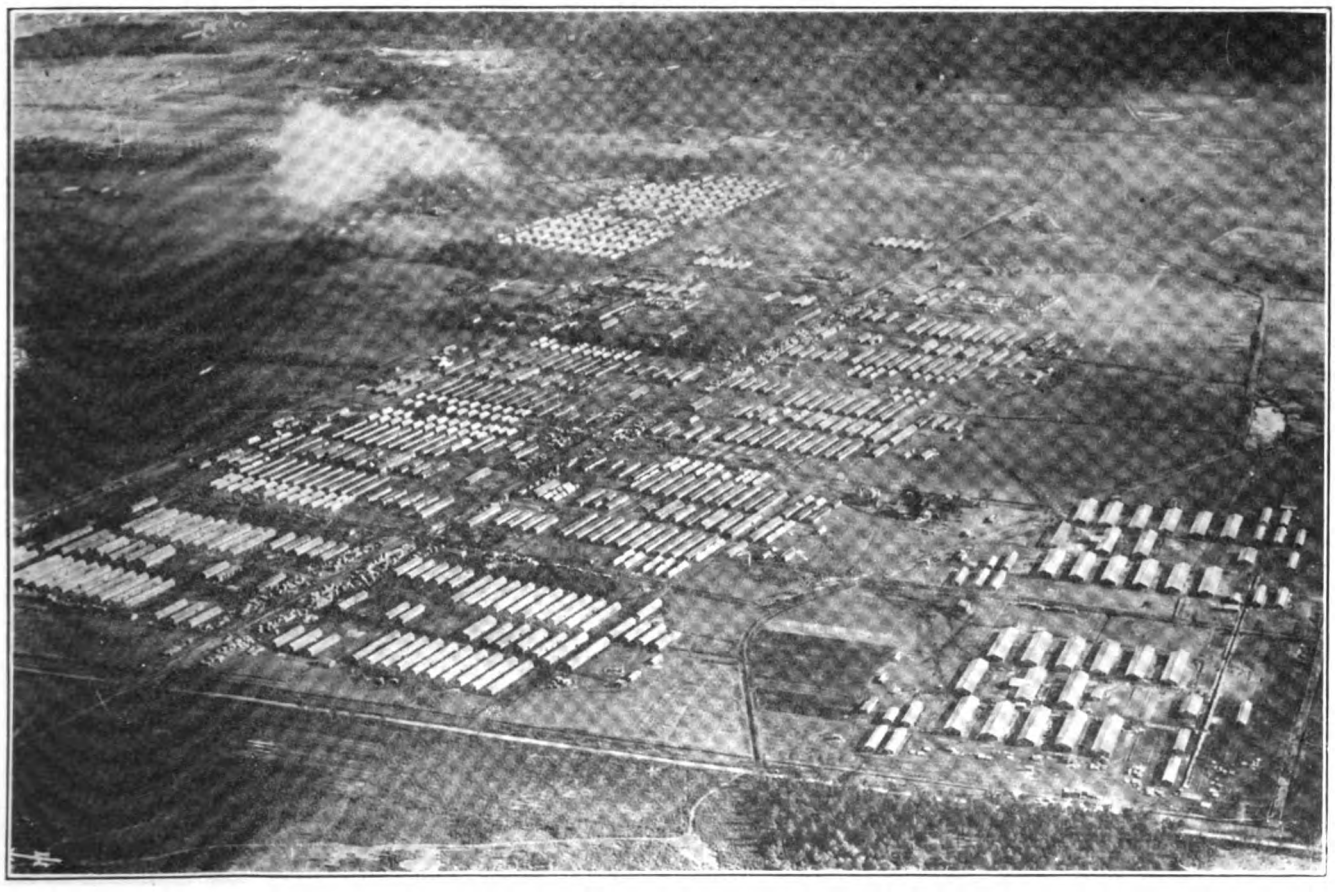
bers of officers and construction men required in such an emergency. The Corps of Engineers by reason of its training, and by reason of the work which now devolves upon it, maintains affiliation with the engineering profession as a whole. It constitutes the natural channel of communication between the army and the civilian engineers. It must, therefore, in time of peace, maintain the machinery for assimilating the civilian engineers at the outbreak of war. It must have prepared in advance tabulated lists of all suitable engineers who will accept commissions, and must have tables of assignments ready for use when these civilians are called to the colors. Any other construction section would have to maintain similar contact and again we encounter duplication which would lead to confusion and delay in an emergency.

Through the Reserve Corps authorized by the National Defense Act of June 3, 1916, the Corps of Engineers has already established such machinery and this is further supplemented by its list of officers who served during the war. The same spirit of patriotism which actuated them in offering their services during the late war would impel them to again come forward in time of emergency. To eliminate doubts and uncertainties and to keep these individuals informed and interested in the service, there should be one single body charged with the duty of keeping them in touch with military progress, and the Corps of Engineers with its great variety of duties and its organization covering the entire country is the logical agency for this purpose.

Not a Scheme for Promotion

The proposal to vest all construction work for the army in the Corps of Engineers has naturally met with opposition in certain quarters in the service. It has been stated that it is a scheme fostered by the officers of the Corps of Engineers to increase their rate of promotion. This is entirely contrary to facts. The question of organizing the army as a whole and organizing the Corps of Engineers as a part of that army must be given consideration on its merits, irrespective of any scheme for promotion. If the single list idea is framed in appropriate terms, promotion incident to the expansion of any branch of the army will be distributed throughout the army as a unit and no one branch will profit at the expense of another.

For many years before the war it was the opinion of a great many officers of high rank and acknowledged ability, that army construction is properly a function of the Corps of Engineers. At least one former Secretary of War and one former Chief of Staff seriously contemplated the assignment of this



American Hospital, Beau Desert, France

The American Army Engineer covered France with camps, hospitals, depots, etc.

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duty to the Corps of Engineers but, on account of the difficulties of obtaining the necessary legislation and the inexpediency of attempting such an assignment without some legislation, their plan was not put into effect. Our experience during the World War has fully confirmed the soundness of their views and, as a result of their observation and experience, disinterested officers throughout the service are now of the belief that placing construction within the Corps of Engineers is the only natural and logical arrangement. It is obvious that to have two engineering organizations in the army doing exactly similar work can only lead to waste of Government money even if both be organized properly to execute this function.

Construction of every kind is the logical function of engineers, and military construction of every kind is the logical function of the Corps of Engineers.

Invents American Shield Tunnel to Carry Vehicular Traffic under Hudson River

The plans for the interstate tunnel under the Hudson River are contained in a report of Mr. C. M. Holland, Chief Engineer of the New York State, and the New Jersey Interstate, Bridge and Tunnel Commissions. The plan adopted was chosen in preference to a number of plans proposed including a double-deck concrete-block tunnel, a precast reinforced concrete tunnel with an outer protection of tremie-placed concrete, and cast-iron tubes of different size from those of the design adopted.

The approved design provides for two circular cast-iron tubes of an external diameter of 19 feet. The mean length of the tubes is 7,345 feet and the mean length of the tunnels, including the open cut approaches, is 9,300 feet. The estimated cost of the project is $28,669,000, which includes $2,500,000 for real estate rights, and engineering administration, and contingencies at 6, 2, and 5 per cent, respectively, of construction and equipment costs. The time required for completion is estimated at 3½ years.

The New York terminals are near the foot of Canal Street and the Jersey City terminals are at 12th and 14th Streets. The southern tunnel is intended for traffic to New York and the northern for traffic in the opposite direction. The alignment of the main portion of the tunnels includes three tangents; the two shore tangents are nearly parallel to each other and approximately at right-angles to the direction of the river. The river tangents make small angles with the shore tangents. Curves and short tangents are necessary in the approaches. The maximum grade in either tube is 3.61 per cent at the New York end of the north tunnel.

Each tube is to be built up of cast-iron segments 2 feet by 6 inches and 6 feet long, flanged and bolted together with 1¾-inch bolts. The weight of the cast-iron tube is 8 tons per linear foot, except in the sections to be laid in silt where it is 8½ tons. The tubes have a concrete lining 19 inches thick. Each tube contains a roadway with a clear width of 20 feet and an overhead clearance of 13 feet 6 inches. A 2-foot walk is provided on one side only. The roadway is intended to provide for two lines of traffic, one fast and one slow, moving in the same direction, and the maximum capacity of each tube is estimated at 1,900 vehicles per hour.

Each tunnel has four ventilating shafts, two 3,800 feet apart near the pier-head lines, the other two between these shafts and the portals. The electrically driven blower and exhaust fans are located in the shafts. Fresh air is carried in the large space under the roadway and admitted just above the curb line. Exhaust air leaves through a similar large duct at the top of the tunnel over the roof of the vehicular space. Drainage is provided for by sumps, at the portals for storm water, and at the low points of the tubes for leakage and flushing water. The latter is carried to the sumps by drains within the lower air duct which prevents the pollution of the fresh air by the drainage water. Electrically driven and automatically controlled pumps remove the water from the sumps.

Traffic tolls proposed are 45 cents for motor and 20 cents for horse-drawn vehicles. It is estimated that at these rates the cost of the tunnel will be amortized and a surplus fund of $67,270,000 produced in twenty years.—*Eng. News-Record.*

Military Organization for the Pennsylvania Railroad

Gen. W. W. Atterbury, late Director of the Railway Transportation Corps, A. E. F., in resuming his duties as vice-president in charge of operation of the Pennsylvania Railway, has adapted to this system the scheme of army organization used in France. The combined lines east and west of Pittsburgh have been divided into four sections, each under a regional vice-president, who will have on his staff a general manager, a superintendent of transportation, a chief engineer of maintenance-of-way, a superintendent of motive power, general superintendents, a traffic manager, a purchasing agent, a real estate agent and an accountant. The duties of the regional vice-presidents are analogous to those of president, insofar as the operation, maintenance and traffic regulations of their territory are concerned.

The relations between the central organization and the regional organizations constitute an entirely new departure, although some features of the scheme were found in the Harriman system of roads as under development at the time of Mr. Harriman's death. It is of interest to note in this connection that Col. C. D. Hine, West Point '92, was Mr. Harriman's adviser in developing this idea.

General Atterbury's duties consist in coordinating the work of the regional vice-presidents in both operation and maintenance. The divisional form of organization which has been the keystone of the Pennsylvania system will be preserved, but coordination will be achieved through a staff in Philadelphia.—*Railway Age.*

The British Ordnance Survey in the War

No branch of the British service was put to a severer test by the war than the Ordnance Survey; certainly none rose better to the emergency, equipped itself more creditably or did work of greater importance. Not only was there a tremendous and ever-increasing demand for trench and other maps for the various fronts, but a great many maps and charts were prepared and printed for the Admiralty and for military use at home, besides the keeping up of a certain amount of the ordinary work of the survey.

The work of the survey may be classified under the following headings:

1. The supply of topographers, observers, draftsmen and printers for the various fronts, of whom about 800 were specially enlisted and drafted abroad in addition to those already in the department.

2. The drawing, printing and supplying of maps, plans and diagrams to the army and navy, of which the total number amounted to 32,872,000, including those supplied by the overseas branch of the survey.

3. The supply of stores, paper, artillery boards and map models. Altogether 12,000 artillery boards and 1,000 map models were supplied.

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Duties of a Corps Engineer

Continued from Page 120

The latter agreed entirely with the corps engineer but naturally felt great hesitation about issuing any order regulating the division commander's method of handling the engineer regiment. Eventually the corps commander, at a conference, made clear his own preference for methods being used by the corps engineer and the other division engineer. This, however, required considerable time and during this time work was delayed and the corps engineer was compelled to arrange for work that should have been done by this division to be done by the other regiments of the corps. The result was, of course, delay in the road work throughout the corps area.

This leads naturally to a consideration of engineer relations with the general staff. Up to the present time these have been the resultant of the personalities of the engineer officer and the general staff officers concerned. If the engineer officer is competent to be a division or corps engineer, greater efficiency will be assured in this day, when operations are so dependent on engineer work, if he is given a chance to present his end of it in the preparation of the plan, and not merely left to fit his work as well as he can to a plan prepared by the staff with little or no consideration of what it may involve in the way of engineering work. It is not advantageous to have the relations that exist between chiefs of service and the general staff sections dependent solely upon the personalities of those concerned. In some cases the writer felt that he never succeeded in gaining the confidence of some of the general staff sections despite his utmost eflorts to that end. In some cases he was made to feel that he was an interloper if he sought information vital to the execution of engineering work, before the issuance of an order. In other cases he was made to feel that engineering advice was entirely unnecessary and that he presumed in trying to be of service, the general staff section being all sufficient in itself. With all of the several chiefs of staff with whom he served he found it easy and pleasant to work, but the same was far from being the universal rule when it came to the chief of staff's assistants. Ease of working with the latter was largely proportional to their experience and the experience of those under them.

It may be argued that with experienced staff officers such difficulties will not occur. That is true but it is equally true that in future wars, as in the one just over, there will be many young and inexperienced staff officers, and difficulties such as the majority of chiefs of service experienced will be repeated unless there is a marked change in the method of handling matters from those in vogue during the last months of the great war. Colonel Jones apparently accepts existing arrangements as impracticable to change, and proposes to solve the difficulties that arise as they were solved in the past, by charging the chiefs of service with the duty of making themselves personally agreeable. This is believed a poor method, even though it worked out after a fashion in the recent war. It should be remembered that, in active operations, officers work under severe nervous strain, and at such times it is not safe to allow relations between officers to depend solely upon personality. Psychological considerations cannot be safely omitted in staff organization, to the extent they apparently are at present. It is to be remembered that the chiefs of service, if they are fit to fill their positions, are specialists along their several lines, and that, if they have the force and self confidence necessary to carry out their functions, they will have considerable personal pride and will be quick to resent, even though they may conceal all outward appearance of resentment, any undue interference with the execution of their work. In the organization of the corps staff there was a strong tendency to decentralize beyond all reason, and to provide in the general staff sections men whose duties almost paralleled those of the chiefs of services. For example, the chief of staff was not supposed to concern himself with road matters but turned it over to G-1; G-1 in turn was not to particularly concern himself with such matters but in turn assigned that duty to an assistant for whom there was often little to do that was not also done by the corps engineer, or some other chief of service.

The writer entered a G-2 office one day and thought he had by mistake gotten into some greatly glorified engineer office, from the number of engineer officers on duty therein, many if not all of whom were engaged in duties similar to those carried on by officers in the corps engineer's office or the corps engineer regiment. Some of the results of this were as follows:

1st—An enormous corps staff.

2nd—Much duplication of work: For example, map reproduction both in the G-2 section and the corps engineer regiment; reconnaissances carried out under direction of G-2 or G-3 by officers who, on account of their lack of engineering experience, would not get the information needed by the corps engineer, who therefore had to send engineer officers on the same reconnaissance to get the engineering information required.

3rd—Uncertainty of chiefs of services as to exact ideas of the corps commander because of the long chain through which information reached them.

4th—Lack of those cordial relations so necessary for good staff work. This latter was minimized to a considerable extent by the corps commander under whom the writer had the honor of serving, by the simple expedient of bringing together in the same mess the chief of staff, his assistants, and the chiefs of services. A few days after this arrangement was put in operation one of the general staff sections remarked on the ease with which business was conducted as a result of the personal conferences incidental to association at mess. This probably promoted smooth operation even more than did the daily formal conference.

In the interest of efficiency it is believed *regulations* should provide: 1st—That in the preparation of plans there shall be the most complete understanding between the commanding general and *all* members of his staff. This will be best accomplished by having the chiefs of service as well as members of the general staff section present whenever plans are under consideration. By this arrangement chiefs of service will not only understand more perfectly the exact intention and wishes of the commanding general, but the commanding general and the general staff section will understand more perfectly just what the services can and cannot do. Finally the several services will have a better realization of their mutual relation to the plan as a whole. Until a plan is decided upon, the relation between the chiefs of service and the chief of staff should be identical with those between the chief of staff and his general staff assistants.

2nd—That a plan having been decided upon and the order prepared, the effort of the services should be *coordinated* by the assistants to the chief of staff, but that such officers should scrupulously limit their efforts to coordination, and scrupulously avoid all actions that will savor of technical command, direction or supervision of work. They should realize that they are concerned only

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with results; that methods are immaterial to them; that even if results are not all that the commanding general desires, its staff is rarely competent to change methods. More will be accomplished by merely pointing out to the chief of service concerned in what respect he is failing to secure results, leaving him to determine what changes in methods are desirable, than by attempting to lay down such methods themselves.

3rd—That assistant chiefs of staff shall personally handle all matters affecting the chiefs of service and not leave such matters to their assistants.

The chiefs of the general staff sections should keep in touch with operations of services by personal conferences and contact with the chiefs of services, rather than through assistants.

In order to avoid a duplication of effort, personnel, and equipment it is believed:

1st—That all drafting, lithography and map reproduction work should be carried out in the offices of the division and corps engineers, and under their supervision, it being of course understood that G-2 is the one whose wishes in all such work are to be met.

2nd—That all road, railroad, river and bridge reconnaissances and surveys be conducted through the corps or division engineers, G-1, G-2 and G-3 having authority to order any they desire.

Strength and Organization of Corps Engineers and Corps

The strength of the corps engineer regiment is considered about correct. It is believed, however, that the engineer train should be organized as a supply company, and should form an integral part of the regiment. Its relation to the regiment is so much closer than that of the trains to the other arms that it cannot be handled in the same manner as other sections of the train without seriously interfering with engineer operations. Its relation to the engineer regiment is very like that of the ammunition caissons to the fighting battery, *i. e.*, it forms an essential part of the unit.

The corps engineer should command all engineer troops of the corps but should not be the regimental commander of the corps regiment. The place of the corps engineer is unquestionably at corps headquarters; otherwise he cannot maintain the proper staff relations. So located he cannot exercise the close supervision over the corps regiment that a regimental commander should exercise.

The pioneer infantry regiments appear to have been regarded by many as unsatisfactory either as infantry or as pioneers. One corps commander made strenuous objection to having a regiment assigned to his corps. It is believed that it would be better to do away with "pioneer infantry" in favor of labor battalions. The writer obtained excellent results from labor battalions during his prolonged stay in training camp. These organizations would best be organized and trained under engineer officers. It is thought that three battalions could be advantageously assigned to a corps in lieu of a pioneer infantry regiment. While it is recommended that these units be trained under engineer officers it is not contemplated that they would be in any sense engineer units. They would probably work more generally under the engineers than any other arm, but should be available also for use under any other service where they might be needed. There would probably be less difficulty as to their effective use if they formed a part of the corps troops and it was clearly understood that they were for use under the engineers only when so assigned by the general staff section.

The writer's experience was that the corps commander is inclined to hold his chief engineer responsible for all utilities, such as electric and water installations, in the corps area, even though organization charts may indicate such matters as within the province of the chief engineer of the army. If anything goes wrong, the corps engineer is invited to remedy it without delay. Such matters should be under the supervision of the engineers, and there is something to be said in favor of handling them, and possibly also light railways, through the corps engineer instead of the army engineer. The writer's experience was too limited to warrant him in expressing any fixed opinion on this matter, but there is reason to believe that better results which would more perfectly fit the needs of the military situation, as they present themselves to the view of the corps and division commanders, would be obtained if all work in corps and division areas was handled by the corps and division engineers, the army engineer limiting his work to co-ordinating the efforts and following up the work of the corps engineers, as the corps engineers co-ordinate and follow up the work of the division engineers.

Engineer officers should be impressed with the fact that they, in common with all other chiefs of service, exist only for the benefit of the troops, and that their correct attitude is to turn their hands to anything they can do to promote the success of military operations and the comforts and welfare of the troops, whether it be advising the commanding general or digging latrines.

Conclusion—There is a marked tendency in our service to make the general staff too much of a class by itself and a privileged class at that, a tendency generally harmless enough so far as older and experienced officers are concerned, but often a dangerous intoxicant to the self esteem of younger and less experienced men. But the question arises, are honor and credit to be obtainable only by service on the general staff? Such service represents but one of the multitudinous phases of duty and there should be room for officers to aspire to other things than service on the general staff. In order, however, that such may be the case there must be honor and credit in service in command of troops or in the technical branches. This is an indisputable fact, the importance of which, however, was forgotten during the war. The writer believes firmly in the necessity for a strong general staff but he is no less firmly convinced that skilled surgeons, skilled signal officers, skilled supply officers, skilled regimental commanders, and skilled engineers are necessary.

Col. W. A. Mitchell

Formerly Division Engineer, 2d Division, Corps Engineer, 8th Corps, A. E. F.

This article covers the ground in an excellent manner, and brings out many points which are worthy of study by engineer staff officers, and by corps and other headquarters staff officers.

However, I differ with the author in his statement that certain work around corps headquarters can under certain circumstances be handled by detachments of divisional engineer troops. I have never seen the time when a divisional engineer regiment should not preferably remain with its division. Naturally there are some times when it will not be occupied with active engineer duties; and these times are always seized upon by some one for the employment of the divisional engineers in some outside work. As a result of this idea, the division engineers have practically no time to drill. It is a curious fact that many infantry, cavalry and artillery officers have an impression that engineers, signal and medical troops should never drill; but when called upon, they should have acquired the art of obtaining the results in some mysterious manner. Now, if the engineers also adopt this idea, the division engineer troops

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will become very poor indeed. As a matter of fact, I have never seen an engineer regiment that I considered well drilled. In the division with which I was on duty, the division engineer had to drill his regiment at every opportunity, even while the other division regiments were resting. On one occasion, he managed to work in a week's drill while the division was in the front line in active engagement with the enemy; and yet he never considered the regiment as at all well drilled at any time.

It is also believed that the corps engineer should demand daily reports from the division engineer officers. Naturally, he cannot give orders to the division engineer officers, but he can very quickly have orders changed when the division commander is not properly employing his engineers. For example, in the first phase of the Meuse-Argonne offensive, cases were known where the division engineer regiments were split up and actually employed as extra infantry companies when there was no emergency calling for such action. Of course the division commander cannot be perfect; but the corps engineer should have known of this failure to use his engineers properly, and he should have arranged so that the division commander should use them properly. The corps engineer in many cases knew that much engineer work was necessary, yet he allowed division engineers to be wasted by inaction in division reserves which every one knew would not be needed in a great hurry and, what is even worse, allowed them to be thrown away as poor infantry in places where they were of no assistance whatever. He should have so arranged that they were ordered to do engineer work, and to be prepared to enter the fight in a short time if the emergency arose. This was done in at least one division; and the engineers were used in both ways during the battle.

Col. Robert R. Ralston

Engineers; formerly Corps Engineer, 4th Corps, A. E. F.

I concur in general with Colonel Jones in his views as to the duties of a corps engineer; but there are one or two points with which I feel I can hardly agree:

Under the heading, *Strength and Organization of Corps Engineer Troops,* Colonel Jones intimates that in training areas and under stabilized conditions there is little need for corps engineer troops, and that for this reason they should be available to the Service of Supply. I cannot agree to this fullly, for it should be remembered that the corps troops aggregate nearly the strength of a division, and their demands for engineer work should be met without using detachments of divisional engineers, which is always unsatisfactory, particularly to the division engineer.

In the 4th corps, due to press of work on the corps engineer regiment, a company of divisional engineers from a corps reserve division was detailed on the construction of a corps headquarters. This division was soon afterwards transferred from reserve to a front line sector, and the division engineer was considerably handicapped by the absence of this company until corps G-1 could be persuaded to release it.

As a matter of fact, assistance should always be furnished from rear to front; that is, by the higher units to the lower, and the service of supply particularly should provide its own engineer personnel without depending on divisional and corps troops, for the latter can always be profitably engaged in training when demands for engineer work in their divisions and corps are not pressing.

While I agree that it is in general impracticable for the corps engineer actually to command the corps engineer regiment, I do not believe that another officer of the grade of colonel should be assigned to command the regiment. Theoretically, the corps regiment should be organized as such with an officer in command who is by rank suited for duty as corps engineer. If conditions are such that he can act as corps engineer and command the regiment also, well and good; if not, the actual command can generally be handled by the lieutenant colonel satisfactorily, as he will be under the direction of the corps engineer, and can have the benefit of his advice and suggestions, if necessary. Higher engineer authority should not insist (as has been done) that the colonel of an engineer regiment, who is also a division or corps engineer, actually command his divisional or corps regiment, for as a matter of fact this is a question which should be settled by division and corps commanders, and if they prefer that the colonel devote his time to staff duty rather than to the command of the regiment, higher authority should not interfere.

There is no need, according to my experience, for another colonel of engineers in a corps, and with the suggestion mentioned the September-October, 1919, issue of PROFESSIONAL MEMOIRS that the corps engineer is entitled to the rank of general officer, I have no sympathy, as the latter seems to be based on the idea that the corps engineer exercises something akin to command over the divisional engineers, which is not the case.

My experience as to the availability of the members of corps headquarters troops for small jobs around corps headquarters was the same as stated by Colonel Jones, as there were too many demands upon them to count on a continuous detail for any length of time, and such work was usually carried on by details from the corps engineer or pioneer regiments with supervision by a member of the detachment of the corps engineer officer.

I agree with Colonel Jones, that for such tasks the proper course is to go ahead and do them, and I think it should be impressed on every engineer officer and enlisted man that in the field, in time of war, the poorest possible excuse for not doing something requested is that it is "some other person's job." It is not excuses but results only that count.

With reference to the idea that a corps engineer should be responsible for all the work in his corps area and be given the men and equipment to accomplish the same, I do not consider this sound, but regard it as proper that engineer functions of higher units be carried on side by side with those of lower units at times when conditions render it necessary. It is similar to the case where divisional, corps, and army artillery may be emplaced in the same area; but each has its own function and carries it out practically independently of the others.

Col. Harold C. Fiske

Engineers, formerly Division Engineer 32nd Division, and Corps Engineer, 3d Corps, A. E. F.

Colonel Jones very truly states that at the outset of our participation in the World War the division engineer was a familiar character on paper, but that the corps and army engineers had not even reached a definite paper stage. At the time of the armistice we had had sufficient experience in active field service to make the status of the division engineer definite, not only in theory but also in practice. In the case of the corps and army engineers their duties were rapidly taking shape but their status was then much more indefinite than that of the division engineer. In the case of the corps engineer there had been a sufficient accumulation of actual experience to define very clearly his duties, powers and limitations, and had the war continued another year the position of this officer would have been as well fixed as that of the division engineer.

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With the corps engineer the difficulty arose from a failure to clearly comprehend the difference in the position of a commanding officer and that of a staff officer, and it was felt that the corps engineer had to be given command of a definite unit, the corps engineer troops, in order that he might have the authority to command, which was felt more or less vaguely to be essential. It is well to have such a unit as a regiment of corps engineers to which he may issue orders directly, but this represented a small and comparatively unimportant part of the duties which fell to his lot. In addition to ordering the execution of work by the corps engineers the chief engineer of the corps was responsible for the proper technical solution of all engineer problems arising within the limits of the command of his immediate superior, the corps commander, and this involved direct responsibility for all technical features of the work done not only by the corps engineers but by the division engineers, and also for the competence from a technical viewpoint of all engineer units included in the corps.

Officers are sometimes confused as to just what is meant by technical supervision, or the responsibility for technical details, or the means by which technical supervision is exercised. In the case of the engineers the trouble comes from the fact that practically every officer, irrespective of his branch of service, feels that he is possessed of a certain amount of engineer skill and experience, and staff officers or commanding officers are willing to issue orders involving technical engineer procedure where they would not think of doing so in the case of some of the other technical services. For example, the chief surgeon of a division will receive his patients from the combatant arms of his unit, and the procedure involved in having men sent to his dressing station or hospital must be connected up with the plans for all other branches of service and here staff or commanding officers will express their views. But once a soldier has reported to a medical officer no one other than a medical officer expects to supervise the future treatment of that man as long as he remains within the jurisdiction of the medical department. If he is sent to a hospital no line or staff officer would think of ordering what medicine should be administered, or what operation should be performed, or what instruments should be used in the operation, or at what hospital the operation should take place. In these matters the lieutenants and captains of the medical corps look to their superiors in the medical corps in the division; the division surgeon looks to the chief surgeon of the corps, and the chief surgeon to other medical superiors of higher command. The principle is the same in the engineer service. Engineers are organized and trained presumably to perform certain tasks for which a certain amount of special engineer knowledge, training and skill are essential and these to a higher degree than that found in officers of other branches of the service. Engineers with a division, corps, or army must keep so closely in touch with the co-ordinate branches within their unit that they may be sure that the work which they do will be of maximum benefit to all other branches of the service. Questions pertaining to their engineer training and technique, and to their co-ordination with other engineer organizations in the corps must be supervised by engineer officers and engineer officers only. It is in this special field of technical engineering that the chief engineer of a corps represents the corps commander, and relieves that commander of all anxiety for, or personnal supervision of, technical details. Within this field he must possess the corps commander's confidence to such an extent that he can without question issue in the name of the corps commander any orders to engineers or to division commanders which are necessary to the proper functioning in technical matters of all engineer troops in the corps or its divisions. It must be emphasized that this does not in any sense give him an independent command or diminish the command of any other officer. It simply causes him to act as all staff officers should act. He becomes, if you will, the engineer portion of the corps commander's brain, and he should keep so closely in touch with all other portions of this commander's brain or staff that he will not issue an order within his sphere which is not harmonious with all orders which may be issued in all other spheres.

This may sound complicated and difficult to put into practice but, as a matter of fact, it is simple and easy and is the only way in which the chief engineer or any other staff officer can function efficiently. With this conception of the corps engineer's position in the general scheme of things the details of his duties flow very naturally, and his relation to the various parts of his organization has been well stated in this paper.

In the matter of training of engineer troops, it is believed that the chief engineer of the corps had not yet found his proper place. A corps is a large organization and often covers a considerable territory. The engineer problems in one corps may be different from those in others, and the officer best informed on the training necessary for the engineers in a given corps should always be chief engineer of that corps. In the A. E. F. there were in existence what were called corps schools; but these schools were actually located at points remote from the rest of the corps and were in no way in direct touch with its daily problems and experiences. Corps schools in general, and the corps engineer school in particular, should be so located as to be readily accessible to the corps staff, and the chief engineer of the corps should be so thoroughly in touch with the army and its policies above him, the division and its needs below him, that under his personal supervision this school will give the engineer instruction most needed within his jurisdiction. This school should preferably be as accessible as are the divisional engineer regiments of the corps. The corps engineer should be as familiar with what is going on, and with what is being taught in the schools as he is as to what is being done within the divisions, this school should be under his technical supervision to the same extent as are the divisional engineer regiments, and it should respond as quickly to the changing needs in his front as does any other part of the corps organization.

The chief engineer of our corps which served with the British is quoted as saying that the corps engineer should be able to furnish all connecting facilities between the divisions at the front and the service of supply in the rear, thus eliminating the army engineer as a commander of large numbers of troops. If the thought underlying this statement could have been generally accepted in corps, army and S. O. S. Headquarters, it is believed that the efficiency of the engineer service at the front would have been greatly increased. At the time of the armistice our army headquarters had not yet learned how actually and practically to sub-divide its duties among the corps and to utilize the abilities, the organizations, the knowledge, and the strategic positions of the corps engineers to anything like their full value. As has been pointed out in this article, there were thousands of engineer troops doing work important to the corps and divisions who looked only to the army engineer for orders and direction. At the same time each of the three corps engineers was much closer to the work, in more immediate touch with the work of these troops, with the local needs and resources, and had a more just appreciation of the rapidly varying demands upon the engineer services, yet the corps engineers were operating with a comparatively small number of troops under their command and they had no authority over army engineer troops doing

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work in their area for which their corps commander held them primarily responsible. They were unable at times to give the prompt assistance to their division engineers which was necessary, and were forced into difficult expedients where had they had more authority and more troops under their immediate orders the necessary results would have been attained without particular difficulty. To a still greater degree was a similar liaison between the army and the S. O. S. lacking. During the last phase of the Meuse-Argonne the engineer troops under the immediate orders of the army commander represented the last available supply. There were plenty of engineer troops in the S. O. S. It is to be presumed that many of them were engaged on work which for the moment was of less importance than was that in the 1st Army upon which the rate of pursuit of the enemy by that army depended, yet there was no definite and sure means by which additional troops could have been brought for the emergency from the S. O. S. to serve in that army.

In the final perfected army the chief engineer of the army will keep in close communication with the S. O. S. His arrangements will be such that in periods of emergency the engineer organization of the S. O. S. will bend all of its energies to furnishing him with supplies and engineer troops to the limit of its ability. Of these the army engineer will retain under his own orders a rather small percentage for service in an area extending from about army headquarters to the vicinity of corps headquarters. The larger part of these resources of men and materials will be divided up among the corps engineers, each of whom will retain a moderate percentage for use in an area extending from wherever the army troops stop working and not far from corps headquarters up to the division engineers and the general neighborhood of division headquarters. These corps engineers will have their corps dumps of engineer material for distribution in their corps area subject to a minimum of restriction from the army, and they will have within reasonable limits a reserve of engineer troops also subject to use in corps areas or at times for re-enforcing the division engineer. Of the supply of men and material received by the corps engineer and by the army engineers a certain amount will be distributed to the division engineers according to their needs.

In general, the division is a unit which moves at short notice if necessary. It therefore keeps its surplus of engineer supplies and the number of its engineer re-enforcements to a minimum. The corps is a slower moving unit and remains in one sector while divisions come and go. The corps engineer then can maintain a reserve of engineer material and re-enforcements, the stocks at hand being proportioned in each case to the probable needs of the immediate future, looking ahead for a week or a month or more depending upon circumstances. The army is still more permanent in location than the corps and has its reserves of engineer material and troops. It furnishes a place to which, if necessary, the corps reserves may be withdrawn when the corps moves and does not take such things with it. Such moves, however, do not occur at very short notice, and in general the bulk of these reserves can be kept distributed among the corps.

The above sketch of the perfect army is not quite as fanciful as it may sound. In the Meuse-Argonne, in the matter of engineer material, for example, there was a large engineer dump in the vicinity of Souhesme, and there were what were called advanced army dumps at Les Islettes, Aubreville, and Dombasle. These three advanced dumps were located one in each of the three corps areas into which this army area was divided and prior to this operation were theoretically stocked with the engineer materials needed in that corps. In other words, we had here the three corps dumps in everything but name and a sufficient degree of authority over them on the part of the corps engineer. Had these been formally turned over, one to each corps engineer, with the necessary personnel to handle them and to replenish them from the army dump at Souhesme the matter of engineer supplies during this campaign would have been handled even better than it was, and it will be noted that the only change needed from the existing to the proposed condition was a change on paper ordering dump commanders to report to the chief engineer of the corps instead of the army. As for the army engineer troops, it needed only an order to assign them to the corps engineers. Had this been done the army engineer would have been relieved from the responsibility for a large and difficult task—the immediate direction of so large a body of troops and the corps engineers would have welcomed their share of this responsibility because of the greater efficiency it would have given both to them and to these troops assigned to them.

Assuming that the corps in the future remains similar in composition to that found in the A. E. F. at the close of the hostilities it will consist of about four divisions in active service, one depot or reserve division, certain corps troops, and a corps school. The engineers in this corps will consist of six or more regiments, one with each of the five divisions and one or more regiments of corps engineer troops, and the engineer section of the corps school. The duties of the chief engineer of the corps will be:

(1) The solution of all engineer problems encountered by the corps.

(2) To see that division engineers solve their engineer problems correctly, each in his own division.

(3) That all work together harmoniously with each other and with all other troops for the carrying out of the whole engineer plan of the corps.

(4) That all these engineer units are properly trained and equipped in technical matters.

(5) That the engineer supplies needed in his corps are in the corps' depot in time to be distributed among the divisions and corps engineers.

(6) That each obtains his share at the proper time and in the proper amount.

(7) That his supply of corps engineer troops is sufficient and their distribution is suitable for the needs of the operation at hand.

(8) That their work ties up properly with the work of the army or S. O. S. engineers in rear and that of the division engineers in his front.

(9) That additional engineer troops are loaned to or withdrawn from divisions in accordance with the best interest of the progress of engineer work.

It would seem that merely to state these duties is sufficient to demonstrate that the chief engineer of the corps cannot be burdened with the duties of the immediate commanding officer of any individual regiment, and further that he needs a permanent staff to help him carry out these duties. It might further be added that the magnitude of his responsibilities and the number of troops over which he exercises either complete or technical command is so great that the rank of a general officer would not be inappropriate.

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Col. J. L. Schley
Engineers, formerly Division Engineer, 82d Division, and Corps Engineer 5th Corps, A. E. F.

In commenting on Colonel Jones' paper on the duties of a corps engineer, comments will be arranged under the same headings.

The subject is very clearly and logically treated by Colonel Jones. I feel that the only useful additions that I can make are ideas formed from my own experience and emphasis of certain features.

Relations between Division, Corps, and Army Engineers

Since the practice of most of our senior commanders had not been ripened by experience in command of large units in war and had not been standardized by training in peace, it is natural that methods varied in the several commands. Experience was crystalizing their opinions as the war progressed, but the influence of the several foreign armies with which we served and the widely different conditions under which the units operated failed to develop uniformity of practice.

My own experience was that the corps commander held the corps engineer responsible for all the engineer operations of the corps. This included the engineer operations in the divisions of the corps. In other words, he expected the corps engineer to keep him informed of engineering conditions, to see that engineer material was supplied, and to see that necessary and adequate engineering operations were accomplished. If the corps commander's assistance in authority or troops was needed for their accomplishment, he expected to be called on in time to furnish them. If the jurisdiction of the division commanders was involved, the corps commander expected the corps engineer to consult him or his chief of staff. He expected further to be kept informed of the instructions received by the corps engineer from the army engineer, required that they be complied with unless they interfered or conflicted with his own plans, in which case he required that he or his chief of staff be consulted before action was taken.

This was an entirely satisfactory method of procedure from the point of view of the corps engineer. It placed full responsibility where it belonged, and it gave the corps engineer a definite status and ample authority to perform his duties.

In determining whether or not proposed plans of the corps engineer infringe on the province of a division commander, the corps engineer finds it necessary often to rely on the division engineer. The division engineer should keep himself so thoroughly informed of the division commander's plans that he can inform the corps engineer whether proposed operations will interfere with those plans. If they do, it is a matter of judgment whether the next step should be a conference with the division commander or with the corps commander. The former is preferable when practicable. In a matter of considerable magnitude or great importance, my experience has been that the matter should be taken up by the chief of staff of the corps with the division commander or his chief of staff. This kills many birds with one stone.

Colonel Jones has discussed this subject with special reference to the use of divisional engineer troops as combatant troops, but interference with the plans of the commander of the next lower unit may involve purely engineering plans only.

Strength and Organization of Corps Engineer Troops

While it is true that in most cases under stabilized conditions there is no urgent need for a full complement of corps and army engineer troops, and the service of supply will have great need of such troops, yet it is important that the full complement be located in that part of the service of supply area which is near at hand in order that these troops can be concentrated promptly and made available to their proper commanders.

The problem of determining the proper strength and organization of the corps and army engineer troops is one most difficult of solution. In an offensive under the conditions in France in October and November of 1918, the number of engineer troops needed by all commanders was beyond any reasonable estimate. At the time, I felt that the corps engineer and pioneer troops were either too few or too many. There were available in the case in mind one regiment of sapper engineers and ten companies of pioneer infantry. As the advance progressed, the division engineers reported to the corps engineer each night the rearmost points on the main roads which could be covered by the divisional engineer troops for the following day. Likewise, the corps engineer reported to the army engineer the rearmost points which could be covered by the corps engineer troops. And the parts of the roads to be worked on by the corps engineers were assigned to the companies in conference that night. The rapid advance of the front lines made necessary the daily advance along the roads of the corps engineer troops. This meant that only temporary repair work could be undertaken by any troops except the army troops and those of the service of supply. And it often meant that rapid movements had to be made by the army engineer troops to take up immediately important work which had to be abandoned by the corps troops. This proved difficult to accomplish and resulted in the assignment by the army engineer of additional engineer units to the corps. The armistice prevented a thorough trial of this plan. In the absence of further experience, I should recommend the same organization as we had for service in similar kinds of warfare. The strength can be varied at the time to meet conditions. I should not recommend placing the road work in the corps and army areas under the service of supply. It seems to me to be an unnecessary division of responsibility, in principle at least. I believe that army headquarters should form the contact with the service of supply for all purposes.

Work to be Done

I wish merely to emphasize under this head the very important part which the division engineer and the corps engineer must take in prescribing traffic routing and regulations. So far as I know this was done without exception by G-1. The subject is too intimately connected with the problem of keeping the roads open to allow the decision to be made without taking this problem into consideration. If it comes to a show-down, the Commanding General must be appealed to in order to make certain that the routes selected can be improved and kept open.

Training

If the corps organization is in existence during the training, general instructions concerning the training will naturally be issued by corps headquarters. The corps engineer should see that these instructions contain the essential general requirements for engineer troops, and limited engineer training for infantry.

Relation with Corps Staff

Under present conditions, it is necessary that the chief engineer create a position for himself at headquarters. He knows that proper plans for military operations cannot be made without full consideration of the engineering fea-

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tures, and he knows that he is in the best position to advise on such features. If plans are made without such consideration, he will most probably be required to do the impossible when the time for execution arrives. He knows that changes in the plan as the operations develop must depend largely on engineering features, and he should be best posted on the development of these features. He must accordingly be consulted and, in my opinion, should be present at the conferences of the general staff officers. He must create this position for himself if it is not done automatically. Since this requires a man of ability, force, and tact, the officers designated as chief engineers of the combatant units should be selected with the greatest care.

In connection with, and as an important element in accomplishing the results described above, I wish to emphasize the advice of Colonel Jones that the chief engineer must be "beforehanded" in his information, his plans, and his work.

Col. Jarvis J. Bain
Engineers, formerly Corps Engineer, 7th Corps, A. E. F.

The writer served as division engineer during the closing days of the Meuse-Argonne offensive and on the march into Germany, and as corps engineer of the 7th Army Corps from February 8, 1919, until May 21, 1919, inclusive. During this time the 7th Corps held the reserve position of the Coblenz bridgehead as a part of the American Army of Occupation, with Corps headquarters in the small city of Wittlich, Germany.

The writer's ideas of the duties of the engineer of a corps during combat and movement have therefore been determined chiefly from the standpoint of the division engineer.

It is believed that Colonel Jones in his article has covered splendidly the general duties of the Engineer of a Corps, and few exceptions can be taken to the statements which he makes. In fact, about the only criticism that occurs to the writer is that, in order to cover the entire field in the short paper, Colonel Jones has made his article entirely too general. In reading the article the idea occurred to the writer that during the time he served as engineer of a corps he had totally failed to appreciate the snap which the fortunes of war had permitted him to enjoy.

The question as to proper distribution of engineer work for an army in the field between the service of supply, army, corps, and division, is a vital one. In a stabilized sector proper co-ordination of engineering activities is much simpler than during field movements either forward or to the rear. There are two possible ways of dividing engineer activities for an army in the field. The first is a territorial division and the second is division based upon the nature of the engineer duties to be performed. It is believed that any system based upon one of these methods to the exclusion of the other would necessarily fail in campaign, and that any successful scheme must be some combination of the two, in other words, based partly on territorial distribution and partly on the nature of the duties to be performed.

The critical point in engineer operations, the same as in the operations of the army as a whole, is the firing line, and all the energy of the engineer organizations from rear to front should be utilized to facilitate the operations of the men on the firing line.

During the Meuse-Argonne advance fully 90 per cent of the work of divisional engineer troops was road and bridge repair and construction. This work was very heavy and in the experience of the writer the division engineers were not able to keep up with the advancing infantry unless they were rapidly relieved from the rear by corps troops. The point where this relief was effected varied according to the exigencies of the moment. As a general rule corps and army troops should at all times take over all engineer construction in rear of division headquarters, and divisional troops should endeavor to perform all engineer duties in advance of their own Division Headquarters, but should not be called upon for any in rear thereof.

The engineer of a corps is in position to be of great assistance to division engineers, and if his co-ordination of engineer work as listed among his duties is carried out with a sincere and energetic desire to co-operate in producing results, there is no excuse for any friction with division commanders. The writer, as division engineer, secured at all times most highly beneficial co-operation and help from the corps engineers under whom he served. It was noticeable, however, that better results could always be obtained by personal interview than by interchange of written or telephonic messages. A division engineer with his troops is working at all times for the good of his division. If he can assure his division commander and members of the division staff that the corps engineer is co-operating with him and rendering all assistance possible, the division commander will not resent the efforts of the corps engineer to co-ordinate engineering activities.

Neither the enlisted nor commissioned strength allowed the corps by table of organization in the A. E. F. were sufficient for conditions as they existed in the 7th Corps in Germany. Upon reporting for duty the writer found an office organization with one of the commissioned assistants in charge of operations, one in charge of administration and office, and the third in charge of supply. This distribution of duties, considering the number of officers available, is considered proper, and was continued until the 7th Corps left Germany en route to the United States. The operations, however, were so varied and so numerous that one officer was not able to handle all of them, even with the direct assistance of the corps engineer, and it was necessary to draft both the administrative and supply officers for some of the duties of the "operations officer." This interfered with the full performance in their own departments of duties which were sufficient to require their entire time, but the sacrifice was accepted as the lesser of two evils. In addition to utilizing these officers it was necessary for the corps engineer to withdraw from the corps engineer regiment officers for supervision and inspection duties under his immediate command when the services of these officers were badly needed on the actual construction work being carried on by the regiment. It was also necessary to secure at all times by detail from the engineer troops enlisted men for administrative and technical duties, which could have been better performed by personnel from the corps engineer detachment if suitable personnel had been available. In addition to the major and two captains allowed as assistants to the corps engineer, there should be four 1st lieutenants.

In the early period of the American occupation of Germany engineer operations were seriously handicapped by two difficulties. The first of these was the inability to secure engineer materials. The second was the disinclination on the part of the engineer personnel, both officers and enlisted men, to perform work energetically. That portion of the Rhineland occupied by the American troops was largely agricultural, and manufactured articles were hard to obtain. One of the early difficulties was that connected

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with the supply of lumber. It was necessary for the engineer troops to take over the operation of such small saw mills as existed. During the closing days of actual hostilities we captured a large number of engineer dumps plentifully stocked with a well selected assortment of engineer construction material. It was not possible, however, to transport any of this material with the troops on the expedition into Germany, and as engineer priority was lost with the termination of fighting, all available transportation was used for food, clothing, equipment, etc. The American engineer officer and soldier performed his duties before the armistice under almost insurmountable difficulties in a manner that was truly wonderful. He did all manner of jobs with an enthusiasm and tireless energy that secured for him the admiration and praise of all other troops in the combat zone. In many cases where divisions were withdrawn from the lines the engineer troops were left in and continued their operations. Corps engineer troops remained on the line practically continuously. When the armistice went into effect the limit of endurance had almost been reached and the engineer personnel was worn out. With the incentive of fighting removed it was natural that the engineer should to some extent lose interest in his work, and long for an early return to the United States, and this was characteristic of all that part of the American Army of Occupation which was under observation of the writer. Both these adverse conditions, however, were overcome, and by the 1st of March, 1919, supplies were reasonably plentiful and the engineer officer and enlisted men had recovered their morale and were producing results satisfactory to all concerned.

By far the most troublesome work of the Engineer of the 7th Corps and his assistants in Germany, was the road work. The corps occupied an area of more than 2,000 square miles. In this area were almost 700 miles of highway subject to military use and about 350 miles of these roads were actually repaired or reconstructed by the engineers of the 7th Corps and of the 89th and 90th Divisions. The corps engineer with the corps troops assumed charge of road operations on the Wasserbillig-Trier-Wittlich-Alf Road, which traversed the corps area from southwest to northeast and carried all the heavy through traffic of the army. This road was designated as the corps axial road. Each division engineer under his division commander was made responsible for all the roads in his divisional area except the corps axial road. The German roads were a great disappointment structurally, and their upkeep and maintenance was a trying problem during the winter and spring. Apparently the Germans have depended upon their wonderful strategic railway system for heavy through traffic and have built their highways to serve only the local traffic, which consisted principally of a few ox-carts on short hauls to the nearest railway station. Practically every village in the 7th Corps area, no matter how small, was reached by a railroad line. Considering the character of the country, which was purely agricultural, it is not possible that the traffic of these villages could warrant the building of these railroads to them from a commercial standpoint, as we view such matters in the United States. The highways that were metalled were smooth and had been well kept, but the metalling was very thin, consisting usually in a surface coat of from three to six inches, well rolled in place. The heavy service that these highways rendered during the retreat of the German Army and the advance of the American Army practically ruined them. During the spring thaw the lightly metalled roads gave way under heavy truck traffic, and long stretches of road had to be entirely reconstructed. The patch-work methods which were so successful on the heavily metalled limestone roads of France gave only temporary relief in Germany, and in many places even where a thickness of 2 feet of metal was put down with a base of large stone placed on edge, Telford fashion, such work had to be renewed several times within a period of a month. The subgrade of the road, under the constant pounding of army motor trucks, became a sort of a jelly and the road failed in most cases by heaving upward at the middle instead of downward under the wheel tracks. The roads of Germany are very narrow and were properly constructed only for one-way traffic of the kind which an army imposes. The use of these roads as two-way roads increased the difficulties of the engineer to a remarkable extent. As Engineer of the 7th Corps I worked up a circulation system for the corps area. This circulation system, however, was never presented to the corps staff because it would have required co-operation with the corps adjoining the 7th and also with the 2nd Army in our rear. It is believed that in such cases a general circulation system should be prepared by the army and adhered to by the corps and divisions in their own areas, each corps and each division forming its own local circulation and traffic systems within its area based upon those of the army.

In addition to the road work the 7th Corps Engineers were very busily engaged in the supervision of the operation of utilities, principally water supply and lighting plants, in the construction of target ranges, barracks, kitchens, mess halls, and stables for the use of the various organizations in the corps. Considerable work was also done in the preparation of grounds, construction of band stands, grand stands, etc., for various athletic fields, horse shows, etc. Several leave and rest camps were erected and a huge re-mount station, to hold about 20,000 animals, was a rush job which was with difficulty completed in time for the engineer and other troops engaged thereon to return to the United States with their organizations. In the operations carried on by the engineer, 7th Corps, a great handicap was the entire absence of labor troops. It was necessary to use engineer soldiers as common laborers when their services would have been much more valuable as supervisors, mechanics and skilled laborers. It was also necessary to secure details from other troops for practically all construction, and such details were secured only with great difficulty.

The rule of the American Expeditionary Forces which required that the engineer of the corps also command the corps engineer regiment is a mistake, and it is not believed that such rule was followed out in any of the corps of the Army of Occupation. If the corps engineer attempts to command the regiment, then the corps commander is deprived of a necessary staff officer. The engineer regiment should have its commander who is responsible for the discipline and administration of his regiment and also responsible for such construction duties as are assigned by the corps engineer.

The writer believes that such duties as are called camp utilities by Colonel Jones are properly the work of the corps engineer and not of the headquarters troop, as stated by him. These duties should by all means be looked after by the engineers. They are usually small jobs, comparatively speaking, but their performance or nonperformance is noticeable to the commanding general and all members of the staff. An engineer who does these small matters promptly and well will naturally have the confidence of his associates on the corps staff. He who neglects them will perform his other duties with a handicap due to lack of confidence.

The relations with the corps staff are believed to have been well stated by Colonel Jones. In these relations it is probably impossible to entirely avoid the personal ele-

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ment in either G-1, the engineer, or both. The secret of success is to keep G-1 informed at all times, to talk with him informally and frequently on all engineering subjects, and to make him an office partner in the execution of engineering projects. The engineer who has the confidence of his commanding general, chief of staff, and G-1 will be able to perform his engineering duties without non-technical interference and will be permitted to make recommendations on engineering subjects. The engineer who has not this confidence will receive orders on engineering matters and the orders will be so worded as to limit him in the execution of work from an engineering standpoint. Most of the difficulties encountered by the writer in his relations with the corps staff were not with the chief of staff or G-1, with whom he worked, but with their subordinates. On one occasion he received a direct order to construct a building and was furnished as a part of the order of construction a detailed bill of material and instructions for the organization of the force on the work. This order came from a subordinate of G-1 and was promptly withdrawn when the matter was taken up personally with the officer who had sent it. The writer has also knowledge of one case where a division engineer was ordered to undertake a large construction program, the preliminary operations for which would have required several weeks, for the use of his division, when it was definitely known that the division would vacate its area and the construction therefore be useless within two weeks from the time when the order was issued. It has seemed to the writer that G-1 in the American Expeditionary Forces, both division and corps, had too many assistants. These assistants were bright and energetic young men, but usually not engineering or other technical specialists. In a praise-worthy effort to find something to do they sometimes lost sight of the co-ordinating nature of their duties as prescribed, and attempted to take direct and personal charge of engineering operations. The writer in his service as division and corps engineer had to resist the efforts on the part of subordinates of G-1 to take over his engineer subordinates and perform engineer work, thus eliminating him as the director of such work while he felt that the responsibility still remained with him and particularly so in the event of failure. It is essential to the proper performance of engineering operations that such operations be kept continually under the direct control of the senior engineer officer in the organization involved. It is believed that it would be preferable, instead of having subordinates of G-1 to look after engineering operations, to have a subordinate of the chief engineer or division engineer in the office of the G-1 as liaison officer pure and simple between the engineer and G-1. This liaison officer would be available at all times to report to G-1 the condition of works when the engineer was not available, and could present all engineering matters from an engineering standpoint and in accordance with the engineering desires and intentions of his own superior officer. Many of the unpleasant episodes which occurred in the relations between the corps engineer and other members of the corps staff were due to the fault of the engineer in either failing to require the energetic performance of engineering work or by neglect or failure to present engineering matters in the proper light to G-1 or to the chief of staff.

The most discouraging feature of the engineering activities of the writer in Europe, both as division and corps engineer, had to do with the entirely inadequate transportation facilities which he was able to obtain to perform the work at hand. It is extremely difficult to convince an officer who is not an engineer, or even an engineer officer who is not personally acquainted with the work at hand, that all military engineering jobs require a large amount of transportation. The writer was enabled to secure a fair amount of transportation at times when no one else needed transportation. At other times it often seemed to him that the engineers were discriminated against in the distribution of transportation, even considering such distribution to be made on a numerical or proportional strength basis, while it is certain that the demands of the engineers, if their work is to be properly performed, require much more than their numerical proportion of the available transportation. The work of the engineers is necessarily widely separated and 75 per cent of the successful operation of this work is proper reconnaissance prior to its undertaking, and supervision and inspection by engineer officers and higher non-commissioned officers. Such reconnaissance, supervision and inspection require an amount of transportation which seems excessive to everyone except the engineers involved. It is the fixed opinion of the writer that no system of furnishing transportation to engineers will be satisfactory unless the engineers control their own transportation.

The duties of a corps engineer follow naturally from a consideration of the mission of engineers in a military force. This mission has been most admirably expressed by an engineer officer in somewhat the following words:

The mission of the engineers in any military force is to plan and execute all constructions, to facilitate the operations of the rest of the military force.

Based upon this mission the writer believes that the engineer of a corps should classify his duties somewhat as follows:

1. Close personal liaison with corps staff.
2. Seeking things to do.
3. Organization of available forces and assignment of duties.
4. Close and energetic personal supervision.
5. Informal and non-technical reports.

Col. L. H. Callan

Engineers, U. S. Army (National Guard), formerly Division Engineer, 32d Division, A. E. F.

Colonel Jones has covered the ground well. Two points within the writer's experience are worthy of mention. The corps should not take possession of the division engineers during the *entire* time the division is out of the line. Engineers need rest and recuperation as well as disciplinary instruction; as much or nearly as much as infantry. Divisional orders are issued covering general cleaning up and training during rest periods. But if the corps has taken over the engineers it is impossible for them to comply with the orders, and upon their return to the division when it is again called to enter the line the engineers have not been properly refreshed, and there is usually some criticism of their appearance. In the Meuse-Argonne the writer's regiment (107th Engineers) went in on the night of September 26 and was not relieved until the end of the war (November 11), although the division came out of line twice.

Engineers should be thoroughly trained as infantry for defensive operations, and used for such only in grave emergency. They should never be used in line for an offensive.

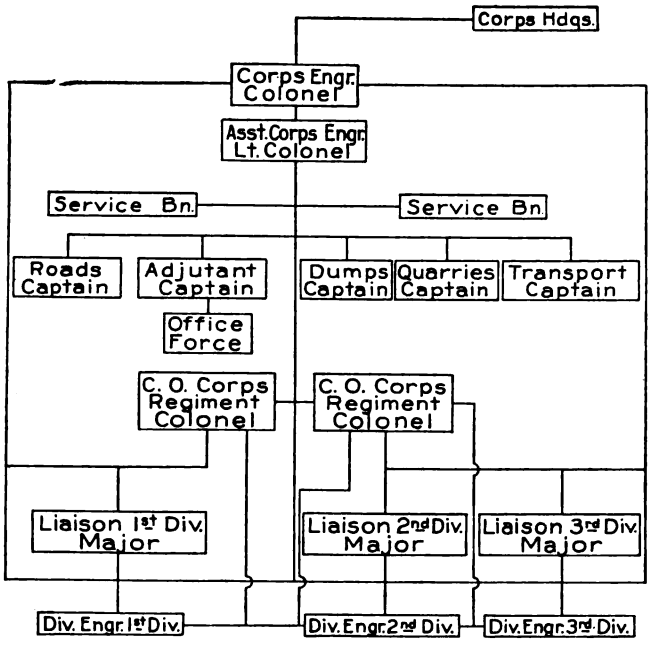
Lt. Col. J. Edward Cassidy

Engineers

The following remarks on corps engineer organization are based on the operations of the 1st Army Corps in the Meuse-Argonne sector from September 26 to November 11, 1918. These operations were conducted on all kinds of terrain, extending from the lower part of the Argonne Forest to a point just below Sedan, a distance of approximately

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50 kilometers. The necessity for a more thorough organization of the corps engineers was fully emphasized by the experiences of these operations. The following chart shows a plan for an organization that would develop the activities of the corps engineers to the fullest extent, and which would be capable of meeting any conditions of service.



In connection with the execution of the corps engineer operations, the following points cannot be too strongly emphasized:

(*a*) The corps engineer must be an officer of broad experience, energetic, of quick decision, and not afraid to assume responsibility; to advise his commander or any members of the staff, or to issue definite instructions to his subordinate officers.

(*b*) The corps engineer as a general rule must remain at corps headquarters where he is accessible to the corps commander and his staff, and where he can be reached at all times by the commanding officers of corps engineer units. When his absence from corps headquarters is imperative, there must be an assistant on duty, who is an officer of wide experience, capable of acting for his chief, and who is fully informed of all the plans of the corps.

(*c*) All engineer troops or labor battalions operating in the Corps sector, excepting the divisional engineers, must come under the jurisdiction of the corps engineer.

(*d*) Specialist engineer regiments should not be used as corps troops although regiments assigned as corps regiments should be furnished special equipment. It is necessary that the corps engineers should be fully cognizant of all features pertaining to the operations of division engineers, and prior to being assigned to a corps should have experience at the front as divisional engineers.

While the line of demarcation of duties cannot be closely drawn between the division and corps engineers, the line can and should be sharply drawn between the corps and army engineers. The army engineers are more in the nature of specialists, and are too remote from the actual combat operations to appreciate fully the military necessities which always confront the division and corps engineers. In the Argonne-Meuse operations, the army engineer officers were to a large extent men from civil life who had not even had the advantage of a military training camp experience, and could not fully appreciate the military necessities of the situation. The success of an operation rests primarily with the division and corps engineers so far as the Engineers are concerned, and in a normal advance under average difficulties the greater burden of work will fall on the corps engineers, as the work of the divisional engineers will largely consist of assisting the infantry and blazing a way for the corps engineers to follow. It developed in the Argonne-Meuse operations that very often the divisional engineers were not able to open roads for the 75's, so that the burden of getting the divisional guns, ammunition and supplies forward, was on the corps engineers. The forward movement of the supporting corps artillery can follow only as the work of the corps engineers progresses. The tendency of the division G-3 to employ the divisional engineers as infantry, places an additional burden on the corps engineers who have to take over the divisional work as well as their own.

The organization of the corps engineers must be so constituted as to function to the fullest extent or its mission will not be accomplished, and a break-down at a critical period may mean defeat in a tactical operation. The old adage that if a thing is worth doing at all it is worth doing well, is particularly applicable to the organization of the corps engineer.

Combat Strength and Losses, A. E. F.; Figures Compiled by Statistics Branch, General Staff

Battle strength	1,300,000
Wounds	205,690
Deaths	49,498
Total battle casualties	255,188
Per cent battle casualties to battle strength	19.6

DATA BY ARM OF SERVICE.

	Infantry	Artillery	Engineers	All Others
Total battle strength	737,000	207,000	96,000	257,000
Battle strength percentage	57	16	7	20
Total battle wounds	183,369	10,110	6,945	5,266
Battle wound percentage	89.1	4.9	3.4	2.6
Battle wound percentage of total battle strength of that arm	24.9	4.9	7.2	2.0
Total battle deaths	44,889	2,039	1,256	1,314
Battle death percentage	90.6	4.1	2.5	2.8
Battle death percentage of total battle strength of that arm	6.1	0.9	1.3	0.5
Total battle casualties	228,258	12,149	8,201	6,580
Battle casualty percentage	89.4	4.8	3.2	2.6
Battle casualty percentage of total battle strength of that arm	31	5.8	8.5	2.5

For same strength, Infantry casualties are—
5.4 times as great as Artillery.
3.8 times as great as Engineers.
12.4 times as great as All Others.

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Soldiers First?

By

Col. Ernest Graves

Engineers

THE article by Colonel Lee in the last number of THE MILITARY ENGINEER contains some fundamental principles which are correctly stated, but I cannot agree as heartily with his views as to the application of these principles. Man is an animal, a dog is an animal, but a man is not therefore always a dog.

The general principle that there should be one man in a definite territory, who is responsible and who is supreme, as a general principle, is good. We have the same principle in the administration of engineer work. One local engineer should supervise buildings, roads, water supply, etc., and be supreme over all. However, there is a limit to this. Anything that is carried to extremes becomes absurd. If the local engineer puts a pipe-fitter in a house to install a water pipe, he doesn't permit the carpenter who is building the house to order the pipe-fitter to leave his work and nail on plank for the carpenter. Just in the same way there is a limit to making army command entirely territorial. We all know that the division commander is supreme over all parts of his division; however, we doubt if this territorial supremacy of command ought to be carried any farther down. When the command is small enough to be properly supervised by one man it is unnecessary to carry the principle any farther.

The principle is again in question when we consider army special troops. The army authorities may desire to keep certain roads in condition for the entire army. Corps or a division may occupy, only temporarily, a certain sector. The commander of this corps or division is principally interested in his mission, and he will take no chances on falling down in that mission. What he leaves for the succeeding corps or division is of secondary importance to him. It is doubtful if he should be permitted to take auxiliary army troops to help him accomplish his mission. His job is certain to be most difficult and the decision as to whether such auxiliary troops are unnecessary is certain to appear to a division or corps commander only one way. The general principles laid down by Colonel Lee need some qualifications.

It is believed that when auxiliary troops are sent by a higher command into the territory occupied by a lower command for a specific purpose, they should be assigned to the lower commander with a restriction as to what they are to do. It should be stated that they are to remain in the territory and be transferred to the relieving command. If the lower command uses them properly, the scheme will work well; if they are not properly used, the higher command will have to keep independent command of them. Of course, if the lower command remains in one territory continuously, its authority over everything in that territory should be supreme in general. However, there are times when even this authority has to be qualified. For instance, a section of the S. O. S. in France sometimes contained a production which supplied both that section and the entire army. In this case the control of the producing forces by a section commander had to be qualified. In theory the section commander could be made responsible for the production and supply to the rest of the army. Practically, it wouldn't work, because a combination of red tape, and the "hogging" of the supply by that particular section left the rest of the army in the lurch. The qualifications necessary depend upon personalities of commanders. Regardless of theory, practically this cannot be avoided.

The above observations are made by a "progressive," not by a "conservative," despite the intimidating challenge contained in the last paragraph of Colonel Lee's article. They are also made by one who has had to get things done, not merely "supreme ly command" some one else to do them.

Value of Scientific Highway Location in Shortening Distance

In the past we have been too prone to build or improve roads along old established lines. The cost of new bridges, new rights of way, new cuts and embankments has been fully realized, but the saving effected by a shortening of the routes between centers of population has too often been overlooked. If we assume that, on the average, a saving of one mile of travel is worth 10 cents to every vehicle passing over the road (a very conservative figure) we have the following astonishing results:

Value of a Mile Distance Saved

No. of vehicles per day.	Saving to owners per year.	Value of saving capitalized at 5 per ct.
100	3,650	73,000
250	9,125	182,500
500	18,250	365,000
1,000	36,500	730,000
5,000	182,500	3,650,000
10,000	365,000	7,300,000

These figures, which are characterized by their compiler as "unassailable," prove that on any route which can be dignified by the title of "highway," first cost of construction is a secondary, almost insignificant matter, compared to distance.

The same economic principle is quite as applicable to all other routes of transportation.—*Eng. News-Rec.*

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Retirement of Colonel Townsend

Col. CURTIS McD. TOWNSEND, Corps of Engineers, U. S. A., was retired from active service, February 15, 1920, at his own request after more than 44 years of service.

He was born in Brooklyn, N. Y., March 22nd, 1856, graduated from the College of the City of New York in 1875, and from the U. S. M. A., West Point, in 1879.

Col. Townsend's entire service was with the Corps of Engineers, in which he attained the grade of Colonel in 1906. By his retirement the Corps loses one of its most brilliant, distinguished and industrious members.

During his long and active career Colonel Townsend was engaged on many important projects of river and harbor improvement in the United States and its outlying possessions. He rose to international fame as an authority on all subjects connected with waterway improvements and water-borne transportation, flood prevention and other allied activities. His numerous lectures, essays, monographs and articles on waterways have been published in professional journals, society proceedings, etc., throughout the civilized world, and constitute an encyclopedia of authoritative information on all matters to which he turned his attention in the performance of his duties.

Early in his career Colonel Townsend was engaged in the improvement of the Mississippi River, and his last assignment with the Corps was as President of the Mississippi River Commission. The great river was his chief interest in life, and he is better acquainted with the characteristics, peculiarities, habits, and the many and varied problems connected with its improvement than any other living man.

Amongst other notable public works with which Colonel Townsend was actively identified are the American harbor at Manila, P. I., and the great locks at the "Soo." The modern port of Manila was developed under his direction, and brought out in most striking fashion the progressive methods of American engineers in contrast with the more conservative procedure of Europeans. The largest American lock at the "Soo" (Davis lock) was built by Col. Townsend.



Col. Curtis McD. Townsend
Corps of Engineers, U. S. Army

His devotion to waterway improvements and his pre-eminence in the field of civil engineering did not cause Col. Townsend to forget that he was a soldier, nor prevent his active participation in the two wars occurring during his career. At the outbreak of the war with Germany he by his own personal efforts created and organized the 12th Engineers, and embarked for the theatre of war in command of his regiment. This was one of the first American units to reach the battle-front, on August 21, 1917. Attached to the British Army, the 12th Engineers, under Colonel Townsend's command, took part in the great Cambrai offensive in the fall of 1917.

Colonel Townsend continued at the front in command of his regiment until February, 1918. At this time the urgent need of a qualified man as Engineer Purchasing Officer for the American Expeditionary Forces, resulted in his being called to Paris to fill this important post, for which his wide experience in construction had so well fitted him.

Colonel Townsend remained with the American Expeditionary Forces in France until the end of the war in November, 1918. He then returned to America and resumed his duties as President of the Mississippi River Commission.

In recognition of his splendid services as a commander and administrator he was elected an officer of the Legion of Honor of France. He is a member of many clubs and societies, including the American and Western Society of Civil Engineers.

Colonel Townsend is a firm and consistent believer in the inherent cheapness and practical value of water transportation, intelligently and scientifically developed; but he has been equally firm in his opposition to ill-advised and wasteful expenditures. The striking economic successes of the great waterway projects in whose planning and execution he was a moving spirit, are monuments to his keen far-seeing judgment, skill and energy, and mark him as one of the great waterway engineers of the world.

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British Motor Transport in the War*

By

Capt. Richard Twelvetrees

R. A. S. C., M. S. E., A. M. I., Mech. E., M. Soc. Ing. Civ., France

Digest by Capt. G. R. Young, Corps of Engineers, U. S. Army

At the beginning of the war the British heavy motor vehicle industry was in an eary stage of its growth. Only a limited number of business concerns had interested themselves in this form of transport, which was regarded as experimental.

A few years before the war, the British War Department, in order to guarantee a satisfactory supply of motor trucks for the army, had provided a subsidy for manufacturers of trucks which conformed to certain requirements as regards construction and performance; the Government to have the right to take over such trucks on the outbreak of war. The plan undoubtedly did much to stimulate the definite idea of what the transport conditions of modern war would be. As a result, even after some years of the subsidy and four years of war experience, the ideal truck has not yet been developed. The purpose of this paper is to indicate the progress toward that end made during the war.

To provide transport for the original British Expeditionary Force, hundreds of vehicles were commandeered at the beginning of the war without regard to their condition. They were at once hurried overseas and put into service under the most difficult conditions of crowded roads, shortage of spare parts, supplies and continuous service. During the initial advance of the British troops to the fighting line, and the fighting connected with the first advance and retreat of the German Army, a great part of these vehicles broke down and were abandoned by the roadside, where they were stripped of spare parts to repair other vehicles.

As a result of this complete breakdown of British motor transport in the first stages of the war, steps were taken to organize the system; the most important action being elimination of types which were unsuitable because of mechanical defects or because of the difficulty of obtaining spare parts. The number of different makes of trucks in service in the British Army was eventually reduced to sixteen.

The question of developing a standard motor truck was considered during the war, but the project was abandoned for the reason that the British tractors were being worked to capacity either on their own products or on munitions, and it would cut down the production of necessary material to turn to the production of a standard vehicle, with the inevitable delay incident to tooling up.†

Four Periods in War Transport

The phases of mechanical transport development during the war can be divided into four, roughly parallel to the strategical phases of the war.

Mobile Warfare. Conditions at this time approximated what had been anticipated by the War Office in organizing its motor transport plans, that is, conditions of open warfare, with the roads still in good condition and with a supply of skilled drivers. Maintenance by the drivers was, however, sadly neglected. Maintenance difficulties were accentuated by the fact that the original plans had contemplated workshops hauled by steam tractors, which were found to be too slow and unwieldly for the service demanded. Fortunately, most of them were captured by the Germans during their advance, and mobile shops mounted on truck chassis were substituted for them.

Stabilized Warfare. Following the stabilizing of the battle line in the fall of 1914, an opportunity was at hand thoroughly to overhaul the vehicles of the army, and to establish a satisfactory maintenance and repair system. This opportunity was in the main overlooked, for the reason that higher staff officers did not understand the complexity of motor vehicles, or the elaborate organization and constant care needed to keep them up. Maintenance and repair were neglected, and the principal duty of the workshop officer was to write requisitions for spare parts, which were never filled.

Mechanical Period. About a year after the declaration of war, the Allied commands began to consider the assumption of the offensive on a large scale. This led them to give serious attention to the mechanical condition of motor vehicles, and a new attitude was assumed by the authorities. Steps were taken to increase the facilities for minor repairs at the front,

*An Address delivered before the Society of Engineers (British). †The British motor truck industry is composed principally of firms making what we call "built-up trucks," that is, vehicles for which they make nearly all of the parts, and assemble them, in their own factories. The so-called "assembled truck," put together out of standard parts which are manufactured by parts companies, has not been developed in England to nearly the extent that it has been in the United States. The development of standard trucks therefore presented to the British much greater obstacles than it did to us.—G. R. Y.

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and to improve the supply of spare parts. It was provided that only a certain percentage of vehicles should be removed from a unit for repair at any one time; thus insuring a systematic overhaul. Pamphlets and circulars were issued broadcast giving instructions on operation, maintenance and repair. Manufacturers of trucks in army service were given an opportunity of inspecting their vehicles at the front, which resulted in many improvements and valuable suggestions. Finally, an inspection service, known as the Motor Transport Inspection Unit, was organized under the Director of Transport, which was responsible for making detailed mechanical inspections of all vehicles in service.

The general tendency throughout this period, which covered the greater part of the war, was a continually increased recognition of the importance of careful operation and of a thoroughly efficient maintenance system under rigid technical inspection. This bore fruit in the steady improvement of motor transportation.

Final Period. This covered the latter stages of the war, and saw the supreme test of the British motor transport organization after the lessons learned from the previous periods had been digested and put into application. The system was under the most extreme pressure; vehicles were becoming badly worn, spare parts were increasingly difficult to maintain, and skilled drivers were very rare; and under these conditions the British Army in the last phases of the war made great advances, in many cases over almost impassable roads. The success of their transport system under these trying conditions is attributable to their sound judgment and correct procedure,

Active Service Conditions

It is desirable here to give some idea of the peculiarly trying conditions imposed on motor transportation by warfare, in order to understand the rapid breakdown of vehicles and the great difficulty of maintaining them.

Difficulties of Production. This was due at first to a shortage of factory personnel. At the beginning of the war this personnel was greatly reduced by voluntary enlistments, and further reduced by the mobilization of men belonging to "Category C"—reservists who received a payment from the Government in time of peace, and were liable to call in war as motor drivers and mechanics. This reduction of personnel applied not only to the workmen but also to executive heads.

A second production difficulty was due to many motor vehicle factories being taken over by the Ministry of Munitions for other war work.

A third difficulty which soon developed, was the shortage of material. This was due partly to the diversion of material to munition and other manufacturing, and partly to the fact that much of the pre-war material had come from enemy countries. For example, magnetos, which before the war had been produced almost entirely by Germany. Again, iron castings for cylinders had been obtained principally from the foundries in the Ardennes, which fell into the hands of Germany.

Difficulties also arose with the factory inspection system, the personnel selected for this work being often quite unsuitable and incompetent to pass on the acceptance or rejection of vehicles.

Bad Storage Facilities. Inadequate storage and neglect of vehicles after manufacture and before shipping overseas caused great deterioration, and necessitated much unnecessary repair work on their arrival in France. There was also much deteriora tion due to their being shipped unprotected across the Channel.

Operating Personnel. At the beginning of the war there was an adequate supply of skilled drivers, but this condition soon ceased to exist. There was a tendency for men to enroll themselves in the motor transport service for the reason that they considered it an easy job. Many of these men were so thoroughly incompetent that systematic instruction in schools was attempted, but it was impossible to continue this instruction long enough to train them thoroughly. The result was not only that vehicles were abused by unskilled drivers, but that these drivers, having no idea of how to make minor repairs on their vehicles, had them turned into shops for the most trivial causes, causing excessive pressure on the shops.

Road Conditions at the Front. Typically French road construction consists of a strip of macadam, stone blocks or other paving, with a strip of hard dirt surface on either side, and fairly deep ditches. The paving ordinarily is not of sufficient width for two motor vehicles to pass each other, with both remaining on it. Consequently, trucks on these roads continually had to turn off and run with one set of wheels on the dirt portion of the roads. This was quickly torn up, and under the conditions of almost continuous rain prevailing in Northern France was ground in deep mud. Vehicles running with one set of wheels in this were in great danger of slipping into the ditches; and if they did not, often found difficulty in getting their wheels back on to the paved roads again. It is estimated that during the winter months, at least one truck was ditched in each night, out of every one of the hundred of convoys engaged in hauling supplies and ammunition. It was found necessary to introduce special courses in the motor transport school on getting vehicles out of ditches.

In addition to this, the frequently rough and irregular surfaces of the paved strip of road caused constant shocks and vibration, which accelerated deterioration and tended to crystallize the metal in

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many parts of the machine. A considerable portion of the repair work in motor vehicles was due to parts which worked loose by vibration, and had been neglected by drivers.

Finally, the paved roads themselves were pounded to pieces by the continual passage of trucks, and adequate repairs were extremely difficult. Corduroy roads held together by wire were a common expedient, but gave a very poor surface for truck transport.

Work of Motor Transport Organizations. It is difficult for any one without experience of front line conditions to appreciate the difficulty, danger, and fatigue under which the motor transport operated at the front. In heavy artillery organizations, the ammunition train (3-ton trucks), and the caterpillar tractors used to haul the guns, had to be kept in readiness not far from the gun position. The gun positions were constantly shifted, this usually occurring at night after the enemy had located the battery and was engaged in counter-battery firing. To the ordinary difficulties of night operation on bad roads was thus added the danger caused by the fire of the enemy, which was always especially intense when he conceived that a change in artillery positions was contemplated.

As soon as the gun position had been changed, it was necessary for the ammunition train to come to the railhead and obtain a fresh supply of shells. It is impossible to make an accurate time-table for the movements of ammunition trains, and they were liable to many hours' delay on the road, while waiting for shells to arrive at the railroad. This period of rest had to be occupied by tightening up bolts and making minor repairs. Then the trucks would be loaded and the train would return to the battery. The return run must be made at night without lights, and the road had often been damaged by shells since the last passage of the convoy. The drivers were very tired, and any accidents which occurred would block the road and cause a frightful congestion of traffic.

Improvements in Design as a Result of the War

Conditions such as described developed many weaknesses in vehicles which operated satisfactorily on good roads under peace conditions. The following points in design are those where special weaknesses developed, and where improvements have been or should be made.

Frames. Many British designers had a preference for the pressed steel channel frame. This frame is too light for war service. The best results were obtained from frames built up of two rolled steel channels braced transversely by heavy drawn steel tubing, which is secured to the main members by stiff bolted brackets. The author considers it a mistake to allow any unnecessary resiliency in the frame; it should be as rigid as possible. Resiliency between the frame and parts such as the engine and gear box should be allowed for in the dsign of the suspension of these assemblies.

Engine Details. The principal defects developed were excessive wear on crankshafts and their bearings, due to insufficient bearing area; and lubrication systems which were complicated or difficult of adjustment. Failure of set screws securing the piston gudgeon pin gave much trouble.

Clutches. Best service was obtained from the external cone clutch. Improvements in this type would, however, result from the substitution of asbestos fabric for leather.

Universal Joints. Many designs of these are needlessly complicated. The best practice is to employ laminated fabric discs connected by coupling arms to the driving and driven shafts, respectively.

Final Drive. The author is of the opinion that the chain drive under active service conditions holds its own with the more modern types of shaft drive and double reduction gear.

Comments

The following comments on Captain Twelvetrees' paper, made by members of the Society before which it was read, are of interest:

Caterpillar Workshops. Valuable results were obtained in Egypt by mounting mobile repair shops on caterpillar tractors. This was especially important because in places there were no roads at all, and if the workshops had been mounted on trucks they would not have been able to come within many miles of where the tractors which they were serving were operating.

Wire Roads. Good results were obtained in Egypt and Palestine by clearing loose sand from the road surfaces, and pegging wire netting over the hard surface underneath. This was, however, suitable only for light traffic, including automobiles; not for trucks.

Comparison of Caterpillar Tractors and F. W. D. Trucks. It was stated that in France the F. W. D. truck with winch gave better service for hauling heavy guns than the caterpillar tractor. The latter made too much noise near the front, and on hard roads its machinery deteriorated rapidly.

Comments by Capt. G. R. Young

The foregoing record of British experience by Captain Twelvetrees agrees at almost all points with the experience of the American Motor Transport Corps during the war. We had the same difficulty that he mentions due to accumulating a great variety of makes of vehicles in the army, and were forced to the same solution of standardizing on a few makes. The difficulties with maintenance and spare parts supply existed throughout the war; and as in the case of the

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British Army, this was largely due to lack of recognition on the part of commanding senior officers of the fact that a motor vehicle is a very complex and delicate mechanism needing a great deal of skill in repair and operation. Our authorities at home early appreciated, as did the British, the desirability of developing a standardized government truck with a view to increasing production facilities and simplifying maintenance problems. What was impossible in this line in England was possible with us on account of the difference in industrial organization in the two countries. Production difficulties were not so great in this country as in England, because our adoption of the draft at the beginning of the war gave a better opportunity for systematizing our calls for men and of reducing the interruption of basic industries. We suffered, however, from deterioration of vehicles, due to inadequate storage facilities, and especially from damage to vehicles during shipment overseas, until the adoption in 1918 of the system of knocked-down crating. We suffered also, as did they, from unskilled personnel; and though the United States had a much greater supply of men with experience in operating motor vehicles than did England, the damage to vehicles caused by poorly trained drivers is familiar to all officers who were overseas.

The lessons which the American Army has drawn from the war, as regards motor transportation—importance of standardization of vehicles, the need of a large and well-organized repair system and abundant spare parts, and the necessity for giving careful training under motor transport corps supervision during times of peace of all persons concerned with the handling or repair of motor vehicles in the army—are thus seen to be borne out by British experience and would, in fact, be borne out by any competent authority of any of the countries at war who had observed motor transportation in operation.

Vocational Education and Maintenance Allowances for Disabled Soldiers

There are two clases of disabled men entitled to vocational education—those who cannot follow their former calling, and those whose disabilities are not of such a nature as to entitle them to certain financial benefits. The first class are entitled to allowances which range from $80 a month for a single man without dependents to $150 a month for a man with a wife and six children, or other dependents.

It is only when a man's disability interferes with his following his former calling, that he is entitled to the maintenance allowance. But other disabled men, if their disability be ten per cent or greater, are allowed free tuition and books.

All applicants must furnish legal proof of honorable discharge from the service, preferably the certificate of discharge. The nearest district office of the Federal Vocation Board will also furnish to the applicant the required blank form, together with a medical examination by the Public Health Service surgeon, or, if one is not available, by a physician in the community.

When a man's eligibility for training has been established, he is assisted by skilled vocational advisers in making the choice best suited to his needs. He may even have a try-out or preparatory course in a shop or school. Training is given in agriculture, industry, commerce, transportation, and other professions, as well as "training on the job" in manufacturing establishments, industrial concerns, offices, and on farms.

A disabled man eligible for training and maintenance will receive traveling expenses, school expenses, fees and books, and $80 a month, or more if he has dependents. While being trained at a factory, a man is paid the same allowance for himself and family as if he were taking school training. No deduction is made because he earns wages for his work. Prior to a man's entrance into training, he and his dependents are not entitled to any support, and if they are in distress, the matter should be reported to the Red Cross.

After the course has been completed, the Federal Board finds a permanent position for the man, and keeps in touch with him. A man who receives no training pay from the Federal Board continues to receive the full amount of that compensation to which he is entitled from the Bureau of War Risk Insurance. The War Department especially desires to contradict the widespread rumor that a man loses his compensation because he takes vocational training. His actual money income cannot be diminished, but it may be increased.

Additional information may be obtained from any recruiting office of the Army, Navy or Marine Corps, from all welfare employment agencies whose work brings them into contact with former service men; from United States Army and Navy Hospitals, all posts of the American Legion, public health officers, chambers of commerce, and various commercial organizations; or by addressing the Service and Information Branch, Council of National Defense Building, Washington, D. C.

Cape to Cairo.—An air route from Egypt to Cape Town is now open. British surveyors and engineers have toiled for a year to explore and plan the route. Three parties of officers and men were assigned to as many sections. They collected information, established airdromes and landing places at intervals of two hundred miles or less, and laid in gasoline and other stores. The length of the route, measuring by the line of railroad, steamer and ground transport, is 6,223 miles and the journey consumes from 59 to 75 days. The aerial line is only 5,200 miles, or fifty-two hours flying time. It is a perilous route, however. In the central zone, especially, heavy jungle makes landing at other than prepared places almost impossible.

National Memorial Association.—The formation of the National Memorial Association, for the purpose of erecting a national memorial in the city of Washington in memory of the dead of the American Army, Navy and Marine Corps, and affiliated civilian welfare services, in the World War, is announced.

According to present plans this organization will be made up of representatives from the Army, Navy and Marine Corps, the American Legion, National Guard Association, Red Cross, Salvation Army, Knights of Columbus, Y. M. C. A., Y. W. C. A., Jewish Welfare Board, War Camp Community Service, Naval Militia Association and the Training Camp Association. Funds will be raised by popular subscription.

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Military Road Building Not A Science—Only A Job

By

Ernest Graves
Colonel, Engineers

THE title of this article is Military Roads, and in the beginning it is desirable to explain what is meant by such a title. Numerous articles and pamphlets have been written on this subject and in every case the discussion has included much matter on road building, which does not pertain to a strictly military road. It is believed that over 90 per cent of the road data we read describes high class civil road work which is of little value in road work that is essentially military.

A truly military operation is offensive and active. It moves fast and there is little time for the elaborate road work usually discussed. Of course, this statement is not absolutely correct if one considers defensive or trench warfare where there is little movement. In such warfare, road work of a slow and permanent nature similar to civil work is of course practicable. However, in such cases, civil practice is in order, and it is useless to elaborate under the guise of giving military instruction. Again, in a military *occupation,* the work is largely of a civil nature and civil practices can be followed. However, even in the two latter cases time is sometimes so urgent that military practices must be followed.

By the above it is not meant that our military engineer should not be skilled in civil practices to a certain extent. He should be. However, in his instruction great stress should be laid on the military short cuts and he should always be cautioned to subordinate his knowledge of civil practices to his sense of the military requirements. It is too often the case that our military engineers are criticised by the army, because they let their knowledge of good civil practice dominate their actions where military results are desired. It is not always the case that the quick results desired by the military authorities is certainly the wisest procedure, but just the same we serve those authorities and it is essential that we think at least to a great extent as they do in seeking results. Possibly we are inclined to wish to play the game too safely and too soundly when a certain amount of gambling is an essential part of military action. While the safer methods may be thought by some to protect their work from failure and thereby protect them, their "reputation" is more injured by such timidity than by an occasional failure. Houses have been built and have fallen down and vehicles have gone through and stuck in roads constructed by engineers whose reputations have not been hurt by these occasional accidents, since by taking such chances they have many times "gotten away" with tasks that would have been impossible if no chance had been taken, and in which a timid would inevitably have failed.

I shall discuss principally some of the road work that has come under my observation from the standpoint of military expediency rather than from the standpoint of good civil practice. The latter is fully expounded in many text books.

My first acquaintance with road work in the army was made in the Philippine Islands. A grand manœuvre was ordered there in 1910. The troops in the Philippines were divided into two armies. One army was to defend Manila from an imaginary Japanese attack by land and the other army was to go up the coast by boat, land at Olongapo and march overland to attack Manila. I was serving in a company of engineers under Capt. P. S. Bond. Our task was to make passable the so-called road from Olongapo across the mountains. Like the war, it was largely imaginary. We came to a bridge which was imagined to have been destroyed, and we imagined it to be rebuilt. Here I obtained a good idea of army requirements. At first I imagined this bridge could be rebuilt in two days. Then I found that my army wanted to cross, so I then imagined it could be rebuilt in seven hours. My superior officer arrived on the scene and found that the army was irritated at being delayed by my imagination, so he imagined the bridge could be rebuilt in two hours and as two hours had already elapsed since I had arrived there, the army marched across.

The job was by no means easy. The trail we were traveling in the mountains could be made practicable for animals, but not for wagons. We decided to feed our army with pack trains while in the mountains, and to carry a wagon train across to operate on the other side, the food to be taken over the mountain trail

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by the pack trains and then to be transferred to wagons. We represented the wagon train by two fully loaded wagons and proceeded to take them across, just to show that we could do it.

By three days of the hardest work I have ever seen we carried these two wagons across. We had to cut out trees, and move huge boulders out of the trail and out of the stream crossings. The wagons were dragged over the hills with a platoon of engineers or a whole company of infantry pulling on a long rope. This we did for a distance of about twelve miles. It could hardly be called road work. However, it is an extreme example of what we are expected to do. All the civil road literature in the world would have been of little use in this case.

In Texas City, about 1915, there was a division in camp. During a rainy spell all the roads broke down. They were made of shell and in dry weather looked perfect, being as smooth as a billiard table. At that time the Army had no motor trucks and only one or two automobiles. These shell roads broke down under the traffic of ordinary escort wagons. The shell simply turned into mud. The battalion of Engineers with all the Infantry were put to work on the roads under the direction of the Engineer battalion commander. It was pretty difficult to do anything. I saw attempts made to help the roads by putting sticks of wood in bad places but these had to be dug out and removed. The only thing that could be done was to fix the drainage and after a place had dried out, add shell. It might be stated here that the first thing to do always is to get water off the road. Road work is always drainage, and then drainage, and then some more drainage. If the water is gotten away from a road, it can be made to serve with almost any materials and under almost any traffic. If water stands on or around a road, it is likely to fail no matter with what material it is made.

There have been several articles written about the road work on the Punitive Expedition into Mexico which give much detail more or less interesting. To my mind, this work was a perfect example of road building purely military. The trail was used before any work was done and it was used for about a year, during which time the work was always either just ahead of necessity or just behind necessity. It never stayed long enough behind necessity to cause anybody to be "canned" or to cause disaster, and it never got far enough ahead to allow one to sleep easy at night. One officer weighed about 240 pounds when he started and 178 pounds when he finished his part in it.

There were a few outstanding features about this work that are worth remembering:

1st. The trucks under necessity would go almost anywhere if large obstructions such as huge boulders and ditches with vertical sides were eradicated.

2nd. In wet weather the trucks could be kept going if the road was kept drained. We spent months grading up a pile of dust of which everybody made fun, but when it started to rain, this ridge of dust turned into a pretty fair road and stayed pretty fair if we kept it dragged and drained so that water could not stand on it. Of course, all trucks of more than 1½-ton capacity were taken off of it.

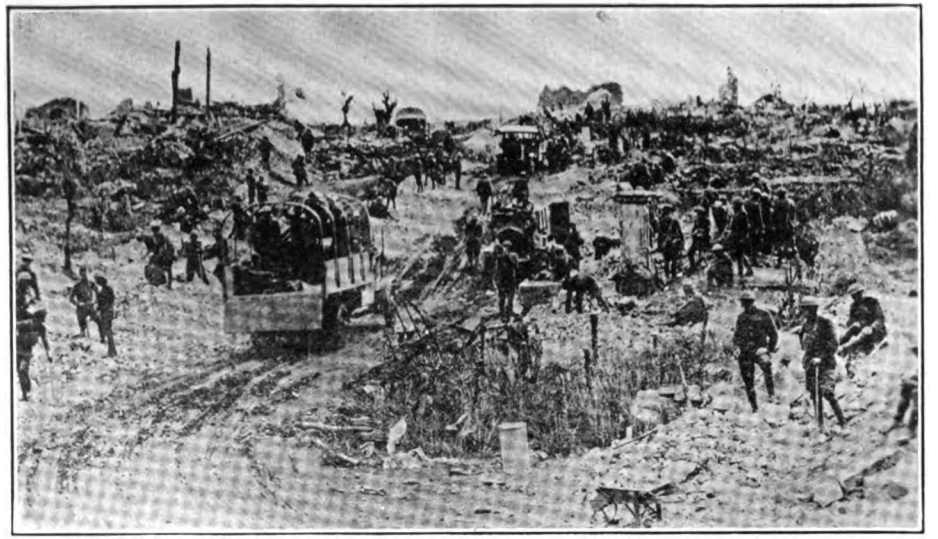
3rd. In dry weather the road was kept fairly smooth by scraping off the dust, and continually scraping the road deeper and deeper as fast as it powdered up. The road thus treated was, of course, on a different location from the graded wet weather road which was above the plane of the natural ground.

Both roads were kept up by continual maintenance, which was *drainage* in the case of the wet weather road, and removal of dust in the case of the dry weather road. Speed regulation also played an important part in dry weather maintenance.

As a matter of fact, the secret of success in this road work, as well as in all other work of whatever nature, is more a matter of organization than of special technical knowledge. In order to work properly it was necessary to subdivide the larger military units and to work in many separate small detachments. I have seen more engineering jobs hindered by a disinclination to send out separate detachments than by all other causes put together. I think the engineer officer who tries to keep his large military unit segregated in one small spot makes a most serious error. Engineers always have to separate. I cannot refrain from elaborating on this subject because it has more influence on road work than all the technical knowledge in the world. Separation gives the organization commander trouble in matters of discipline, rationing, etc., but the work cannot be done if men are herded together. If men are kept together good men, who have some initiative and who will accept responsibility, do not develop. The best engineer organizations I have ever seen, worked in detachments separated by great distances. The officers, non-coms, and even the privates developed remarkable resourcefulness and ability each to stand on his own feet. The occasional rows that happen, due to lack of constant and close supervision, bother inspectors a good deal but they can be kept within bounds, and the work accomplished more than compensates for disciplinary troubles. In Mexico we have had many road detachments with only non-coms in charge. In this connection, an incident that happened in Mexico is interesting.

About the 1st of August, 1916, a bridge at El Valle, 200 miles south of Columbus, washed away. Originally the bridge had been built with great difficulty, the lumber having been hauled from El Paso to Dublan on the railroad, and from Dublan to El Valle, 60 miles, by small Mexican teams. It had barely been possible to get enough lumber on the site to build a trestle 150 feet long. I was at Dublan when I heard this had washed away and I felt hopeless. I did not see how the lumber could be replaced in less than two months. I figured quite a bit about it and decided

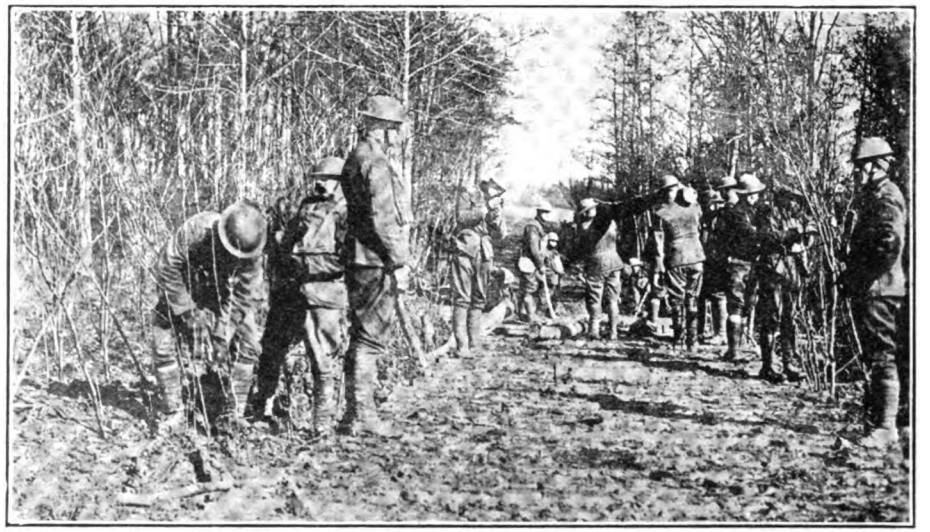
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Must be ready by nightfall. No chance for scientific road building here



Open up the ditches and put on plenty of rock. There is nothing else to it



Opening up a "cut-off"



Road rollers are fine—when you can have them. Note the activity of the workers. They are fighting men, bnt this is part of the game

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to let somebody else worry if possible. So I wired the battalion commander of what had happened, then I promptly got out on the road and applied myself to supervising a grader I had working about ten miles from Dublan, thinking when people began running circles around themselves they would not be able to find me. I had not been with my grader long when an automobile from General Pershing's headquarters showed up with an order for me to go to El Valle in person and supervise the repair of *certain bridges* in that vicinity. About the same time I received a wire from my commanding officer reading: "Go to El Valle, see what is necessary and do it," so I could not dodge it and I did not see anybody else offering any advice as to what to do. That is always the way. When solutions are obvious, advice is plentiful. When there is no solution, the advisers disappear. This is perfectly natural.

I returned to Dublan where I had about 15 men, collected some two by fours there, took 7 men and started for El Valle. Just before leaving I remembered to take ten days' rations for ten men. I expected to pick up two or three men from a detachment of about ten men that were on the road half way to El Valle. One of my seven men said he would cook. I told him we would get cooking apparatus by splitting 50-50 with the detachment on the way. When we reached the detachment, I sent my cook to the detachment cook to get half his cooking utensils. Pretty soon both cooks showed up with worried looks. I asked them what was the matter. One said, "I have no cooking utensils, but one knife and one spoon." I said "What do you need to cook with?" He said, "A knife and a spoon." I told them that they had been out long enough to take care of themselves and they should not worry me with their cooking utensils as I had other troubles, that I had to eat the same thing they did, so they could divide what utensils they had and get along, that we were going to work on a bridge if we had to eat the food raw. I started off, but those cooks looked so up against it, I had to solve their problem for them, so I said to mine, "You come with me." Thereupon I went over to an Infantry company nearby and walked up to the kitchen, where I found the Supply Sergeant. I said "Sergeant, lend me a knife and a spoon a little while and I will return them. We are kind of short of tools over at our place." The sergeant handed the knife and the spoon to my cook, and we went back to our camp, jumped into our trucks and moved off. I expect that the infantry sergeant thinks my idea of a "little while" is quite a long time. However, I was desperate.

This story illustrates to my mind two exceedingly interesting and important principles:

1st. Order a man to go to a place and see what is necessary and do it.

2nd. Soldiers separated from constant supervision learn to take care of themselves. They get interested in the problems put up to them, and solve them just as those cooks learned to cook with only a knife and a spoon.

Now we come to road work in Europe during the World War. My ideas on the subject are so at variance with those of the majority of people that the two are more or less irreconcilable. I will have to discuss that about which I know and refer briefly to that concerning which my information is only hearsay.

During the war there were formed both in the English and in the French service, large and more or less independent road services, which are alleged to have operated efficiently and to have done an enormous quantity of road work. I have read treatises on both services, and I believe that they did much more such work in active operations than we did. I think such services functioning as they did were similar to civil organization, and were possible only in stationary or trench warfare.

We started off with a road service as part of our railroad transportation service. Quite soon this service, together with light railroads, was taken from the transportation service, and made a division of the engineer service. This division was in existence until after the armistice. In the S. O. S., road work was actually done by the section engineers under the Director of Construction and Forestry. In the armies road work was actually done by the Army Engineer force. The Division of Roads and Light Railroads tried to attend to the supply and distribution of road machinery, plant, etc., and to road materials to some extent. Perhaps it did, but I got my plant and matériel in general by rustling for it and I believe every body else did the same. I did not think the Division of Light Railroads and Roads knew where all the plant was. Their reports, I believe, cover all road work.

I am inclined to believe that separate road services simply clog the game and are unnecessary. The representative engineer in any territory, no matter what you call him, should supervise all construction work of whatever nature, including roads. It is essential that engineer labor and materials be applied to the most urgent necessity at all times and there should be one supreme coördinating head in each locality to supervise all engineering work.

Although the 1st Army had some little road machinery such as road rollers, etc., their most vital work was done by hand. They broke rock by hand, transported it by hand, and put it on the roads by hand. Of course, they did work by the slower and more elaborate civil methods, but the work which required the utmost mental and physical capacity was the hand work. Such work and traffic regulations are the salient feature of the army road work in so far as we, as military engineers, are concerned. While the heavy, slow work no doubt was useful, the other type of work gave the army most concern.

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I should mention here that the English and French had adopted a plank 5 inches thick for plank roads, and that we had imitated them and provided a great quantity of these. I was never able to learn of any of these planks having been used. They could not be brought to the front on account of lack of transportation. A small quantity of them may have been used and I may not have heard of it. This size of plank was adopted by the English and French to stand the wear and tear of stationary trench warfare. We had no use for such a thick plank. If we had used plank roads to any great extent, we probably would have passed beyond them or changed them to rock roads before a 3-inch plank would have worn out. In other words, I think we should have provided for a plank road of 3-inch instead of 5-inch plank.



Road material was sometimes received by rail



Portable rock crusher. It was often cheaper to crush by hand

I have read an article in the PROFESSIONAL MEMOIRS on roads, and I do not agree entirely with it. I think it is useless to elaborate on a number of theories on what roads will have to be provided. One has to solve the problem after it develops according to the demands which develop. I take particular exception to the statement that concrete roads were not used on account of scarcity of coal to burn the cement necessary. As a matter of fact, when the armistice occurred our depots were stocked with more cement than was needed. There can never be any chance of building any kind of road which requires materials to be transported to it over very great distances. This is a fundamental principle of all road building, whether civil or military, but it is of vital importance in mobile warfare.

Most of the road work in Europe with which I was concerned, occurred after the armistice. About December 1, 1918, the French indicated no little uneasiness about their roads for the coming winter weather. This was shown by instructions from General Pershing in person, which started our work.

The instructions were that the Americans would make good any damage done by them; that is, they would keep up roads in continuous use by them. A separate road service to do this was suggested. It was proposed that there should be one strong man in charge of road work from the Rhine to the Coast. However, this suggestion was made after instructions had been issued to the 1st and 2nd Armies to take care of the roads used by themselves and these instructions had produced little or nothing in the way of road work. The road question was stirred up with life before the instructions had ever gotten through red tape out to divisions. I might explain that I was in on this because I was Section Engineer of the Advance Sector of the S. O. S., in which the 1st and 2nd Armies were billeted and in which G. H. Q. was located. In other words, the automobiles around Chaumont bumped over deteriorating roads in my area. As section engineer I was the representative of the Director of Construction and Forestry, and supervised all engineer activities in the advance section.

After the C. in C. had become interested in what was being done on his first instructions, or rather what was not being done, the Chief Engineer of the A. E. F. and the Director of Construction and Forestry, were called to Chaumont in conference. They opposed a separate road service and said the existing organization of the D. C. & F. could best do this work. The Division of Light Railways and Roads did not want the job. The result of the conference was G. O., No. 2, G. H. Q., 1919. On the basis of this the D. C. F. issued instructions to the various people concerned which are quoted later.

While the above mentioned conferences were going on, the idea was promulgated that an American soldier cost so much per day, which by adding up rations, clothing, transportation across the ocean, fighting submarines, etc., could be boosted to $10.00, and that it would be cheaper to pay the French to do the work. I took the position that the soldier cost $10.00 per day whether he worked on the road or snoozed in a billet, that the French neither could nor would do the work, that our movements would be stopped by roads breaking down, that we were told to get this work done,

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and not to study economics, that the above mentioned argument would be considered by G. H. Q. as a device of ours to get out of work and that I would not subscribe to any such argument. We would go home when the C. in C. sent us home, and we had better get this road work done, so we went to work.

The following is a compilation of instructions issued on the subject which instructions I, of course, believe to be quite a masterpiece for the purpose for which intended:

HEADQUARTERS
ADVANCE SECTION, S. O. S., A. E. F.
OFFICE OF SECTION ENGINEER OFFICER.
20 March, 1919.

COMPILATION OF ALL ROAD INSTRUCTIONS.

I. ADMINISTRATIVE

1. All roads in continued use by the American Expeditionary Forces will be maintained and kept in repair by our forces. Since the enormous mileage involved and the scarcity of road machinery make it impracticable to do extensive resurfacing with machinery, the work will be done by hand, with simple hand tools improvised if they cannot be otherwise secured. The French cantonnier system will be adopted in principle and road maintenance detachments will also be so stationed that all parts of all roads can be reached for repair. These road maintenance detachments will be provided with quarters and attached to organizations for rations by the commanding officer of the districts in which they are distributed for this work.

2. All road work in France and Luxembourg is placed under the Department of Construction and Forestry; the Chief Engineer or the Director of Construction and Forestry, or his direct representative, will issue instructions direct to the chief engineers of the armies, corps and divisions on the subject of road work in the same manner as instructions are now given to section engineers in the S. O. S.

3. Commanding generals will supply their engineer officers with sufficient additional personnel to carry out the instructions of the Director of Construction and Forestry.

4. In Luxembourg, available personnel will be supplied by commanding generals, and, in addition, civilian labor may be employed by the Director of Construction and Forestry. He will also arrange to send to his representative such additional personnel as may be needed. (G. O. 2, G. H. Q., A. E. F., 1919.)

(*a*) The economic aspect of the work to be done is not the concern of officers who have received instructions for work. However, what is being done is the highest economy. Men are in France in abundance. The cheapest way to maintain roads is by using labor to continually replace worn out soft rock. It is cheaper to break rock by hand than by crushers, as men have to be maintained anyway. There is slight chance of any engineer or labor personnel being sent to the United States until the roads in use by American troops are in good condition. (S. E. O., Advance Section, S. O. S., 16 January, 1919.)

It is expected that Army and Corps Engineers will supervise Division Engineers. Every effort to supply the Division Engineers direct will be made, but if there is any lack of absolutely necessary tools, Corps and Army Engineers should inform the Section Engineer Officer, Advance Section, who will distribute as rapidly as possible all available tools and equipment. Supervising officers will instruct and educate the working force how to accomplish the results with what they have or can readily obtain rather than requisition what is not available in France.

Attention is especially invited to the natural disinclination of many regimental, battalion, and company commanders to dividing their organizations over large areas. The good company commander can divide a company in detachments of 5 or 10 men and feed and supervise his men properly. Junior officers and non-commissioned officers will take a pride if given the responsibility for specific sections. In other words, the supervision of the company commander will produce better developments both in his men and their work if the personnel of his company is so located as to give some responsibility to his subordinates instead of keeping them all near his headquarters. Corps and division engineers should educate their road personnel without delay along these lines, as the work in the various areas will be under frequent and irregular observation by higher authority and any backward area is quite likely to receive severe criticism. (D. C. & F. to C. E., 1st Army, 3 January, 1919.)

Note: There has been an opportunity to watch the results of employing colored soldiers in small isolated groups of two or three. They are very much better workmen when thus employed. When used in large detachments a great deal of man-power is wasted. When two colored soldiers have been assigned permanently to maintain a kilometer of road, the best work is accomplished, and roads are in best condition.

1. The Commander in Chief has made very clear his desire that this road work be promptly undertaken and that the best practical results be obtained. Road reconnaissances, reports and other substitutes for work will not meet his wishes. It is understood that you will attend to all roads in your area that you do not find already being cared for by my forces, and if not already done, it is requested that you get started at once as outlined in above mentioned memorandum.

2. The Section Engineer Officer, Advance Section, S. O. S., is my deputy in this matter in the Advance Section, and will in the interest of expedition attend to any matters for me which you present to him. In the event that you desire me to act on anything personally, mark the communication thus, and the Section Engineer Officer, Advance Section, S. O. S., will send it to me.

3. Road machinery will probably not be available for work except on the main roads from the ports to the 3rd Army. (D. C. & F. to all division engineers, 28 December, 1918.)

"Number 203, G-4. Details working on the road in the vicinity of Chaumont are loafing on the job. Little will be accomplished by such work. We realize that you have done everything in detailing personnel and material for this work, but it now becomes necessary to put some 'pep' in its execution. Please therefore detail some officers to supervise this work. Where officers and non-commissioned officers in charge of detachments fail to get the most out of the men rigorous disciplinary action should be applied at once." (Telegram from C. in C., 13 January, 1919.)

This work is expected to prevent the necessity of more extensive road work in the future, and work must be carried on regardless of difficulties encountered. (S. E. O., Advance Section, S. O. S., 28 December, 1918.)

II. TECHNICAL

In France roads are constructed with the shoulder above the rock surface, and through the shoulder drains carry water to the side ditches. In Luxembourg and in Germany, the shoulders slope from the rock surface to the side ditches, so that drainage from the rock surface is continuous. While the French system requires more care in maintenance, in order to keep the drains open, it has the advan-

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tage that vehicles cannot easily run off the rock, wear holes adjacent to the macadam, and break down the edges of the rock road. The theory of the French road is the fine road surface is washed into the drains. When the drains are cleaned the material gotten therefrom is piled and used as binders for repairs. (S. E. O., Advance Section, S. O. S., 28 December, 1919.)

The maintenance of the French roads may be ordinarily divided into two classes: Maintenance of first-class roads, and maintenance of second-class roads. The first-class roads consist of those roads built of the harder rocks, such as trap rock, dolemites and the wash gravel. The second-class roads are usually built of the limestones which are usually found to be close at hand.

In the maintenance of the first-class roads the chief tools necessary are the mud hoe, shovel, pick, and roller,



Resurfacing a road by hand labor



American tractor train hauling road metal

and their importance is in the order named. All French roads may be considered as mud-bound macadam. It is this mud which appears on the surface of a used road after a rain, and it is of the utmost importance that this mud be moved immediately, for if it is left on the road it forms collectors for small pools of water which rapidly finds its way into the road and causes its rapid deterioration. The mud hoe is found to be the best instrument to move this material although the street broom (power-driven) may be used to good advantage. (S. E. O., Advance Section, S. O. S., 9 January, 1919.)

All roads are to be kept free of water, even if a man has to follow each vehicle and open drains. Men will be distributed over the roads for this purpose as often as it necessary to accomplish the result. (S. E. O., Advance Section, S. O. S., 16 January, 1919.)

The time to patch a road is when it is wet. On the first-class road throw small rock, usually No. 3, in the low spot and parallel with center line of the road. Then throw some good binder (usually any of the dirt alongside the road) on the rock. This should be thrown in the same direction. The ratio should be about two of rock to one of binder. If the patch should be made without the use of a roller, and the traffic is such as to not properly allow the proper binding of the patch, sod or its equivalent should be used as a binder. With this kind of patching, two men per kilometer of road have been found sufficient. (S. E. O., Advance Section, S. O. S., 9 January, 1919.)

It is expected that available materials will be used and that soft rock or any other kind of rock will be placed in holes as fast as it goes out, even if a man replaces it after each vehicle passes. (S. E. O., Advance Section, S. O. S., 16 January, 1919.)

When the roller is to used, it is usually necessary to dig out the place to be patched. This not only permits the proper sizing of the rock, but anchors the patch, and at the same time the rock is locked. Experience has shown that the proper number of men per roller is 17. This puts 2 men on the roller and 15 on the ground. The cross section of a patch so made should resemble the frustrum of a pyramid. Small patches may be made without the roller, provided heavy tamps are used. Good results have been obtained from this method.

In ordinary patching of the second-class road, it rarely becomes necessary to take out the patch. Care should be taken that too small a rock is not used in the patching. In case a weak spot develops in the base, the road ought to be dug out, telford replaced and the rock sized as in the ordinary macadam roads.

The first things to be looked for in any road are the location and drainage. As the first is usually determined, drainage becomes the foremost question. Therefore, along with the maintenance be sure the road is properly drained. (S. E. O., Advance Section, S. O. S., 9 January, 1919.)

Roads in use by American troops are be gotten smooth and drained, and they are to be kept in this condition. (S. E. O., Advance Section, S. O. S., 16 January, 1919.)

In freezing weather drains can be cleaned, stone can be distributed, and rock can be broken. Short periods of thawing in the middle of the day can be used for patching. Small local quarries can be worked by hand, so that stone will not have to be transported long distances. The help of the nearest French Road Official should be gotten to obtain rights in such quarries. Cart loads of stone can be purchased delivered, in any locality where found practicable. (S. E. O., Advance Section, S. O. S., 28 Dec., 1918.)

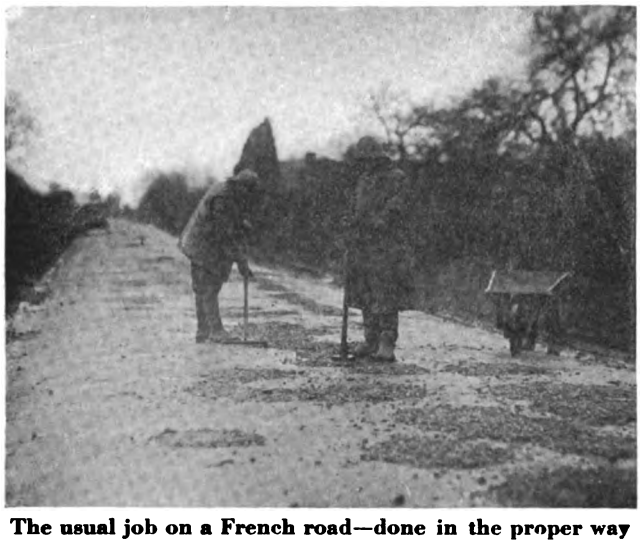
The French have maintained their roads by a system of cantonniers living along the roads. These road tenders watch the roads constantly and make small repairs before serious damage is done. They work on particular features according to the weather. Of course, drainage is always kept open. The patching done by cantonniers is done, generally without digging, by grading the rock put into a depression, and tamping it in. A cantonnier my care for 10 kilometers of road.

Roads used by American Forces are to be put in repair and

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maintained by our troops. The French cantonnier system will be used in principle, and every part of all roads will be maintained by a detachment so located as to constantly clean drains, patch and repair generally. Each officer will study carefully what he sees the French cantonnier doing, and will teach his men to do likewise. The road detachments and the officers supervising them should consider this work most excellent training and should see that valuable knowledge and training is obtained on this important engineering work.

While the necessary hand tools, such as hammers, shovels, tamps, rakes, hoes, wheelbarrows, etc., will be supplied



The usual job on a French road—done in the proper way

as rapidly as possible, mainenance should not be delayed for lack of some of these tools. Tamps can be improvised from a log of wood, and drains can be cleaned with almost anything. (S. E. O., Advance Section, S. O. S., 28 December, 1918.)

Note: Since the above was written, experience has shown that the methods employed are eminently sound. The French instructions require their cantonniers to dig out square holes before patching; observation shows they do not generally follow this theory, but use the rough methods of patching outlined above.

It took quite a time and no little trouble to get men separated sufficiently to do this work, but we finally accomplished this by persistent effort. The division engineers who complied with the principles of the instructions had to work but kept out of trouble. Those who did not get on the job with life were soon in serious trouble. I was more or less in trouble all the time, but managed to get by with the job, in the Advance Section. Other sections had about the same troubles I had. I saw to it that plenty of men and facilities were placed around Chaumont, and after several trials I got a man there who would keep me out of trouble by keeping smooth the road over which the C. in C. and his personal staff traveled.

The French roads have been sufficiently described in other literature, so it is useless for me to repeat. Luckily, their drainage system was fundamentally about perfect, so we only had to keep it clear.

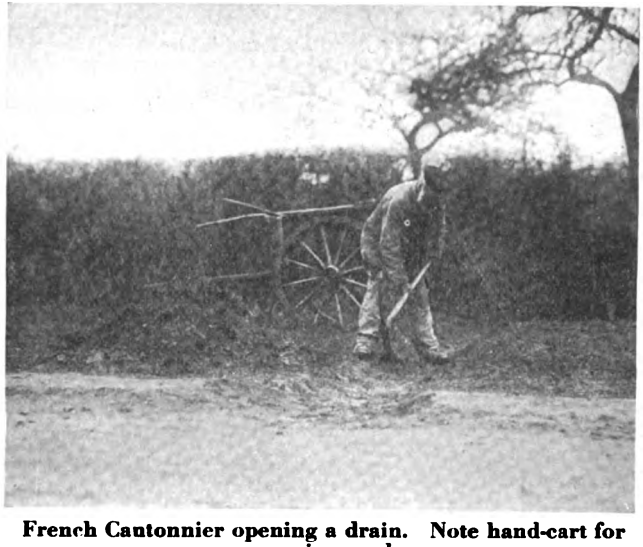
The Creator supplied plenty of water (delivered on the job) for water-bound macadam.

The rock was mostly soft limestone varying from very soft to moderately hard.

As the instructions said, we simply had to keep the water off the road and put on stone, either soft or hard. As I said, it was mostly a question of supervision and drive to make men do the work by hand and not waste time figuring on economics.

I consider this work the most creditable with which I was connected abroad. When we started, everybody said it was impossible. Of course, after it was done, that was forgotten and it appeared easy, like Columbus' egg. There was no technical knowledge necessary other than "keep water off the roads" and "put rock on them." The roads could be kept smoother by properly grading the rock in patches but they would stand up if rock was put on, and rock would be put on if the officers properly supervised. There were plenty of men if they would work conscientiously and intelligently 50 per cent of the time, but it required no little push and drive to make them do this. The average infantry soldier would much rather be shot into ribbons and go to the hospital (or to hell) than work on a road. That is the spirit which wins battles, no doubt, but it leaves the roads in awful shape.

In Germany the 3rd Army had quite a little trouble, but I think no more than we did. The problem was different. In France, drainage was perfectly laid



French Cantonnier opening a drain. Note hand-cart for carrying rock

out; in Germany it was not. In France the roads were broad; in Germany they were not. In France the shoulders were broad and high; in Germany they were not. In France the rock was generally soft; in Germany it was hard. In France the rock surface was generally thick, in Germany it was generally thin. In France drains through the shoulder had to be constantly opened, but the shoulders prevented trucks breaking off the edge of the metal. In Ger-

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Concrete Caissons for Breakwater Construction

Continued from page 130

narily taken. Occasionally a slight leak will be found after a caisson is launched, but it usually closes in a short time by the deposit of sediment from the water.

The largest caisson heretofore built, 54 feet long, 24 feet base and 21 feet 3 inches high, contains about 250 cubic yards of concrete. These caissons have been built in continuous operation in one 10-hour day. This necessitated employing 12 men in addition to regular crew, and so arranging the work that no one did more than the 8 hours prescribed by law. To accomplish this, a thoroughly organized and trained crew, working at high speed, is required. The construction of still larger caissons is in contemplation. Should larger caissons be undertaken, it will probably be necessary either to mold the caisson in parts on separate days, or to work 16 hours per day, using two shifts. In the former case it is probable that the bottom would be molded one day and the walls a subsequent day. It is believed the limit has been reached for a single day's work of 8 hours. The standard labor organization for molding the largest size caisson consists of twenty-two men, distributed as follows: One man loosening sand in bins; three men on sand and stone cars; two men loading cars in cement shed and transporting cement to mixer; two men emptying cement into side loader of mixer; one engineman on mixer; one fireman on mixer who assists in landing the concrete bucket at mixer; one man landing bucket at mixer and cleaning up around bucket; six men on top of form, dumping the bucket and puddling concrete; one engineman and one fireman on locomotive crane; one overseer on top of form, in charge of the dumping and puddling; one foreman at mixer; one general superintendent and engineer. In addition, two men are employed at the Milwaukee plant in operating the steam tug and gasoline launch and in general utility. For molding smaller caissons, the crew is somewhat less, the number of puddlers being reduced by one or two men, and only one man is used in the cement shed. During the season of 1919, the scale of wages paid for the foregoing was as follows: general superintendent and engineer, $200 per month; foreman, $140 per month; overseer, $120 per month; engineman on locomotive crane, $133.33 per month; engineman on mixer, $116.66 per month; fireman, $110 per month; laborers, $4.40 per day.

The foregoing crew, when not molding a caisson, is employed in taking down and erecting form, weaving reinforcement units, preparing caissons for launching and towing, etc. With no delays, with single crew working 8 hours, and with two sets of ways, it is possible to build three caissons per month.

Launching

Caissons usually remain for ten days on the ways before launching to insure sufficient set of the concrete. In favorable weather, when hardening progresses rapidly, and with the long ways now in use, whereby launching stresses are greatly reduced, caissons have been successfully launched on 8th day after molding.

Four shoes, each about 28 feet long, are used in launching. The shoes are trapezoidal in longitudinal section, so that when resting on the sloping ways the upper surface is horizontal. Shoes are made of 12 by 12 fir, except the bottom piece, which bears on the launching way, which is 10 by 20 oak, laid flat. A 6 by 12 inch ribbon or flange, bolted on one side of the shoe, prevents it from sliding off the stringer.

When ready for launching, the ways above water are thoroughly greased by pouring melted beef tallow thereon. Formerly the tallow was mixed with lard oil, but tallow alone has been found satisfactory. The shoes are then pulled tightly into place under the caisson by aid of the locomotive crane. As complete a bearing as possible is obtained by driving in thin wooden shims between the top of the shoes and the caisson, so as to prevent distortion due to unequal bearings on the shoes when the blocking is cut away and the caisson lowered from the jacks. The two outside shoes are then blocked with 8 by 8 struts, extending from a notch cut in the 10 by 20 inch oak timber to a pile cap of the ways. The ends of the struts next to the shoes are forced into position and there held by jacks. The end of the strut, which fits into the notch in the shoe, has to be cut with care, so that it will readily release in launching and still hold after the supporting jack is removed.

The blocking along the outside edges of the caisson is now cut away and removed, the caisson being now supported by the jacks. The jacks are then lowered and removed, throwing entire weight of the caisson on the four launching shoes. In the meantime, the releasing device has been placed. This consists primarily of two iron weights of about 575

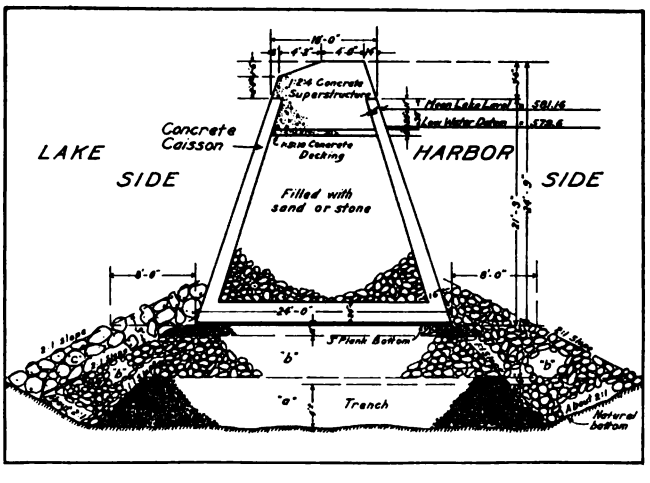


Fig. 3. Cross-section of completed breakwater

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pounds each, suspended by a rope in a gallows frame, which when released fall through a height of about 8 feet, striking an iron bar, one end of which rests on the strut at its upper end and the other on a block placed for that purpose, which in turn knocks out the strut, entirely releasing the caisson. The ropes by which the weights are suspended are led around in front of the caisson and connected by a short piece of rope. The cutting of this short piece releases the weights. The releasing device and launching shoe are shown in Figure 2.

This launching device has proved very satisfactory. Formerly a caisson was released by two men knocking out the struts at each end. To effect perfect release, the struts must be knocked out simultaneously. Unfortunately, in one instance this was not effected, one man failing to knock out a strut. In consequence, the caisson started sidewise, tore the ribbons from the shoes, and crashed through the ways, completely wrecking them. Since then the releasing device above described has been used.

After a caisson is released, unless the ways have been recently and thoroughly greased, it frequently fails to move. Initial impulse is given by jack screws placed between the caisson and the adjacent wharf. Of course, in such cases there has been no pressure on the restraining struts, and even when the caisson starts without impulse, it is believed the pressure on struts does not exceed 10 tons each, or about one-third the theoretical pressure, disregarding friction. Struts are made of Pacific Coast fir, and show no signs of crushing.

Caissons are launched with open top, as the ways are extended to such a depth of water as will permit them to float off. Formerly the ways terminated in about 6 feet of water, the caisson plunging off the ends of the ways, and being completely submerged. This not only necessitated decking a caisson before launching, but was very destructive of the ways, the upward thrust along the stringers breaking and crushing the timbers. Since the ways were extended to their present length, about 40 caissons, some of them weighing 500 tons, have been launched without any damage to the ways, which in the past two or three years have required only very minor repairs.

The launching of a caisson, as above described, usually takes about 6 hours. The preparation for launching requires the services of about ¾ of the construction crew. The remainder of the crew is employed in taking out braces, bolts, etc., from the form of caisson last molded, and getting it in readiness for transfer. As soon as the caisson is launched, the work of laying foundation for the next caisson on the ways just vacated is begun.

Towing

On account of the cost of installing a suitable plant it is more economical to build the caissons at a centrally located plant and tow them to the harbor where they are to be used. This statement is, of course, subject to modification in a case where so large a number of caissons are to be used at one harbor that the cost of towage from the central plant would equal or exceed the cost of a new plant installation. This, however, could not occur, unless the distance was very great, exceeding say 150 miles, and the number of caissons was very large. The cost of towing caissons from Milwaukee to Sheboygan in 1914, a distance of about 55 miles, was about $75 each. At present high prices of labor and materials, it is estimated that the cost of decking and towing a caisson 100 miles will be about $250. This makes no provision for possible accident, involving the loss of one or more caissons. However, it can be stated that during the past 12 years 130 caissons have been towed in the open lake for distances varying from 12 to 55 miles, and but one caisson has been lost, which occurred through faulty decking, a cause which it is believed has been entirely eliminated. The risk is therefore no greater than ordinary marine risk.

The towing of caissons has been done by the U. S. steam tug *Manitowoc,* the United States assuming all responsibility for the caissons until delivered to the contractor at destination. Two caissons are taken at one time, the average speed being from 2½ to 3 miles per hour.

As ring bolts or any similar contrivance imbedded in the concrete, to which towing hawsers would be fastened, would probably tear out when towing caissons, especially if in a sea, an apparatus for towing has been devised whereby the entire pull on the main hawser is transmitted to the rearward end of the caisson. This consists primarily of 12 by 12 inch timbers placed across the ends of each caisson and held together by 1¼-inch turn-buckle rods extending fore-and-aft along the sides of the caisson. Wire cable bridles to which the Manila towing hawsers are fastened, are secured to ring bolts at the ends of the timbers. When two caissons are taken in tow, the forward caisson is provided with two of these frames, the hawser from the tug leading to the lower frame. The towing frame for the after caisson is placed so as to correspond with the lower frame on forward caisson, and the hawser connecting the two caissons leads downward from the upper frame on forward caisson. This method forms a couple and aids materially in towing, as it holds the forward end of the front caisson up, and tends to prevent it "going by the head." Formerly the tension in the turn-buckle rods was depended upon to create enough friction to hold the timbers in place; but it was found that the timbers were lifted by waves and the surging of the caissons in a sea. Recesses 1 inch deep and 12 inches wide are now formed in the end walls of each caisson, in which

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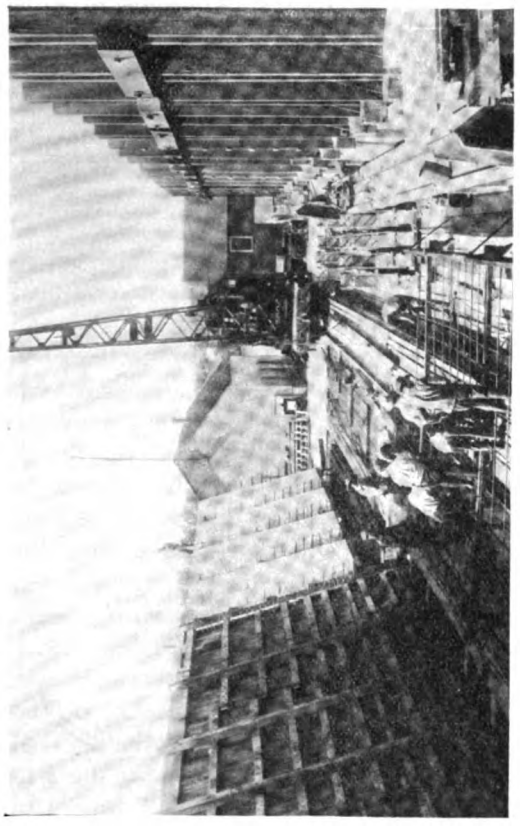


Fig. 5. Assembling steel for side wall. Note crane

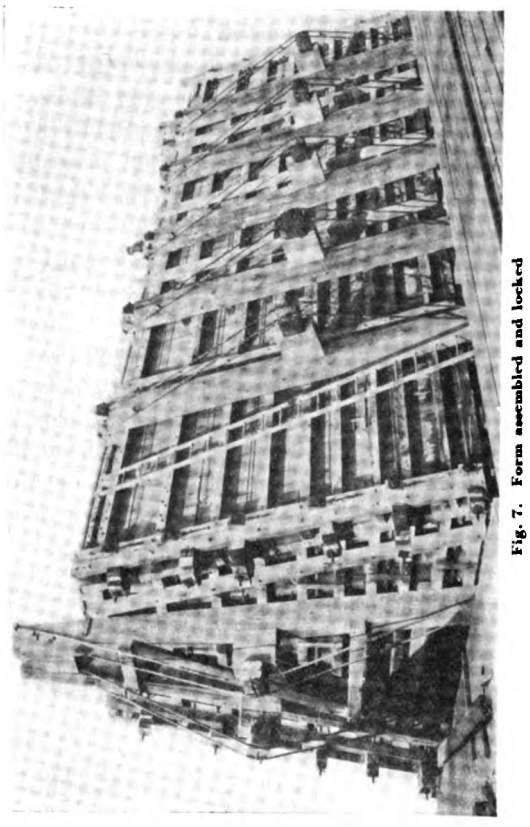


Fig. 7. Form assembled and locked

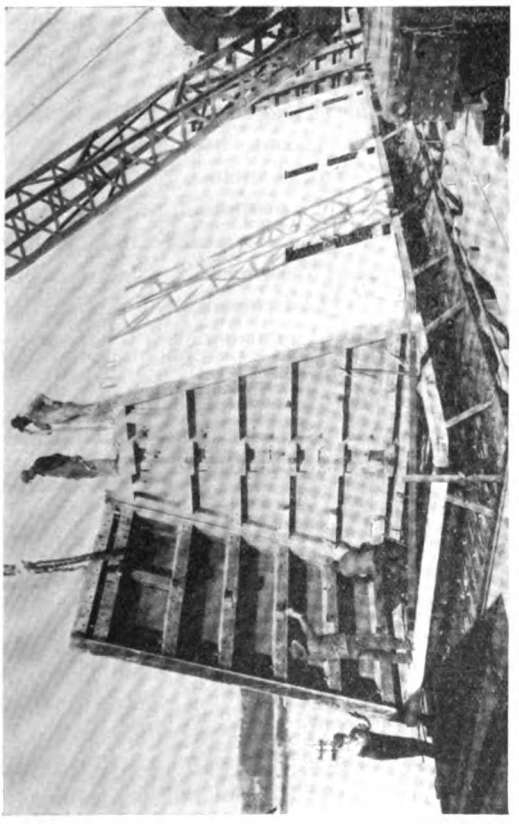


Fig. 4. Erecting Core Forms

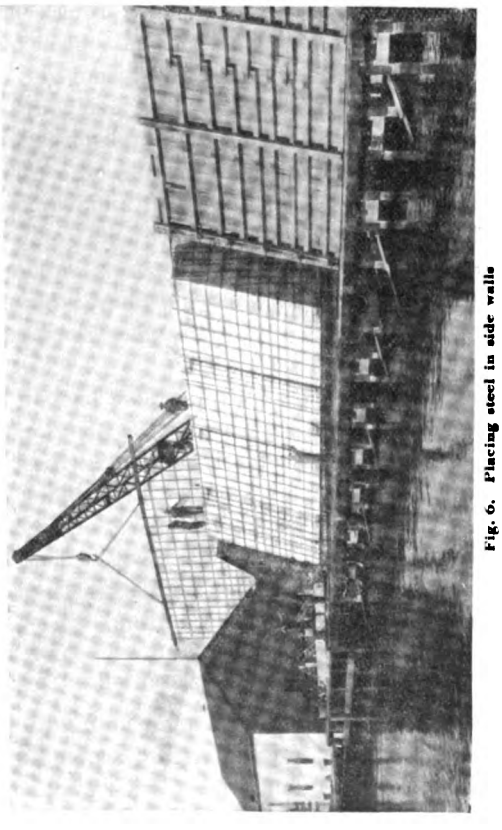


Fig. 6. Placing steel in side walls

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the transverse towing timbers are placed. This effectually prevents displacement.

While it is unnecessary to deck a caisson for launching, it has to be carefully and thoroughly decked for towing in the open lake, so as to be completely water-tight. The standard deck for a caisson is made in four sections, one for each compartment. Each section is provided with a hatch through which access can be had to the compartment. Hatches are provided with waterproof covers which are securely battened when towing in open lake. The decking is 2 by 10 matched (tongue and groove) planks, covered with 15-ounce canvas, painted, which in turn is covered with 1 by 10-inch matched sheathing. The sections of decking are held down by bolts imbedded in the concrete, and passing up between two 4 by 4 timbers through long washers placed on top of the timbers. Ordinary ½-inch pliable rubber garden hose is placed between the decking and the top of the caisson wall, and is squeezed down tight by the anchor bolts, thereby making a water-tight joint. The joints between sections are calked and pitched. Figure 8 shows a caisson decked for towing, with towing timbers in place. This caisson will be placed in rear of tow, and therefore has but one set of towing timbers. Note the notch molded in end wall and the hatches in the deck (with covers removed).

This decking is very satisfactory. It is readily placed and removed and is absolutely water-tight. Caissons which have been out in very rough water and have been completely submerged, have been found entirely dry when the decking was removed. The decking is saved for future use. Formerly decking was made of a single layer of 3-inch planks over which canvas was spread, and ordinary cotton was used in place of rubber hose. This proved inadequate to insure water-tightness, and in consequence one caisson was lost while being towed in a severe storm, the compartments filling with water through the open seams. There has been no trouble since the present style of decking was introduced.

If caissons are not to be delivered at a harbor soon after launching or are to be stored over winter, they are parked on the natural lake bottom near the plant by filling them with water by means of ordinary pipe syphons. In parking caissons, consideration must be given to probable changes in lake level which may occur during the storage period, as well as allowance for some settlement into the lake bottom.

Placing in Breakwater

A caisson is sunk on its permanent foundation as part of the breakwater, by admitting water to the compartments. This is done either with syphons or pumps. This method of sinking is very advantageous, as should a caisson be sunk out of line, or if for any other reason it should be desirable to reset it on the foundation, it can be readily floated by unwatering. Caissons filled with water only are very stable and frequently have gone through severe storms in that condition without being moved.

Until recently most caissons have been placed on pile foundations, although as long ago as in 1909 a number at Manitowoc were placed upon a rubble foundation.

This has been discontinued not only on account of the expense and difficulty involved in properly preparing pile foundations, but also on account of their instability under certain conditions. Rubble stone foundations are quite as cheap in first cost, and are usually more stable. It is believed they should be used in preference to piling whenever the condition of the bottom will permit. If foundation piles project more than 3 or 4 feet above the bottom, and if the spaces between the projecting piles are not completely filled with rubble stone so as to provide lateral support, experience has shown that they are liable to be cracked or broken by the "weaving" of a caisson during severe storms. In very soft bottoms it may be necessary to use piling on account of the settlement under load of the stone into the mud. In sand bottoms it has been found advisable to dig a trench at least the width of the caissons, and from 4 to 6 feet deep, which is then filled with small stones, on which the rubble foundation is built. The stone filled trench prevents scour with consequent settlement of the foundation. Some of the stone filled timber crib breakwaters in this district, placed on stone foundations on sand bottoms without trench, have settled over 3 feet. Where trenches have been used with some of the later caisson breakwaters, settlements have not exceeded 3 or 4 inches.

After the caisson is properly sunk on its foundation, it is filled with either stone or sand to within about 3½ feet of the top. Water above the filling is then pumped out, and the filling temporarily sealed with a 6-inch layer of lean concrete. After the caisson has been thoroughly settled on its foundation, a concrete superstructure is molded in place to a height of about 4 feet above water surface. This mass concrete is carried down monolithically inside the caisson and rests on the concrete seal.

Costs

Information as to present costs of caissons is subject to modification at any time, owing to the constant changes in the prices of labor and materials. It may be said, however, that the field cost of caissons 18 feet 3 inches high, and 22 feet wide on the bottom, built during 1919, has been about $3,700 each. This is the cost of the caisson in the water at the construction plant, not decked. It includes a "rental charge" for the use of the plant, based on its maintenance and depreciation. The forms, as they are used repeatedly,

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are included as plant. The materials entering into this caisson are approximately as follows: concrete, 200 cubic yards; reinforcing steel, 14,000 pounds; plank for bottom, 3,500 feet b. m.; wire spikes, 150 pounds. In addition there are steel knees for supporting cores, tarred paper for covering plank bottom and wire for weaving steel reinforcement units, all of which are incorporated in the concrete. From the foregoing, it appears that the concrete is reinforced at the rate of 72.2 pounds per cubic yard, and that the present cost of a caisson, including all materials, is about $18.85 per cubic yard of concrete. When a trench is used in forming the rubble foundation, this caisson is adapted for breakwater construction in depths of water varying from about 19 feet to 25 feet. For depths greater than 25 feet, it would be more economical to use a higher caisson, as maximum economy indicates that caissons should be set as close to the bottom as practicable. At present prices the cost of such a breakwater in 22-foot depth, filled with sand and provided with standard concrete superstructure, is about as follows:

Field cost of caisson, launched	$3,700.00
Decking, towing, etc. (100 miles)	250.00
375 cubic yards trench excavation, at 50 cents	187.50
400 tons stone, trench filling, at $2.50	1,000.00
650 tons stone, foundation and riprap, at $2.50	1,625.00
Sinking caisson on foundation	400.00
325 cubic yards sand filling, at $1.00	325.00
9 cubic yards lean concrete filling, at $12.00	108.00
105 cubic yards concrete superstructure, at $12.00	1,260.00
	$8,855.50
Overhead, contingencies, etc., 10 per cent	885.55
Total for 54 feet of breakwater	$9,741.05

Cost per linear foot, $180.39.

The foregoing estimate is based on prices in a recent contract awarded for a caisson breakwater at Indiana Harbor, Ind. The government will deliver the caissons to the contractor at this site.

It may be stated generally, that at present prices and availability of lumber and other materials, a caisson breakwater is, in this district, more economical in first cost than a timber-crib or rubble-mound breakwater. Also, as a result of about 12 years' experience it is believed the caisson breakwater is more durable and stable than one of cribs, and probably equal to rubble-mound breakwater. The choice between caissons and rubble mound would be then a matter of first cost, which of course will vary considerably in different localities. If only a small number of caissons are to be built and there is no manufacturing plant available, it would probably be cheaper to adopt some other form of construction, as the necessary plant installation is costly. The Milwaukee plant as herein described, has cost about $70,000, exclusive of floating equipment. The addition and enlargements proposed to be made before another season will probably cost about $30,000, making a total plant investment of $100,000.

With suitable construction plant available, caissons can be built as rapidly as timber cribs, and a caisson breakwater can be built more rapidly than can a rubble mound. It is believed that considering present first cost, durability, stability, and speed of construction, the concrete caisson breakwater is superior to any other type thus far used in Lake Michigan, and in many instances would probably prove equal, if not superior, to any other type for use in other localities, whether on the Great Lakes or elsewhere.



Fig. 8. Caisson decked, ready for towing

Discussion

Edward H. Schulz
Lieutenant Colonel, Corps of Engineers
District Engineer, Milwaukee District

Mr. Tompkins is the principal assistant engineer of this office, and during a part of the World War was in charge of the District. He gives a very clean cut account of the processes of constructing and placing concrete caissons for piers and breakwaters.

These operations include assembly of the plant and materials, placing the forms, mixing and placing the concrete, launching, storage, towage of the caissons, preparing the foundations, placing, filling and capping the caissons. The size of crews, cost of caissons and comparative cost of the caisson, crib and riprap constructions and other data, are also given.

It appears that caissons of iron, or metal, filled with concrete were constructed experimentally in Europe as early as 1905, but it remained for the Milwaukee District, under Col. W. V. Judson and his assistants (under a patent granted Colonel Judson in 1901), to design and develop a practicable reinforced concrete caisson. The first of these was built in 1908 and was of rectangular form about 24 feet in length. Later development has led to the trapezoidal form, the caissons being 10 feet wide at top, side slopes of 3 on 1, length 54 feet, and height varying from 18 to 21 feet. The standard rubble foundation on erodable soil is shown on Fig. 3. Some of the first caissons were placed on pile foundations. Where the soil is stable and erosion not to be feared the trenching and stone fill can be omitted or reduced in quantity, thus reducing the cost.

There are in the Milwaukee District, which now includes the former Grand Rapids District, 30 different lake harbor improvements. The 16 on the west shore include Manis-

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tique, Menominee, Oconto, Green Bay, Sturgeon Bay, Algoma, Kewaunee, Sheboygan, Two Rivers, Manitowoc, Port Washington, Milwaukee, Racine, Kenosha and Waukegan. The 15 on the east shore include St. Joseph, South Haven, Saugatuck, Holland, Grand Haven, Muskegon, White Lake, Pentwater, Ludington, Manistee, Portage Lake, Arcadia, Frankfort, Charlevoix and Petoskey. These harbors have been under improvement during the last fifty years, some dating back to 1850.

The works comprise various forms of revetment, piers and breakwaters. These designations, while somewhat elastic, are nevertheless fairly descriptive. Revetments are generally the inner ends of the structures, of less generous proportions and strength and intended to stabilize the existing channel banks connecting the lake with inner harbor or river. The piers are the extensions of the revetments into the lake, generally parallel and 200 to 450 feet apart. The breakwaters are the most substantial, and of the arrow-head type, inclosing a stilling basin and harbor. The revetments are generally of pile, slab or sheet pile construction, the piers of piling or cribs filled with rock, and the breakwaters of crib or caisson type. No caisson construction has been built on the east shore, but in the Milwaukee District proper some 144 have been constructed and placed, having a total length of 5,916 feet. In addition 12 54-foot caissons have been constructed this season for Indiana Harbor.

The total lengths of the various structures of the district is close to 30 miles, being very evenly divided between the two shores of the district. In the old Milwaukee District proper, the works include about 23,000 linear feet of pile pier, 29,000 feet of cribs, 16,000 linear feet of pile and sheet pile revetment, 3,200 linear feet of slab pier and 6,000 linear feet of caisson construction. The pile pier construction has some 8,600 linear feet with concrete superstructure and 900 feet with rubble mound. The pile revetment has about 664 linear feet with concrete superstructure and 260 linear feet with rubble mound. The crib work has some 10,000 linear feet of concrete superstructure, and the cribs have been variously placed directly on the lake bottom, or on piles, or stone foundations. The width of structures has varied from 14 to 32 feet and the elevation from 5 to 9 feet above low water datum (79.6 feet above sea level).

In the former Grand Rapids District, the works include about 34,000 linear feet of pile pier, 39,000 feet of crib, 2,500 feet of plank revetment, 1,600 feet of sheet pile revetment, 1,185 feet of concrete superstructure on piles and 900 feet of rubble mound. The pile pier work has 2,200 linear feet with concrete superstructure and the crib work about 400 feet with concrete superstructure. The pile piers are 10 to 30 feet wide and extend 4 to 8 feet above low water. The cribs are 16 to 30 feet wide with timber superstructures extending 6 to 9 feet and concrete superstructures 4 to 6 feet above low water.

In recent years, repairs to timber piers and breakwaters have been made by cutting down the timber and removing stone to about 1 foot above low water datum, and placing a cellular concrete superstructure to elevation of about 4 to 6 feet above low water datum. Some new construction of concrete on pile and sheet pile foundation has also been built. This type bids fair to be especially successful in repairing old structures.

Mr. Tompkins gives the present approximate cost of construction, towing, and placing caissons at Indiana Harbor, including preparation and construction of foundation at about $180.00 per linear foot. These caissons are for depths of 22 feet and their construction is, in this locality, about 33 per cent cheaper than rubble mound of the same depth and stability, and likewise cheaper than any crib construction at present prices. As the depth becomes less, the relative cost of a rubble mound breakwater increases rapidly with the depth. To construct such a breakwater in water 30 to 35 feet deep would take enormous quantities of stone. Crib construction, even if otherwise satisfactory, would be costly and an unwarranted demand on the timber resources of the country. Moreover, the continued maintenance of timber structures above the water line is very expensive and tedious. It thus appears that future economy points to more general use of caisson construction or in case of repairs, of concrete superstructure on old timber substructures.

The present capacity of the caisson plant at Milwaukee will be doubled during the coming season, and steps are also under way to secure an additional and larger area near the harbor entrance, where rail, vehicle and water traffic will all be available. The new site will have 6 ways and with double crews, will provide an output of 12 caissons per month or about 60 per year, equal to 3,040 linear feet.

Regarding the heights of structures, the tendency in recent years is to bring the height down to 5 or 6 feet above low water datum. the object being to reduce the cost and at the same time to have the structure high enough to be visible in stormy weather. This question of height and width with respect to wave action will receive further study in the near future, including other features of construction and design and will be discussed in a paper at a later date.

W. V. Judson
Colonel, Corps of Engineers; M. Am. Soc. C. E.;
Division Engineer, Northwestern Division

In the article by Mr. Tompkins and the discussion by Colonel Schulz there is very fully covered the present state of the art of breakwater construction, employing floatable reinforced concrete caissons. I desire at this time to testify to the great skill, interest and persistency of Messrs. Tompkins, Lion, Reed and Hoeing, civil engineers on duty in the Milwaukee district office at the time the construction of caissons was inaugurated there, and all except Mr. Lion continuously in touch with caisson construction and emplacement from 1908 until the present time. These gentlemen gave me great assistance also in the preparation of the paper for the Western Society of Engineers, referred to by Mr. Tompkins, in which was embodied all we knew about such caissons in 1909, and many suggestions as to their future use under different conditions.

Perhaps I can perform no greater service at this time than to set forth various suggestions looking to the employment of caissons under unusual or novel conditions, trusting that some of these suggestions may assist other engineers in the solution of similar problems.

While I was on engineer duty for the War Department at Milwaukee from 1905 to 1909 I was also lighthouse engineer from Lake Michigan. During the earlier part of this period Congress appropriated funds for a lighthouse "at the end of the Milwaukee breakwater." Now as river-and-harbor engineer, I knew that the breakwater would probably be extended a thousand or more feet. Nevertheless, the lighthouse board pressed me to proceed with the lighthouse which Congress had directed be built. Under these circumstances the concrete caisson came to the rescue.

There was tentatively designed a caisson 60 feet square

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and 24 feet high with five cross-walls equally spaced and parallel to the sides and the same number similarly arranged with relation to the ends. These cross-walls, with the sides and ends, made 36 compartments or air-chambers to provide flotation, and with the thickness of the walls chosen the caisson would float with a 7-foot free-board. At certain intersections of the cross-walls the angles were so filled in as to make columns of considerable cross-section and from these columns there was designed to arise a steel skeleton structure supporting a deck some 50 feet above the water, above which deck were provided quarters for light-keepers, a fog signal and a lantern for a suitable light, the latter about 90 feet above the water. With all the load of skeleton structure and lighthouse features the caisson would still float with more than 3 feet of free-board. Thus a design was reproduced for a movable lighthouse.

I proposed to sink this caisson upon a rubble-mound foundation "at the end of the Milwaukee breakwater," prepared so that the top of the caisson would project 2 feet above the water; fill the pockets with sand; seal each pocket at the top with a large concrete block and place the lighthouse in service where directed by Congress until the breakwater might be extended. When the extension was completed I proposed to lift out the concrete blocks, remove the sand from the pockets, float the caisson with its superincumbent lighthouse structure to a newly prepared foundation at the new end of the breakwater and fill the pockets and seal them up as before. Aside from the cost of preparing the new foundation the removal of the lighthouse would have cost but a few hundred dollars. I could not help regretting that Congress revoked its appropriation for the lighthouse before we started upon this caisson. Plans were later made for a foundation for a lighthouse at the end of one of the breakwaters at Colon, Canal Zone, Panama.

At Panama several other uses were made of the concrete-steel caisson. For instance, the guide wall projecting into Gatun Lake from the upper end of the Gatun locks was constructed in the form employed for concrete-steel caissons, being built in place, however, before the water rose in the lake, with a view to securing economy and relieving pressure upon the foundations.

At Colon when the first breakwater was begun, it was entirely uncertain whether the soft bottom would hold up an enrockment breakwater. At the request of General, then Colonel, H. F. Hodges, I made several tentative designs for concrete-steel caisson structures that might be used with little pressure upon the bottom if the latter proved impossible as a foundation for any other kind of breakwater structure. The most interesting of these alternative designs in my opinion was for a structure with one caisson placed upon another. The bottom caisson was 60 feet wide, 25 feet high, closed on all sides, including top and bottom, with hollow compartments into which water might be admitted to sink the caisson and ballast it in place. The superincumbent caisson was trapezoidal in section, 40 feet wide at the bottom, 28 feet wide at the top and 25 feet high. It also possessed a number of chambers into which water could be introduced. The upper portion of the upper caisson was to be filled with concrete and a superstructure of concrete placed thereon. All of the chambers designed to be filled with water were to contain nothing but the latter. The weight per square foot brought upon the bottom by a breakwater consisting of a combination of caissons as above described was but 1,866 pounds. It proved that the bottom would support an enrockment breakwater, however, and rock from Culebra Cut was a drug in the market, so that it proved unnecessary to resort to caissons.

Regarding the matter of patent, an application was made in 1900 and patent was granted me the following year to include the following claim:

"1. A caisson or similar structure, comprising a mass of concrete with stiffeners embedded therein, arranged to provide air-chambers or voids, so that flotation may be availed of to introduce the caisson into position as part or all of a foundation, breakwater, pier, retaining-wall or revetment, substantially as described."

In the description of the invention, forming part of the letters patent, occurred the following:

"It is the office of the metallic or wooden stiffeners to act by special virtue of their tensile strength, while the concrete or other masonry furnishes the necessary weight, surface areas, and resistance to compressive stresses."

At the time I applied for this patent I felt, as most inventors naively do, that many persons were doubtless about to develop the same thought into patentable form, and that there was imminent danger that the Government would be compelled to pay royalties for the employment of a method of construction for breakwaters and the like which appealed to me strongly as being at once cheaper and more durable, under certain conditions, than any other. My principal reason then for applying for a patent was to protect the interests of the United States, which purpose I certainly accomplished, for it came to my knowledge several years after my patent was granted that only the evidence it furnished of priority of invention prevented the issue of a patent to another party. I take the liberty of dwelling thus upon the facts above stated for the reason that some engineers, and probably some officers of the Corps of Engineers, do not believe in the propriety of patents for engineering inventions. I do not know whether today I am certain in my own mind as to the highest ethics in such matters. I can not speak of the great body of civil engineers of the country, but note that apparently most officers who have really conceived of things novel and useful in the field of engineering have in fact patented them. As to how many, like myself, have licensed the United States to the free use of such patents I am not informed.

War Teaches Us to Express Our Thoughts in Writing

The World War was a most potent force for education not only in matters military but in the fields of commerce and industry as well. Among its collateral benefits is noted an increasing appreciation of the value of a concise but clear and comprehensive literary style which is exemplified at its best in a well-drawn "general order," and is also characteristic of the letters written by military men on matters of military concern. That the faculty of brief but adequate expression had been neglected in civil life before the war was strikingly illustrated in the early days of the struggle by the correspondence of many, if not most, of the civilians inducted as officers into the military service.

The following on this subject is quoted from a recent magazine article:

"Many business firms have realized for a long time how costly a thing unskillfully constructed letters may become. Ambiguity, omission of essential details, unnecessary length, untranslatable signatures, lack of friendly personal touch, roughness of diction, omissions of enclosures, the clumsy or inadequate form letter—all these and other sins of correspondence are mischief-makers. In some large offices specialists review the daily correspondence, in the effort to effect improvement, and call attention of employees, and owners, too, if necessary, to the delinquencies and bad habits of their letter writing. They work out form

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letters, and seek generally to reduce the length of correspondence wherever it is possible and otherwise act for efficiency. Not only does the result show itself in relations with those with whom the firm does business, but there is a direct money-saving in bills for stenography and typing and office supplies. The Army and Navy training has helped this work along. Many a man who thought he could write a first-rate letter has had his conceit destroyed by some one higher up in the service who received his efforts. The Army rule of typing the signature as well as penning it has been adopted in some establishments, which is an excellent plan, for many signatures are blind, though their owners do not always realize the fact. 'Dictated but not read' and 'signed in the absence of' are less often seen than formerly, because they could not be used officially in the service, though the protest against the practice had already been heard and in many cases heeded. At the top of a letter the subject to be treated is now often found. This, too, had previously been established as a practice in some offices. Altogether this new influence which came into business out of the war should work out results of a good deal of importance. The beginning has been made. The added impulse should send the movement for good letter writing a long step forward. Among the customs which might well become general is that of indicating, when answering a letter from some one connected with a large company, the person for whose attention the letter is intended. In every large office time is wasted almost daily in trying to determine for whom letters are intended."

The German Long-Range Gun

At 7.15 on the morning of Mar. 23, 1918, only two days after the Germans opened their offensive against the British Fifth Army before Amiens, the people of Paris were startled by an explosion of something that had fallen on the Quai de Seine. This explosion was of such magnitude that it was heard over practically all of Paris. A few minutes later it was followed by a second, near the Seine on the Rue Charles V. These explosions then followed regularly throughout the day at intervals of 15 minutes, covering the major part of the city. Up to that time Paris had never been bombarded except from aircraft, and naturally everyone thought at first that these were aerial bombs, probably dropped from aircraft at such great height that they could not be seen. This theory was soon found to be untenable, and in their surprise at these mysterious explosions the entire population of Paris practically suspended all their normal activities; the shops, ticket offices and even parts of the Metro System closed down, and the streets were thronged with people looking skyward to locate the source of the shells.

It appears that the Germans in emplacing long-range guns from which these explosive shells were fired had so timed the commencement of fire as to practically have it coincide with the beginning of the great Mar. 21st offensive, with the intention of throwing Paris into a panic and thus breaking down the French morale and at the same time improving their own. For a few days, while the source was a mystery, the effect seemed to be more or less in accordance with their expectations—certainly until the ordnance experts determined from the fragments and the direction of penetration of the shells that they were coming from the vicinity of Soissons, about 70 miles away. When this was discovered the shells no longer frightened the inhabitants of Paris, but simply angered them at this unjustified attack on their city.

Many interesting theories were advanced during the first few days after the commencement of this fire in the various newspapers. By some it was maintained that they were projectiles fired from larger projectiles, a fuse driving the smaller projectile forward at increased velocity at some point in the flight of the larger one. Other theories suggested that these shells were being fired from some of the abandoned quarries a short distance from Paris. It was soon determined, however, that the shells probably came from a long-range gun located near Soissons. It was found that points of burst of the shells had a very great dispersion in the direction of fire and relatively small dispersion perpendicular thereto. It was also possible, by consideration of the bursts and fragments, to determine the probable life of each gun firing, which was soon found to be about 50 rounds. The dispersion for the new gun was very small compared to that after the tube had been considerably worn. It was also calculated that the muzzle velocity of this gun should be about 4,500 foot-seconds, and it is interesting to note that the actual muzzle velocity used was between 4,750 and 5,000 foot-seconds, learned from the Germans since the armistice.

The material effect of these shells was decidedly less than that of the 500 to 750 pound airplane bombs, the latter frequently making holes as great as 30 feet wide by 20 feet deep, whereas these shell holes were rarely greater than 12 to 15 feet diameter and 4 to 6 feet deep. During the entire 44 days of bombardment, ending Aug. 9, 1918, 303 shells were fired, of which 183 fell within the walls of Paris, killing all told 256 persons and wounding 620. The greatest casualties were caused on Palm Sunday, Mar. 29th, by a shell which fell on the Church of St. Gervais, near the Hotel de Ville. On account of the attendant circumstances this may be classed with the invasion of Belgium and the sinking of the *Lusitania* in building up a feeling of hostility against the Germans throughout the world. Here, again, is a good indication of the faulty psychology of the Germans in their estimate of the effect of their frightfulness on the morale of their enemies.

The Germans used for this long-range bombardment seven guns and had three others under construction. The original caliber was 8.15 inches, but practically all of the guns were rebored after being considerably worn to a caliber of 9.3 inches. They were constructed from worn-out 38 cm. (15-inch), 45 caliber (17.1 m. or 56 feet in length) naval guns. A tube 98½ feet long was inserted within the 38 cm. gun, 40.23 feet projecting beyond the end of the original gun. This tube was reinforced by a jacket which extended beyond its end so as to support an additional tube 23 feet in length inserted within this jacket. One of the peculiar features of this gun is that this end section had a smooth bore with an inside diameter equal to that of the main rifle tube plus twice the depth of the grooves in the rifled section. This portion was assembled to the gun in the field and was not removed until the gun was worn out. The original weight of the 38 cm. gun was 152,550 pounds, and of the long-range gun 318,000 pounds.

There has been much speculation as to the reasons leading to the addition of the smooth-bore tube. The best ordnance opinion is that this smooth-bore section has a stabilizing tendency on the projectile tending to decrease the deviation from its theoretical path due to the increasing angular velocity caused by the rifling. There is, however, some evidence that the smooth-bore section allowed additional linear velocity to be given the shell.

Another interesting point in reference to the ballistics of the gun is the very high muzzle velocity secured, viz, about 5,000 feet, which was accomplished by the very long tube, about 121½ feet over all, and a very slow-burning powder developing high initial pressures. The maximum range of 76 miles was secured from this gun at 55° elevation, which,

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according to theoretical considerations, would not give as great a range as an elevation of about 45°.

The carriage was of the railway type used for the 38 cm. rifle, from which the trucks were detached and the carriage set on a prepared base capable of rotating 360 degrees. This base was of built-up steel plates laid directly in a pit. In the emplacement in the Bois du Chatelet, 5 miles north of Chateau-Thierry, no concrete whatever was used. Inasmuch as the Germans held the site of this gun only about six weeks, it is evident that the emplacement was constructed in a shorter period than that, being carried to the site in large sections made up in the foundry.

The projectile used in this gun weighed 264 pounds, the charge for which was divided into two parts by a diaphragm, one fuse being provided for each of the two parts of the charge. A noticeble fact in connection with the projectiles from these guns is that there was not a single case recorded of a shell which failed to explode on impact, indicating a very perfect type of construction and also probable benefits from the two fuses.

There are some interesting camouflage features connected with the gun in the Bois du Chatelet. The spur track left the main railway line in the open field, and after passing over about ¼ mile entered a forest. The spur tracks through the open field were camouflaged by cut branches of trees laid over an area extending out several hundrd feet on each side of the track. The aviators could tell that some kind of work was under way, but were not able to discover the spur track. Within the forest and including the immediate vicinity of the emplacement, wooden boxes were set upright in the earth under the tracks at intervals of about 30 feet, and in these boxes small trees were inserted during the day, thus giving the original appearances to the forest During the construction camouflage screening was also used over cranes and other appliances.

It is the general opinion that these guns produced no effects, either material or moral, at all commensurate with their cost and the difficulty of constructing and operating them. It is unlikely that any such weapons will be again employed in the near future.—Lt. Col. H. W. Miller, in *Mech. Eng.*

A Motor Vehicle for Every Ten People

Ten million motor cars and trucks will be in service in America by the end of 1920, according to the statisticians of the B. F. Goodrich Rubber Co. There are now more than seven and a half million registered in the 48 States, which is an increase of 26 per cent over the preceding year.

The following are the numbers of people to each motor car in certain foreign countries:

England	270
France	400
Germany	680
Italy	1,000
Austria	2,700
Russia	5,300

In America there are about 10 motor cars to every motor truck, but the motor-truck output is increasing even more rapidly than the motor-car output. In 1904 America produced only 400 motor trucks, whereas in 1918 the production was 227,000. Astonishing as this increase has been, it is dwarfed by the rate of increase of tractors, of which the output was about 30,000 in 1916, as compared with 315,000 in 1919. Most of the tractors have been sold to farmers, but many also to contractors.—*Eng. & Cont.*

Military Road Building Not A Science—Only A Job

Continued from page 168

many, with low narrow shoulders, the road might break off on the edge. Trucks would tend to stay off the high French shoulders, while they would cut up the low German shoulders. Soft limestone in France was easily patched, while the hard rock in Germany did not lend itself to patching. Much more reinforcing was necessary in Germany, and, in addition, the thin German roads required extra thickness being put on in many places. There were in Germany more road rollers, proportionally, so this work could be done. The fact that the Americans had control of everything in Germany, including rail transportation, made heavy work much easier than in France.

About Christmas, 1918, great stretches of road in Germany broke completely down, due to a combination of insufficient drainage, thin metalling, and want of control over truck drivers. Roads were closed and reinforced, and traffic at times stopped. However, they got by without catastrophe.

I did not see any of our roads in France completely broken down, because we either put rock on them or stopped the traffic before the rock could be completely mashed into the mud. If we had let a road get thus, we couldn't have found the stone to rebuild it.

However, I saw one road used by the French turned into a continuous quagmire for 20 or 30 miles. The stone had entirely disappeared and nothing could be done but wait for summer and build a new road.

The frost heaves in France are interesting. The French road service issues voluminous and careful instructions about stopping traffic during them, in order that roads may not be ruined. Apparently this trouble breaks out only in spots, but might develop long stretches. It seems that water which gets under the road surface freezes and when it melts it produces a mass of stuff like very thick soup from the road surface down. If traffic strikes this before it dries or is repaired the road will be ruined. Such a surface has to be dug out and replaced with dry material. We had a few of them but we stopped traffic and repaired them, and so kept out of trouble. One division was completely tied up for a while because traffic was not stopped soon enough. Only animal transportation could be used until roads were repaired.

So, the technical road business from a military standpoint is nothing but good organization, drainage and rock, with traffic regulation if possible. The real problem is common sense in administration and supervision, which must be applied with punch on the job.

After this was written an officer familiar with the road work in Europe read it and said, "I see what idea the article intends to convey, but it doesn't say it." So let us say it. Technical road knowledge in war is of no importance compared to the ability to make men work, and to make them work with whatever facilities are available for the job on hand.

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The Military Engineer

Dedicated to the National Defense

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Vol. XII MARCH-APRIL, 1920 No. 62

The Construction Division—A Dispersion of Force

THE Construction Division of the Army was an emergency organization, brought into being by the War, for the purpose of taking over the construction work of the Quartermaster Department. Its operations did not extend to the theatre of war. They were limited to the home country, which was not touched by the war, and where the conditions were, in many respects, more favorable than those which usually exist in time of peace.

In the theatre of actual conflict, where construction work must be done under all the disadvantageous conditions incident to warfare, neither the Quartermaster Department nor the Construction Division was called on to execute any of the emergency projects of construction. This work, including all construction in the battle areas and under fire, naturally and logically fell to the Corps of Engineers, which for over a hundred years the Government has maintained for the express purpose of executing construction work under war conditions, where the agencies of peace cannot function.

To achieve success under such conditions our military engineers, our construction men, must be both soldiers and engineers. They must be thoroughly trained soldiers, thoroughly conversant with military methods and the fundamental economics of warfare, which differ in some essential respects from those of peace. The direction of all construction in the theatre of war must be in the hands of such men. To place non-military men, however efficient in civilian practice, in control, would be to court disaster. This was fully appreciated by the military authorities of the American Expeditionary Forces, and all work in the theatre of war was directed by the Corps of Engineers.

The officers of the Corps of Engineers proved themselves qualified to do the work—they proved this by doing it. They were qualified first because they were thoroughly trained soldiers, and second because they had been given practical experience in engineering construction in time of peace.

In any future war in which the United States may engage, the difficult emergency construction work within the theatre of war, from the battle line to the base ports, to our own frontier, or even within the frontier, will fall again to the Corps of Engineers. Such work, under such conditions, is their special and natural function.

To keep the Corps of Engineers constantly trained and ready to do this work when necessary, to "deliver the goods" when called on, is vitally important to our national security, and an essential part of any plan of preparedness, or national insurance, or military policy.

In the past the Corps of Engineers has secured this vitally necessary construction experience in the execution of the public works on rivers and harbors, lighthouses and other similar projects. Without such experience they would not have been equal to the mighty task which devolved upon them in France.

In the early days of our history the Military Academy at West Point was the only engineering school in the country and, in consequence, its graduates in the Corps of Engineers were called upon to organize, direct and execute numerous public works, many of which were only remotely connected with the national defense. They organized all the public surveys; they built lighthouses and public buildings, were connected with the construction of railroads, organized the public works in all new possessions, and were invariably

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called upon whenever an emergency in the way of construction confronted the Government. This excellent and varied experience was one of the important causes of the reputation for efficiency in construction which the Corps of Engineers established over a hundred years ago and which it has since consistently maintained.

But, with the growth of the nation and the reorganization and reassignment of its activities in connection with new Governmental departments, many of these duties have been taken out of the War Department and the Corps of Engineers has lost these opportunities for its necessary training. The government surveys are no longer in its charge (except the survey of the Northern and Northwestern Lakes); the construction of lighthouses is placed elsewhere; civil public works departments have been established in the outlying possessions, and the reclamation of arid land, though akin to the work of the Corps on Rivers and Harbors, was assigned to another department. If a Bureau of Public Works should be established, it may, unless special arrangements to the contrary are effected, result in depriving the Corps of the work on Rivers and Harbors, the only field in which engineer officers can now obtain the experience so essential to them. Such action is by no means necessary and, in fact, would be most unwise for, if the World War demonstrated anything at all, it proved that the rôle of the engineer in war is more important and more diversified than ever before in history. The so-called military engineer must now be not only a specialist in the design and construction of works of defense and offense, but must be thoroughly versed in those practices of engineering which find their principal application in times of peace. War has become a vast and complex affair and the engineering of war is involved in the complexity. A sound training and a broad experience, both of a military and an engineering nature, are indispensable.

Notwithstanding this very recent lesson in national needs, it is apparently one of the chief aims of some who are now agitating the establishment of a Department of Public Works, to deprive the Corps of Engineers of the last opportunity that remains to it for gaining experience in time of peace. This is a very short-sighted policy from a patriotic point of view, as all should be able to see. It gives ground for some suspicion as to the real motives of some of those behind the agitation, which is undoubtedly entitled to support in so far as it aims to bring about the coördination or correlation of similar activities in the various governmental departments.

Contrary to the practice of all other countries, and for some reason which is difficult to understand, or more probably through lack of definite policy and without any good reason, the construction work of the Army in time of peace, has never been assigned to the Corps of Engineers, although they are always called upon to do it in time of war. Army construction work during peace has heretofore been performed by the Quartermaster Department. The late war indicated the advisability of relieving the Quartermaster Department of this work, for the reason that it had too many other important and unrelated functions to perform. Yet instead of turning it over to those who are in every way naturally fitted to perform it, and who in the interest of military preparedness, need the splendid experience which it would afford, it has been proposed to organize an entirely new department to perform such work.

It is very difficult to perceive any good reason for adopting such a policy. Of all the government construction work, that for the Army most nearly approximates in time of peace the work that the Corps of Engineers is inevitably called upon to do in time of war. It would afford the officers and men so far as it goes (it being normally very limited in amount and variety), the most valuable construction exper-

General Pershing indorses aims of the Society of American Military Engineers

The following letter has been received from G. H. Q., A. E. F.

AMERICAN EXPEDITIONARY FORCES
OFFICE OF THE COMMANDER IN CHIEF

Washington, D.C.
March 23, 1920.

Gentlemen:-

I have been much interested in reading the February issue of the official journal of your Society, The Military Engineer. I am glad to see that steps are being taken to interest the engineer in civil life in the military aspects of his profession. The complete cooperation of the engineering profession throughout the country is necessary to any policy of National Defense, and I feel certain the Society of American Military Engineers will serve a valuable prupose in furthering this cooperation and interest.

Very sincerely yours,

John J. Pershing

The Directors, Society of American Military Engineers,
Washington Barracks,
Washington, D.C.

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ience which they can obtain in time of peace. It is purely military work and not open to the objection of being a "civil function," however little justification such an objection may have when it is against the best interests of the national defense. In an effort to avoid giving to the Corps of Engineers the work which is logically its function, in order to prevent the Corps from obtaining any experience which might render it more useful in case of war, it is proposed to establish a new department, with additional personnel and additional overhead expenses. And the Corps of Engineers is to be maintained in time of peace in comparative idleness while those who will *not* be called upon to do the work in war are gaining the experience which the Corps must have if it is to continue to be dependable in an emergency.

It is stated by the advocates of a separate Construction Division that the efficiency of the division "will be impaired" if it be turned over to the control of the Corps of Engineers, because "such men do not have the kind of technical training which is required in the construction work." This is equivalent to saying that officers of Coast Artillery or Cavalry, or Infantry, or any branch of the service except Engineers, are better qualified to direct construction work than Engineer officers, because generally speaking they (the officers of other branches) have had no previous experience in such work; whereas, generally speaking, Engineer officers have had previous experience. Is such an attitude in accord with reason, experience, and common sense?

The work of the Construction Division was actually performed largely by civilian experts and will in any emergency again be thus performed. The most expert of these civilians have long since left the military service, which they entered for the war only for patriotic reasons. To transfer the activities of the Construction Division to the direction of the Engineer Department simply means that the chief and superior officials of the division will be engineers with previous experience in construction and in the direction of public works of all classes, instead of officers formerly of the line or staff who generally will have had no such previous experience. Is an Engineer officer less qualified to direct construction work than an officer of the line of another staff department?

Because the Corps of Engineers is a carefully selected body of technical men, because it has a reputation for honesty and efficiency extending back to the beginning of our history as a nation, because it "made good" on the Panama Canal and still better on the huge construction project in France, because the nation needs a trained corps of engineers for war, because that corps needs construction experience in time of peace to prepare its officers for their duties in war, because the army construction is the best construction training that can be given our Corps of Engineers in time of peace—because of all these things, is it wise that a new and expensive department should be created to do the work that the Corps of Engineers can do and should do?

We wish to cast no reflections upon the work of the Cantonment or Construction Division in the late war. But however well it may have done its work it was not, and never will be, the organization that is relied upon to do the real emergency construction incident to a great war. That work, as always heretofore, will, of military necessity, be done by the Corps of Engineers, and its officers should be given every possible opportunity in time of peace to acquire the construction training necessary to maintain their efficiency for *war*.

Under the new army organization, proposed by Congress, which provides for promotion from a single list, the Corps of Engineers will receive no increased rank or emoluments from the work of army construction. They will get nothing out of it except experience and training which will be of the greatest value to the country. And the government will save expense by not creating a new and wholly unnecessary department.

The statement that "the Corps of Engineers has never had any experience which would qualify it to do the work of army construction," has been made so often in certain quarters that certain people who have not sought the facts are beginning to believe that it must be true, simply because it is so frequently repeated As a matter of fact, no statement could be more utterly untrue or absurd. There is no other organization in existence whose experience so well qualifies it to perform the work of *army* construction. The Corps of Engineers has for over a hundred years performed a large part of the construction work of the army during peace, and during several great wars. The variety of this work, as shown in the article on Army Construction appearing elsewhere in this issue (and in that describing the work in France in our January-February issue), is almost infinite. If a hundred years of continuous experience is "no qualification," how long will it require for a *new* organization to really qualify itself?

The Regular

The shouting and the tumult dies,
The Captains and the Kings depart.

EVEN SO! The shouting has long since died out. The glory of war and of warriors has faded. The reaction has become chronic. But this is not all.

Economic pressure, ruthless and severe, forces the regular soldier and his family, living on his reduced pay, to face discomfort, embarrassment and hardship—even privation and despair. Professionally, the

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bottom seems to have dropped out. His capacity, demonstrated in war, counts for naught. He is back again in the rut, little job, little prospect, little pay to meet greatly increased needs. And who cares? The regular feels he's quite forgotten, if not indeed despised.

Then, through old friends, or through the citizen-officer whom he commanded during the war, come offers from business people who have achieved new business successes. Great advances are in progress. Able men are in demand. Men who proved their quality in emergency can obtain positions bringing more than present army pay, and offering greater financial prospects for the future, and the regular thinks hard.

He can do it. He has faced worse difficulties and won. And who cares, anyway? Hasn't he been forgotten in the service? What does his experience count for now? What prestige has a soldier and what can he expect? Will not the pacifists and the pro-German and the reds all hate the uniform the more bitterly in the future? Yes, and what about all the buncombe that is being put over on the soldier now— being put over by men who know not war? And what of his poor, dear wife? (This hits him hard.) She is doing all the work now in the little apartment—all they can afford. And then what of the children and their future?

There, awaits the new position, big work, big prospects, the old pay guaranteed and more promised—a splendid opportunity!

The regular reasons that he ought to accept for his own good, and for his family's. He owes it to them. He owes it to himself to do work worthy of him.

Well, why not? Somehow, the regular doesn't say "Yes," but why not? Back in his head something says quitely, "No." It isn't laziness; it isn't fear of failure; it isn't love of the pomp and glory of war. No, the regular has been through the fire; the crystal of his vision is purified and clear. The "No" is something deeper and beyond. The very soul of the regular is struggling—his instinct says he *must not*—and this is why:

Granting success, wealth, fame, ease and comfort for himself and his family "on the outside," granting this and even return to the colors in the next emergency with increased grade, prestige and relative personal advancement; granting all these benefits and justifications, the regular remembers that he is a Regular and therefore he can't quit.

He can't quit, for the Army is in a hole. It's the darkest hour of its and of his career. Everything is against him and the Service. He must not quit. He realizes the Service needs him now as never before. Someone must hold on. Someone must stick by the ideals and true worth of the Army, to keep it fit, keep it ready, keep it clean of inefficiency, to weed out the dead timber, ruthlessly, and it takes strong, fearless men to do that. True men must stay, unbaffled by false doctrine, weak follies and oft-repeated fallacies. They must stand staunchly, holding to the faith, quietly remembering in all the clamor, clatter and criticism the old motto we learned as lads to hold sacred: "Duty, Honor, Country."

That is the reason.

Old pal, have courage. Set your teeth. Be a Regular—dependable, constant, worthy. And don't quit—YET. For there is still hope, and the Army and the country need you now.

This is the spirit of the regular. This is the spirit which has held the army together in spite of what sometimes appear to be deliberate efforts to destroy not only its morale, but even its patriotism.

Let us be steadfast, true to our ideals, worthy of our glorious record in war as in peace, superior to abuse, criticism, contempt, hardship and poverty. For America needs her army, and the backbone of that army must not give way under the strain. Let us hold on yet a little while, and hope for better days.

—J. C. H. L.

Standardization in Military Operations

THE war has taught us, if we needed any teaching, the vital necessity of standardization in quantity production. It has also taught, what we did not before fully realize, that the nation that leads in quantity production must, unless overwhelmed at the start because of unpreparedness, eventually win any war.

Standardization is essential, yet invention and improvement must continue. Therefore we must standardize; continue improvement, and move forward by long, not mincing strides, to new standardizations. Progress must be made in large strides which permit the standardization of each improvement, and not by continual changes which prevent standardization and hence limit quantity production.

Engineering and Contracting says that *excessive* standardization tends to lessen progress by invention, and refers to recent progress in the development of the steam railway and the motor vehicle. The former has arrived at an era of unchanging repetition, whereas the latter is still improving at a rapid rate. The point of view is interesting. Standard designs are not necessarily economical, says our contemporary. The answer would seem to be that too much of anything is bad. Standardization has a value which cannot be denied. We have only to think of what lack of standardization in pipe-fittings, for example, would mean. What we need is temperance, not abstinence. not too much standardization which discourages in-

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vention, not too much invention which disregards the value of standards.

The beginning of any industry is the natural period for invention, but standardization makes for progress on a large scale. As time passes more standardization and less invention is the logical process of development. The two should not be natural enemies, but natural helpmates. Standardization, like invention, should keep up to date. Let invention devote some of its efforts to giving us intelligent standardization.

This matter is of particular interest to the military engineer. There is no practitioner who is more frequently called upon to improvise to meet emergencies—this being a form of invention. Yet on the other hand, there is none who benefits more by standardization. Standardized materials and methods reduce the time required in construction, which is always the chief concern of the military engineer. During the late war every effort was made to standardize our materials and methods wherever this could possibly be accomplished. Standardized buildings, standardized trenches, dugouts, pill-boxes were found to be absolutely essential. As indicated in the article on Military Roads by Colonel Graves, which appears in this issue, standardized methods of road repair were vital to the continuance of transportation. The lack of standardization in artillery calibers and ammunition, due to the alliance of many nations and the rapid developments in ordnance manufacture, was most embarrassing. The lack of standardization in aeroplane construction threatened our superiority in the air. The future developments in the interest of national security will consist largely in the standardization of our equipment for war. The vast amount of supplies and equipment consumed in modern war could not be produced without the aid of standardization.

We witness then the peculiar paradox that warfare, while the least subject to rules and precedent and the most stimulating to invention of all human endeavors, is yet the most dependent on standardization. The belligerent who clings slavishly to his prewar standards will soon find himself hopelessly distanced by an active, resourceful and inventive enemy. But the belligerent who attempts to improvise all his equipment new as he goes along will find himself smothered by the standardized shells and standardized aeroplanes of a foe who is prepared for the conflict. And so invention and standardization must march hand in hand along the road of progress. We cannot dispense with either. Each is a check or balance for the other, but cannot be permitted to become a hindrance. As in most other affairs there are two sides to the question, and the golden mean between unreasonable extremes must be found.

The Dempsey Case

THE wave of indignation from the American Legion announcing that Jack Dempsey, the American heavyweight champion pugilist, is a slacker, has brought about an investigation and now indictment before Federal Grand Jury in California. The ex-soldiers of the American Legion say if Dempsey is proven to be a slacker he must not appear as the American heavyweight champion against Georges Carpentier, the Frenchman who fought all through the war.

It has been claimed that this man fulfilled his patriotic obligations by working in the shipyards, and that he was thus excused from rendering actual military service. Nevertheless, it is humiliating to Americans to feel that their champion fighter failed to fight in France. The American Legion is taking the legal means of expressing a just and deep indignation. The man whom Dempsey deposed as champion seems to have been even less worthy of national respect during the war. These two great fighting men, who should have displayed the best of courage and good example, now receive only the contempt of the nation.

Whose fault is it?

It's our own fault. We have degraded and debased the sport of boxing by legislating it into almost a criminal class. Before the war it had lost public confidence, and contests could not be staged in any state in the Union.

When the war came America called for all the strength and manhood of the nation to serve the flag. The better to fit our men for battle, instruction in "the manly art of self defense" was inaugurated at all the training camps. Hundreds of ring fighters and former ring fighters volunteered their services as instructors. But very few of them actually went overseas, and very few fell in action. As a body, ring fighters did not make in the war the showing we had a right to expect of them.

This is not true of other sports. The sporting instinct, which is developed in football, tennis, baseball, polo, and many other games, proved itself in the great struggle, since with few exceptions practically every outstanding performer in these sports came to the colors. The exceptions were mainly in baseball, a sport which, like pugilism, has become too highly commercialized. Nevertheless, hundreds of baseball stars did, as individuals, volunteer for combat service. The same is true of every other clean sport in America. The leaders of sports were leaders in the fighting. Athletics more than justified themselves in the struggle.

Now if boxing were really a *sport*, recognized as such by the country and worthy of our respect, this

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humiliating circumstance of our national "champion" appearing as a national "slacker" could not exist. Had the American people kept boxing a clean, manly sport; had they given it proper support and encouragement and prevented it from becoming sordid and commercialized, we would not now be witnesses to what must be regarded as a national disgrace. Dempsey and his managers would have been ruled by the same fine instincts as the devotees of other sports, and our national champion could not have done otherwise than prove his manhood and sportsmanship on the field of battle.

We have wondered why England is apparently so backward in pugilism at the present time. It is largely because so many of her pugilists lost their lives in the bitter struggle. Many of England's ring fighters went to battle and many of them never came back. Boxing is an honorable national sport in England and all through the British Empire. Throughout the great British Armies boxing contests are of regular occurrence, and at each such affair there is at least one bout between officers. Boxing is a cleaner sport than under our rules. When one opponent downs his man he steps back and gives him a perfectly fair chance to regain his feet.

At one of our training camps in the winter of 1918, a group of British officers, training specialists, attended the American boxing bouts. During one of these affairs a boxer floored his opponent, and stood over him in a menacing attitude, apparently on his toes to knock him out as soon as he had regained his feet. A British Major jumped to his feet and started to climb into the ring. He was red with indignation at the apparent violation of the rules of sportsmanship. He was pulled into his seat by his fellow officers, and then realized that he had no part in the game. The incident indicates the difference in the American and British points of view. When a British boxer floors his man he stands back until he is completely on his feet. Every Britisher knows this and the officers who father the game in the Army are keenly and vitally interested in the observance of the sporting rules, which to them is of far more importance than who wins the contest and pockets the "prize" money. In America we commonly call the sport of boxing, "*prize* fighting"—a term which too well expresses what it has become.

We should learn a lesson from this Dempsey affair. We should give boxing a fair chance, put it on a clean, sporting basis, make it again the "manly art" which it once was and always should be. A clean boxing contest brings out the best there is in a man of courage, stamina, endurance and self-sacrifice. "Prize fighting" as conducted in America too often develops the lowest and most sordid traits. It is not the fault of the pugilists alone. It is chiefly the fault of the American people who have degraded and commercialized a manly sport.—J. C. H. L.

Civilian Engineers in the U. S. Engineer Department

THE Corps of Engineers of the U. S. Engineer Department is not an exclusively military organization. In the vast program of construction which the Corps has planned and executed it has at all times relied greatly on the civilian engineers who are an essential part of the organization. The reputation of the Corps is built upon the splendid work of its civilian assistants, as well as that of its officers. These civilians are highly trained experts in various lines, but they do their work with so little noise and so little thought of advertising themselves that they have never received the public recognition which is their due. But the Corps of Engineers fully appreciates their efficiency and above all their loyalty, and it is fully aware and gratefully acknowledges that without these splendid co-workers it would never have accomplished the great projects with which it has been charged, and would not enjoy the reputation for efficiency which it has to-day.

That most of these civilians remain long years in the service is sufficient refutation of the statements that military and civilian engineers cannot work harmoniously together in producing results.

It will thus be apparent that the Engineer Department is composed of both military and civilian engineers, who by long coöperation have learned each other's worth and how to work harmoniously together. In other words the organization is the same as that proposed for the new Construction Division, except that all its members are *engineers* with practical experience in construction.

Civilian engineers without any military training cannot *alone* conduct *army* construction in the most efficient manner. Military construction must be done by a military organization whose directing heads understand military requirements as well as the best and most up-to-date methods of construction. This organization in time of peace must necessarily employ civilian engineers and civilian labor. In time of war it will of necessity be assisted by temporary officers of the reserve corps and will employ the labor of troops. The Corps of Engineers is such an organization, and is the only one which exists or which has been even proposed. It has been eminently successful in peace and still more so in war, and may be "judged by its works."

Estimated Strength of the Army, April 6, 1920

United States	14,587	158,623	173,210
Philippines*	697	18,860	19,557
Germany †	709	16,746	17,455
Panama	201	4,365	4,566
Hawaii	204	3,625	3,829
Porto Rico	54	1,526	1,580
China	47	1,318	1,365
Alaska	20	871	891
France	73	5	78
Siberia	7	55	62
England	19	12	31
At sea, en route Europe	77	3,185	3,262
At sea, en route Europe	90	1,940	2,030
At sea, en route Europe	7	4	11
At sea, en route Hawaii	9	1	10
Total	16,801	211,136	227,937

*Includes Philippines Scouts, 238 officers and 8,352 enlisted men.
†Includes all troops under jurisdiction of Commanding General American Forces in Germany.—*War Dept. News Bureau.*

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The Use of Aerial Photography in Mapping

By

E. H. Marks

Major, Corps of Engineers

There has been a great deal of publicity given to this subject and there is a tendency in many quarters to believe that it has entirely superseded the orthodox methods of surveying or is a science complete in itself. These ideas are erroneous and should not be allowed to continue, for they will serve only to hinder the proper development of aerial photography.

Now just where does aerial photography fail in being a thing apart from surveying? *In no case, at the present time, can we obtain from aerial photographs alone the data necessary for the principal uses to which maps will be put.*

The main omission in these photographs is the representation of relief or relative elevations of points on the ground, and inasmuch as nearly all engineering and military uses of maps require primarily this data as to relief, a photographic map will not itself fulfill the general needs of the country. This data as to relief must of necessity be secured by surveyors or topographers on the ground.

Another vital necessity for maps which cannot be obtained from the air is the control. Projection must also be considered, the necessity for which is brought about by the fact that the earth is a globe and our maps are flat surfaces.

Aside from the three essential and fundamental elements necessary in map construction mentioned above, and upon which too much stress cannot be laid, the photographic mosaic gives a very good pictorial idea of ground, so far as certain features are concerned, but it is not a map as engineers understand the term, or as required for engineering and military purposes.

The photographic mosaic is subject to errors, caused by the tilting of the camera at the tme photographs are taken, those due to ground relief, those due to shrinkage or expansion of individual photographic prints in developing or printing, those due to the personal errors in pasting photographs together, those due to curvature of the earth, those errors in scale caused by a varying height of the plane in flight, and errors due to lens and certain types of shutters, and a number of others.

Individual photographs, as opposed to the mosaic, can however, be used to excellent advantage by surveyors and topographers to assist the orthodox methods of map making, and when properly taken and used will probably lessen the cost of the work and certainly hasten its completion. If we have a system of ground control tied to points which can be recognized in photographs, it is possible in territory of low relief to restitute the photographs, and by plotting the desired information in connectioin with the established control, obtain a plane map showing roads, woods, houses, and other cultural features, as well as streams, lakes, and so on. This plane map can then be taken into the field by topographers, and the contours showing relief added, thus giving us a complete map for practically all uses.

To illustrate more fully how closely the question of aerial photography is connected with that of surveying, take the very simple case of a plane flying over absolutely level ground, plane and camera being held horizontal. In this case, the plate resulting from a single exposure would represent a true map were there no distortion caused in developing, but to determine the scale of this map it is necessary to measure with transit and tape some distance on the ground which can be compared with the corresponding distance in the picture. The scale could, of course, be determined without the ground measurement if the exact height of the plane were known at the moment of taking the picture, but there are no altimeters in existence so accurate as to determine this elevation, with necessary precision. This simple case of an absolutely horizontal plane and camera is practically impossible to secure, and a true map will not result from a tilted picture or one over other than level ground, without further treatment. There are, however, well known methods of restituting photographs, providing the location and elevation of four points on the ground and visible in the photograph are known, but the means of restitution are laborious, and when applied to photographs over considerable territory, stupendous. The problem of horizontalization is, then, one for which some solution should be made to obtain the full benefit of aerial photographs. I, personally, do not think it will be practicable to secure a gyroscope to hold a camera level, but I believe that a gyroscope may be developed and probably has been developed, which can be connected with some form of indicator to determine the tilt of the plane at the instant a photograph is taken, and it would be comparatively easy were this tilt known to use a transforming camera to restitute photographically, and thus avoid the laborious hand restitution.

The complications caused by relief of the ground are difficult of solution, but it is possible that this present complication will be of assistance in determining the relief of the ground from photographs by the application of stereo-photographic principles, and investigation is being made on this line.

It is scarcely necessary to mention the great value of aerial photography in map revision, but here again the question of laborious and costly restitution enters and awaits the solution of the horizontalization problem.

To sum up, aerial photography has not reached a point where it can supplant the present day methods of surveying, and its application for accurate original map work is to-day pretty much limited to comparatively flat terrain, but the advantages in surveying which will arise from the use of aerial photography in this type of terrain are enormous, and in revision work aerial photography has to-day a wide field of usefulness.

Tractor replaces the elephant.—Teak is cut in the forests of Burma, hauled to the nearest stream, floated to market, where it is hauled out of the river. This work has been done for many years by the elephants sung about in Kipling's "On the road to Mandalay." A leading lumber firm of Burma has recently employed tractors with considerable success, on ground too soft for elephants.—*Forest Service Bulletin.*

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The Infantry Must Dig as Well as Fight

By

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THE necessity for trenches in almost all phases of modern warfare and their proper relation to the activities of all branches of the service are so well established that a discussion of these points is here unnecessary. The force on the offensive advances against the enemy, meeting at first with only nominal resistance. Eventually this resistance increases. The attacking force proceeds more slowly and makes increasing use of the protection afforded by the natural features of the terrain. Finally, the point is reached where the enemy's fire prevents further movement forward, and the attacking force must prepare to hold the ground already occupied. Natural protective features are used to the utmost extent; where these do not exist artificial protection must be obtained and the soldier equipped with his entrenching tool begins, each man for himself, to dig a hasty rifle pit. This affords the individual the most quickly obtained means of protection. If the enemy's resistance weakens the command again advances, and abandons these temporary shelters, but if the resistance does not diminish, and particularly if it increases, then more elaborate protection is needed, and that perhaps very promptly. In this case each man first strengthens his own personal defense and then, if possible under the supervision of his immediate commanders, begins to connect his defense with those of the men adjacent to him. In this way the beginning of the trench system is formed.

Prior to 1914, military training in trench work did not extend in much detail far beyond this stage, but during the first three years of the World War it was learned that this stage is but the first and most elementary part of what may become a very extensive and complicated system of trenches. If the enemy cannot be driven from his position, and if, on the contrary, his resistance augments to the verge of his taking the offensive, this action on his part must be prevented by a continued development and elaborate strengthening of our own trenches, and the soldier, in addition to being a fighting unit, assumes the character of the day laborer, doing the hardest kind of manual labor, that is, excavating earth and carrying by hand enormous quantities of material for the further strengthening and development of the system of trenches which have been started.

A trench system having thus been begun, work on it never ceases. The first temporary work disintegrates and must be done over, new units replace those first occupying the trenches and they bring to the sector different needs and plans, which mean further work. Our plan of defense brings about corresponding developments on the part of the enemy. He endeavors to minimize the effectiveness of our work. This must be met with further changes and developments on our side. Thus, as long as the infantryman occupies trenches a large part of his time must be spent in manual labor.

The moving of huge quantities of earth and the utilization of the immense amounts of materials which are involved in any extensive trench system, form a problem in engineering, and in the World War this problem developed into one whose magnitude was, perhaps, the greatest of any engineer operation in history. Armies have long contained a certain percentage of engineer troops, provided to meet engineer problems, and as trench warfare develops their duties and responsibilities continually increase. Because armies contain this engineer organization and because the construction and maintenance of trenches are primarily an engineer problem, the question sometimes arises why at this stage engineers do not take over altogether this engineer problem and leave the infantry free to devote its whole time and energy to its primary duty, that of fighting the enemy. In other words, why is it that engineers require assistance from infantry in the performance of engineer tasks, and if they need this assistance, just what is it that is expected of the infantry soldier and officer?

The answer to the first question, "Why is help needed?" is that a very large amount of engineer work must be done, often very quickly at critical moments. Calculations could be made for a typical sector to show the amount of earth that must be handled and the quantity of heavy material, corrugated iron, timber, broken stone, sand, water for concrete, etc., which would be needed for its proper development. However, perhaps, a better mental picture will be formed by listing the work which was done in the preparation for an actual attack made during the second year of the World War. Note that all of this work had to be done by one division, in our service a body of men consisting roughly of 1,500 engineers and 25,000 other troops, and in the

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army where this work was actually done the division and the number of troops available was much less than would have been the case in our service. Also note that all this work was done simply to prepare for an attack, that most of it was done above ground where it could not be concealed from the enemy's aircraft, and that, therefore, it had to be completed as quickly as possible so that the attack could be delivered before the enemy could make equal preparations to meet it. The following is a summary of the engineer work in one division during the period of preparations for attack:

(*a*) Eight miles of new trenches:
10,630 yards of main approach trenches;
2,450 yards of communication trenches;
2,370 yards of assembly trenches.
(*b*) Thirty miles of other trenches were cleared, deepened, repaired, improved, traversed, etc. Many were blown in by shell fire and had to be repaired more than once.
(*c*) Eighty-six dugouts of more than 14,350 square feet floor space, excluding those in (*k*), (*l*), and (*m*) following.
(*d*) Thirty-three observation posts:
1 for survey;
3 for division;
4 for infantry brigades;
25 for artillery.
(*e*) Thirty-six special emplacements in front line for ten gas cylinders each. (Cloud gas was not employed towards the end of the war.)
(*f*) Thirty-one bridges to carry vehicles over trenches of which four were for heavy motor traffic.
(*g*) One and one-half miles steel trench tramway for taking up ammunition and evacuating wounded in daylight. The trenches had to be widened considerably for this purpose.
(*h*) Six sets of trench water tanks, capacity 3,350 gallons each, with pipe connections.
(*i*) Deep-well pump and engine, with steel-concrete shelter. During operations this was the only water supply available in the trenches owing to the pipes of the main supply being continually broken by shells.
(*j*) Twelve ration dumps to hold rations and water for 10,000 men for two days.
(*k*) Emplacements and dugouts (not included in (*c*)) constructed for twenty-one medium trench mortar batteries close to the front line.
(*l*) Dugouts and gunpits for sixteen batteries of artillery.
(*m*) Five deep-mined approaches, total 2,500 feet, were run to within 30 yards of the German lines, and twenty Stokes mortar emplacements were constructed off them in the middle of No Man's Land for intensive bombardment prior to assault.
(*n*) All trenches, trench junctions, and other routes signposted.

In addition, the following work was carried out for the Corps in the back area:

(*o*) One-hundred huts to accommodate four battalions, four huts for a field ambulance, and seven for officers, etc.
(*p*) Two wells dug, 28 and 57 feet deep, with tanks and pumps to supply the above hutments.
(*q*) Two wells dug to a depth of 130 feet each, with boreholes 130 feet lower, pumps, tanks and standpipes erected.
(*r*) Two reservoirs of 21,000 gallons capacity, and 3¼ miles of 4-inch pipe for a water point. Troughs were erected to water 8,000 horses, and standpipe to fill 75 water carts per day.
(*s*) Two artillery and one grenade and mortar ammunition dumps.
(*t*) 2,600 trees felled to provide timber and brush.
(*u*) Several cross-country roads were laid out and prepared for the movement of troops.
(*v*) 3,800 cubic yards of stone (mostly flint) quarried for repairs to roads.
(*w*) Cage for prisoners of war.

The foregoing were the principal items only. A multitude of miscellaneous small tasks were performed.

It will be noted that in this case an elaborate trench system already existed, and that all this engineer work was done in addition. At the time the United States entered the war in force in 1918, methods of attack had changed to such a degree that many of the operations above listed would not have been carried out at this later period. On the other hand, new weapons and methods not previously employed on a large scale at the outset, such as tanks, heavy artillery, etc., had come into prominence, and the engineer preparations for their full development would probably have compensated for the classes of work which had ceased to be of importance. In the future, the detailed operations of the past will not be exactly duplicated, but it is safe to say that the volume of engineer work, routine or emergency, will never grow less. Surely, then it is a self evident fact that the rapid performance of such work requires vastly more than 1,500 men per division. Therefore, throughout the period of trench warfare, and particularly at moments of greatest activity, every available man, irrespective of the arm to which he may belong, must be called upon for the important engineer work.

Military engineering is sometimes divided into two classes, called pioneering and construction. Under "construction" are usually included all engineering operations which require special engineering training on the part of officers and skilled workmen or mechanics among the soldiers. Pioneering may be said to include those engineering operations where special training and the services of skilled men may be dispensed with if necessary. In trench warfare the infantryman must expect to perform more or less pioneering work as long as he is in the front-line trenches, and he must be prepared to furnish a certain amount of unskilled labor for the more technical operations under the heading of construction.

In order to determine the amounts and kinds of pioneer work which the infantry will be called upon to do, let us first consider the various situations in which an infantry regiment finds itself when taking

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over a sector of an established trench system. Such positions will include fire trenches, connected by communication trenches, flanked by machine-gun emplacements and strengthened by wire entanglements, together with command posts, observation posts, and shelter for the garrison in the shape of deep dugouts. The immediate task of the infantry will be the maintenance and repair of the various works. In an active sector the constant repair of damage caused by shells will be a considerable item, and this will be in addition to the maintenance which is inevitable because of the comparatively rapid deterioration of hasty works done by men with little skill or aptitude for such work, and inadequate tools and materials.

The enemy is constantly trying to improve his position to neutralize the effectiveness of opposing trenches, gunpits, etc., and as he succeeds in doing this, as he surely will from time to time, wholly new work must be begun to counteract his advantage. In a quiet sector the works require less labor because they are subjected to less destructive fire, and less new construction will be necessary. But the regiment will be extended over a wider front and the total amount of engineer work will be about the same.

In an attack, after the objective is gained, the position must be held against the enemy's artillery fire and counter-attacks. The protection offered by our barrage cannot be continued indefinitely, and immediate steps must be taken to strengthen or consolidate new positions by providing a strong firing line with cover, an obstacle of some sort, even if it is only a simple wire entanglement, and communications to replenish the firing line with ammunition, rations, water, and engineer supplies. The work to be done in consolidation may be divided into four main parts:

1st. The establishment of an observation or outpost line from one to two hundred yards beyond the position to be consolidated or as close as possible to our final barrage line.

2nd. The preparation for the defense of the captured terrain, including the provision of a fire step, traverses, some shelter and wire in front of the trenches.

3rd. The organization of a line of trenches and strong points further to the rear to give depth to the position.

4th. The opening up of communication trenches to the new position.

Of these the first two must, of necessity, be initiated and carried through by the men on the spot, which will be infantry with as many engineers as can be made available. The third item is the duty of the engineers aided by as much infantry as can be made available; and the last item is the duty of the engineers with the assistance of large infantry working parties. All of this work will be complicated by the fact that it will presumably have to be done under a more or less destructive fire from the enemy, much of it will have to be done over two or three times, and the transportation of material and supplies will often be effected with great difficulty; but on the rapidity and efficiency with which the work is prosecuted may depend the success or failure of the entire operation.

In all of this work the infantryman will take a prominent part, he will also be furnished engineers for technical supervision when engineers are available; but frequently, or in major operations, perhaps, as a rule, the volume of engineer work will be so great that the infantry officer will be expected to perform the simpler operations without technical advice, all the engineer personnel being required for the more technical operations. It will be evident that the infantry officer's education is not complete when he knows only how to function with his branch of the service as a part of the troops in combat. He must also be familiar with the laying out and construction of standard types of trenches, obstacles and shelters. He must know how to organize his command and how to direct it to get the most effective results when called upon to do this simpler type of engineer or pioneer work.

The recent war has put the intrenching tool on an equal footing with the rifle. Nowadays, the soldier is at the same time a combatant and a workman; one cannot be imagined without the other. He uses his rifle sometimes; his intrenching tool every day. When the soldier has conquered the ground, if he counts on his rifle to hold it he will be greatly disappointed. He must, tired as he may be, immediately start digging; he must know that each shovelful lifted, in spite of fatigue, is a check to the counter-attack which the enemy is preparing against him at that very moment. For officers and non-commissioned officers to lead their men to the field is a rather easy matter; but to make exhausted and decimated troops work without rest or delay is a far more difficult task. It is, however, just as imperative a duty as the first; the least counter-attack may turn an apparent victory into defeat if the infantry does not immediately "dig in" and hold its gains.

Two great principles must always be present in everybody's mind:

1. Never delay starting a work because the necessary time for its complete achievement may be lacking. This principle holds under any circumstances.

2. In the fight, after the advance, the best means of reforming the troops consists in showing the work to be done and obliging the men to start it at once.

To thoroughly inculcate the second principle, it is necessary in training exercises to order that every infantry maneuver must be closed with a staking out of the lines and commencing work on the final position occupied. Officers and soldiers will thus get the habit of considering maneuvers and intrenching as one and the same thing; both of which are to be executed with similar means and commands. It is wrong to have separate maneuver and intrenching exercises. Intrenching is a part of the maneuver to the same degree as extended order or assault drill. During the active operations of the American Army many

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infantry units moved forward in attack; some of these made assaults, some did not, but all had to intrench sooner or later. Whether on the offensive or defensive, there is no maneuver without intrenching.

What is the relation between the engineers and the infantry in the various classes of engineer work with which both may be concerned? First comes the elementary task of pioneer work which consists in developing a line of rifle pits or shell holes into a trench to be occupied by infantry units. As a general rule this task will fall to the infantry alone and the infantry officer and his men must be trained to handle all problems arising under these conditions with confidence and without technical advice. It is not sufficient for the infantrymen to know the dimensions of the profile of the trench, the thickness of traverses, etc., he must have his unit so trained that the proper dimensions will be obtained automatically, and he must further have trained both himself and his unit so that this trench will certainly be begun the instant that the intensity of combat begins to diminish; and furthermore the trench as it develops must be properly located. Dimensions of profiles, etc., are found in various official War Department documents, and are included in the infantry drill regulations. All infantrymen should be thoroughly conversant with these dimensions and with the general principles governing the location of fire trenches. Further, the infantry unit must be so trained that its commander can place them on the line to be occupied and direct the course of their work with the same ease and certainty that he can handle them in close-order drill. Sometimes it may happen that engineers are present with the infantry at this time. If there is no technical engineer work on which they can be employed they should assist the infantry in laying out and constructing the line of trenches. Presumably, they are more thoroughly trained in this than are the infantry, and if so full advantage of this should be taken. They should be able to locate the line easier and quicker. They should be able to act as foremen and overseers in directing the efforts of men of less skill. The infantry officer should consult the engineer officer, or non-commissioned officer, in command of the engineer detachment, with a view to utilizing the technical troops to the best advantage. But whether engineers are present or not the responsibility of the infantry commander on the ground remains unchanged. He alone is responsible that the work is begun promptly, that the lines are properly located, and that his men work efficiently. The presence or absence of engineers cannot change his responsibility.

Next comes that class of work wherein the bulk is to be done by the infantry but where engineers are present to give technical advice and assistance. Examples of such work would be the maintenance and repair of trenches, the construction of simpler forms of shelter, and in open or semi-open warfare, the repair and maintenance of roads. Here an infantry unit is given a certain area in which it is responsible that the trenches are maintained, or that the highway is kept in good condition. To this unit is attached an engineer detail, commanded by an officer or non-commissioned officer. The theory is that the infantry are fully capable of doing practically every task that may arise if they know how, and that it is not a difficult matter for one who does know how to teach one who does not. The engineers are then present first as teachers, and when the infantry have been taught the special task at hand they remain as inspectors to see that the technical standard is maintained. They also give special assistance in the matter of obtaining technical supplies, tools, etc. The engineer is not forbidden to wield a pick or shovel if there is nothing better for him to do, but if numbers have been properly apportioned he should have his time and attention fully occupied with instruction and the supervision of the work, and he would be open to serious criticism if the technique of the work fell below par while engineers were doing manual labor, or if other technical work suffered because engineers were detailed elsewhere performing non-technical tasks for which unskilled labor was available.

In this case, as in the preceding case, the infantryman is responsible for the quantity and quality of the work and for the discipline of the troops engaged upon it. Again, the presence of engineers can not in any way diminish the infantry officer's responsibility. Quantity is entirely in the hands of the infantry officer. As to the quality, it is sufficient for the engineers, when necessary, to bring to the attention of the infantry commander the fact that it is below par. The engineer may not take any disciplinary measures to secure better workmanship. A cordial understanding between the infantry and the engineer detachment is essential to proper and harmonious work. In general, it is desirable that the engineer and infantry details be independent of each other as regards discipline, rations, transportation and billeting arrangements. In this work a certain amount of engineer instruction for the infantry is necessary. It will, therefore, be obvious that once an infantry unit has received this instruction its whole energy can be devoted to the performance of its task, and as long as the same unit is detailed to the same task, time once devoted to instruction will not have to be spent again in new instruction. In other words, if the same unit can be continued on the same class of work for a long period of time more useful work will be done than if a number of independent units are in succession assigned to the same task, each in succession having to be taught how to do the work. At the beginning of trench warfare the importance of this continuation on one task was not fully appreciated by our Allies

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but by the winter of 1917-1918 the Allied armies had included in their regulations orders which assigned infantry units to this class of work for periods of a week, a month, or even longer. This is a sound policy and one to be encouraged in our own service.

Finally comes that class of work which is primarily technical and the duty of engineers, and there the infantry is present either in the nature of unskilled helpers to skilled workmen or as carrying parties for the transportation of material by hand where the nature of the terrain, or the enemy's fire, or both, prevent transportation by other means. Instances of the infantry being used as unskilled helpers would occur often in road building, in the construction of deep dugouts, etc. Infantry would be used as carrying parties to bring up timber for a plank road, or a deep dugout, sand, gravel and even water for the concrete in an observation post, gun emplacement, etc. Here the engineer soldiers and officers are present in larger numbers and the engineer officer is chiefly responsible for quantity and quality of the work performed. The infantry commander in this case must not, however, feel that he is without responsibility in these matters. Whenever infantry is detailed for engineer work each detachment must be accompanied by its usual quota of officers and non-commissioned officers, and while on engineer work the infantry officers and non-commissioned officers have the same responsibility with respect to discipline and attention to duty on the part of their troops as they would have at an infantry drill. It is not proper for an engineer officer to attempt to discipline an infantry soldier. It is the duty of the infantry commander to see that his officers and non-commissioned officers are properly distributed, constantly on the alert, and that they maintain the same activity and attention to duty as would be required if at extended order infantry drill. Here also cordial relations and a good understanding between the infantry and engineer commanders are essential, and here, as in the preceding case, continuance of the infantry unit on the same task is of high importance, and the precedent set by our Allies was to keep such infantry units on these engineer details for periods up to three months.

When engineer officers are present with infantry detachments on simple pioneer work, it is proper for the engineer officer to aid the infantry commander by suggesting suitable reliefs and the number of spare men, to suggest the best method of securing a good output (explanation of the work, piece work, competition, smoking, times of rest), and how long it ought to take to complete the work. The engineer officer should assist in every possible way in getting the men to work where difficulties arise, but in no case is it his business to drive the infantrymen or to enforce discipline among them. Cases have occurred where the infantry officer, or non-commissioned officer in charge, has thought that his duty consisted in marching the parties to and from the work, and in distributing tools, leaving the supervision of the work entirely to the engineers. Under no circumstances is such conduct justified.

If possible a visit should be made to the site of the proposed work by daylight, and the work should be marked out before the actual workers arrive. The main cause of the small amount of work sometimes done is lack of organization. The infantry non-commissioned officer should work with the men as much as possible, in our service it is a rule "that a corporal works," that is, that he both supervises his squad and encourages it by his example. Even the senior non-commissioned officers should encourage their men and set them an example by themselves working for short periods. The output is also bad when company officers go away and smoke or sleep, and when the battalion or regimental staff officers do not inspect the work in progress. Work should be allotted by sections or platoons. The same section, or platoon, should, if possible, be employed day after day on the same piece of work, so that there may be no loss of time in beginning each day and that the men may take interest in the progress and the completion of the job. Sections, or platoons, should be allowed to rest or cease work or return to their billets when their own particular piece of work is finished.

It must be impressed on all that tasks given to working parties are of just the same importance as orders issued for an attack, and that the work must be carried through with the greatest determination. The success of a whole operation may be endangered by the failure of a working party to carry out the task allotted to it. Special arrangements must be made to see that working parties do not retire prematurely if shell-fire is opened.

The secret of getting work done is keeping at it steadily and deliberately, even slowly, without stopping to look about and talk.

Continual smoking during the working hours is to be discouraged; it is unnecessary and unusual in civilian work except when men are exposed to stenches or in exceptional conditions. It is generally advisable to adopt the principle of the 10-minute halt.

Much energy is sometimes wasted in carrying tools several miles back to billets instead of forming a dump near the job.

As a matter of principle men should not be allowed to go to work without their rifles and fighting equipment, which should invariably be placed so that they can be rapidly picked up both by day and night.

When infantry and engineers are to work together at night, special care must be taken in the selection of the rendezvous, so that there can be no chance of their missing each other. Guides who know the way must be distributed along the infantry column, other-

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wise touch is sometimes lost in the dark and a large part of the column may fail to reach the work. Sufficient time is not usually allowed for working parties to reach the site of the work; it is not safe to assume that large parties will move faster than one mile per hour at night across country or over roads congested with traffic.

Finally, it should be remembered that no two engineer problems are alike, and that each one will have difficulties and phases peculiar to itself. It is for these special features that the presence of engineers is always to be desired, even for presumably simple operations, and where they are present a cordial understanding between the infantry and engineer commanders is always essential to success. The engineers should always be able to give appreciable assistance in the details of organization, in the obtaining of engineer supplies and tools, and in suggesting the expedients to be adopted in overcoming unforeseen difficulties. When an infantry commander has been detailed for pioneer duty he should first of all get in touch with the engineer officer with whom he is to work and discuss freely with him all phases of the task. If possible, they should together visit the site of the work, familiarize themselves with the terrain, the best means of bringing in the details, and material. They should visit the dumps and assure themselves that the engineer material and tools, which will be needed, are actually available and can be obtained when wanted. Details as to billets, rations, transportation, and the like should be settled at the start.

The following classes of trench work will usually be executed by the infantry under the direction of their own officers, with technical supervision by engineer officers and soldiers, though in busy times this supersision may be lacking:

Excavation of trenches,
Erection and repair of wire entanglements.

Less frequently:

Revetment,
Drainage and flooring of trenches,
Sentry or lookout posts.
Camouflage of working parties, trenches, and lookout posts.
Latrines.

Sometimes the construction of light shelters, or simple machine gun or light mortar emplacements, will also fall to the infantry alone.

The above mentioned work represents a large amount of labor. In order that this labor may be directed economically, it is essential that all infantry officers be familiar not only with the simple types of construction for the above mentioned items, but also that they should have a practical knowledge of the principles necessary to plan and organize the work so as to obtain the maximum result with the minimum effort when engineer supervision is not available.

The different points to be considered and determined before starting on any work include the following:

The kinds and quantities of material required.
The number of men required.
The kinds and quantities of tools required.
The kinds and quantities of transportation required for tools and material.
An estimate of the time required.
A study of the technical and tactical conditions.

In considering the material required, effort should be made to utilize material immediately available in close proximity to the work, in order to reduce transportation. Material will not be called for which is difficult to obtain, when other material more available will answer the purpose. At least 10 per cent in excess of the amount estimated should be provided in order to allow for errors in computation, and avoid the risk of the work being stopped on account of lack of material.

In computing the number of men required, the work should be organized in advance, so as to make full use of every man in the working party. For certain work, such as construction of wire entanglements, the duties of each man can be definitely assigned before starting the work and the exact number of men required, called for. In general the smallest party, consistent with effective work, should be used in order to avoid unnecessary fatigue of the command. If the proposed construction is concentrated in a small space, such as a machine gun emplacement, or an observation post, there is little advantage gained in increasing unduly the size of the working party, for too many men would be in each others' way, and would not increase proportionately the work accomplished. If, on the other hand, the work is extended over a large area, such as the construction of a long line of entanglement, the work can be expedited very materially by dividing it up into short sectors and assigning a squad to each sector, so that the work will be proceeding simultaneously along the whole front. In allotting tasks, every effort should be made to utilize men with special qualifications in doing work similar to that in which they are skilled. In certain forms of work, such as barbed-wire entanglements or revetments, it is important to drill certain men to perform each operation in order to obtain speed in construction. These men then should be used wherever possible for the duties in which they are trained.

The transportation of material and supplies should be assigned to a definite detachment designated for that purpose and nothing else, and a careful computation should be made of the number of men needed, taking into account the distance to be traveled and the average load of each man, in order to provide a carrying party of just the right size to properly supply the working party, so that no time will be lost either by the working party in waiting for the material to come up, or by the carrying party in stand-

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ing around waiting for orders. Great care must be taken that the working parties are not ordered to the site of the work until the supply of materials is assured.

Computation of the time required is important in order to provide enough tools and men to complete the work in a given time. So many conditions enter into the estimate of time for doing any piece of work that it is difficult to adopt or use any standards, but in order to plan the work properly, some estimate must be made even though it is at first inaccurate.

The best rules to follow are those gained from one's own experience, as no manual can be made to fit every case. However, the Engineer Field Notes issued by the Engineer Department were prepared after a careful study of the best engineer practices in our own army and in those of our Allies, they give definite rules and tables for the guidance of the man in the field, and until the officer has acquired an extensive field construction experience himself, he should make these notes his chief reliance in laying out his work and in organizing his working parties.

The amount of work accomplished can usually be increased by allotting tasks to each man. Care should be taken that these tasks are not excessive at first, so that by energetic work a man will complete his task and be relieved earlier than the usual working period of 8 hours, which stimulates him to put forth his best efforts.

The technical considerations, which must be thought out beforehand, consist mainly in having a clear idea of the work to be constructed, dimensions, etc., and if necessary rough sketches or plans should be made, showing all dimensions, method of making joints, or other details likely to arise in the prosecution of the work.

The tactical conditions which must be considered and allowed for in executing work often impose restrictions which materially alter the plans, for example: All the material may have to be brought through the communication trenches; possibly the work must be executed, if not under the enemy's fire, within reach of his fire if discovered, in which case the working party should not be too numerous in order not to attract attention or present too large a target, if discovered. Possibly the work will be done in such close proximity to the enemy that no noise can be permitted, and very often it must be done at night. These conditions impose restrictions which will influence the organization and conduct of the working party.

In any event, the importance of carefully planning work beforehand in all its details, including computation of material, men and tools and the consideration of the technical and tactical conditions is evident. The time spent in planning and organizing the work will be saved many times in the execution.

The engineer duties of infantry have been here discussed chiefly from the viewpoint of trench warfare. It is to be remembered that trench warfare is but one phase of warfare in general and was chosen as the basis of this paper because under these conditions infantry finds its engineer duties greatest in magnitude and in variety. It is true that this special phase of warfare may not recur soon, perhaps not even during the lifetime of this generation, but the infantry officer who is prepared to meet his engineer duties under these conditions is ready to meet them under the simpler conditions of open or semi-open warfare.

What has been said concerning these duties applies most forcibly to trench warfare but it must be remembered that all this also applies in some degree to any type of warfare where trenches appear, and trenches will undoubtedly appear whenever any army remains stationary in the presence of the enemy for a period of 24 hours or more. Such pauses, or temporary halts, are usual in any campaign and infantry must then expect, in all warfare, to apply the principles here discussed, and perform to some extent the duties mentioned.

Every officer must be thoroughly impressed with the fact that when an infantry unit is detailed on engineer work its commander is responsible for the quality and quantity of the work performed.

An Army Association. In a letter to the Editor, concerning the Society of American Military Engineers, a member says:

I feel that with conditions as they are, the time is ripe for the formation of an Army Association and the consolidation of all our military publications into one Service Journal. We now have the Infantry Journal, Cavalry Journal, Field Artillery Journal, Coast Artillery Journal, etc., etc., with their corresponding associations in most ceses, each striving to keep its head above water and issuing a lot of stuff of greater or less merit. One single journal, with a section devoted to each arm of the service, would be of great advantage; for it would tend to break down the splendid isolation of each arm and keep the work and aims of all the arms before all, for every officer could subscribe to one journal, whereas, he cannot subscribe to all that are now being issued.

Such a Service Journal would necessarily be devoted to purely military matters, and technical matters would, so far as the engineers are concerned, have to be disseminaed by "Professional Papers" or "Occasional Papers", as above indicated, and in the Artillery by "Artillery Notes". It would, however, never be handicapped by the financial problem, as it would naturally include among its subscribers practically all army officers, and as a medium for advertisements would appeal to advertisers such more than the many exclusive publications we are cursed with now.

NOTE. Our correspondent's ideas are interesting and we are inclined to agree with his as to the need of a service journal. But it does not seem possible that such a journal could *replace* all the journals of the various branches without being unduly bulky. Every trade and profession has its own journals, and the arms of the service must likewise have each their own. But there is still a field for a journal, devoted to the interests of the service generally, The *Army & Navy Journal* and *Register* fill most of the need, and a Service Journal would be primarily technical and tactical. A few efforts have been made to start such a journal, but none of these was over successful. ED.

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Operating Experiences at the Keokuk Lock and Dry Dock

By

M. Meigs

United States Civil Engineer

AS is well known, the Keokuk lock and dry dock were built by the Mississippi River Power Company in connection with construction of a power dam across the Mississippi River at the foot of the so-called Des Moines Rapids, and the drowning out of the old Des Moines Rapids canal. These rapids are in a gorge between the hills, with a low water slope between Keokuk and the head of the rapids of 22 feet in a distance of 12 miles.

The bed of these so-called rapids consisted of flat ledges of limestone rock nearly horizontal. The stream being nearly three-quarters of a mile wide, the low water flow of 20,000 cubic feet per second was insufficient for even flat-boat navigation. It is related that on several occasions the river has even been waded at low water.

The old Des Moines Rapids canal extended upstream 7.6 miles from Keokuk, was 300 to 350 feet wide, and formed by building a long embankment parallel with the shore and three locks 80 feet by 350 feet, one at the head and one at the foot of the canal, and one 2½ miles above the foot. But little of the canal was in excavation. The cost of the project was about $5,000,000. It provided for 5-foot draft on the lock sills at low water and, except in later years when the increasing silt in the river made continuous dredging necessary, this depth was maintained, though with some difficulty.

A passage through the canal was, for the larger boats, a slow and tedious maneuver, with the added difficulty and danger of landing a heavy boat three times in locks not much wider than the boat.

In addition there was the danger incurred in navigating a 200-foot open channel excavated in rock, which connected the canal with the head of the rapids at Montrose, 3½ miles away.

All of this old canal with its locks and dry dock are now submerged from 6 to 26 feet.

The Engineer Department as well as river men generally, when the new dam was proposed, recognized the great benefit to navigation that a single lock of larger size than those of the old canal would afford. It would provide a lake with deep water for many miles above the dam, allowing full speed at all times, and there would be a further advantage if the locks were built so that the time required to pass a vessel were held to anything near what it was at a single lock in the old canal.

Accordingly little objection was raised to building the dam and power plant. It was recognized as a great improvement to navigation as well as a notable conservation project, in that it made available in the heart of the country an immense water power which had previously gone to waste.

To the genius and perseverance of one man, Mr. Hugh L. Cooper, M. Am. Soc. C. E., the fruition of the project is due. After six years of unsuccessful effort to finance the project, he enlisted the help of the Stone & Webster Corporation of Boston, Mass. Together these two built and placed in operation the entire plant in the space of 2½ years.

One thing that made the project feasible and comparatively easy was the excellent foundation everywhere available. Fig. 8 shows the 25-foot cut for the tail-race of the power-house and the nature of the bed of rock on which the dam and power-house stand.

It is the purpose of the writer to describe herein the general operation of the lock, dry dock and gates, the difficulties encountered and overcome, and the experience gained in this operation.

The engineering magazines in the last four years have all published a number of articles, many of them quite complete and well illustrated, giving the details of construction of the dam, power-house and lock. One of these is particularly authoritative, being written by Mr. B. H. Parsons, the mechanical engineer assistant to Mr. Cooper, the chief engineer, and who designed all the machinery. It is in two installments contributed to the *Engineering Record,* September 18th and October 9th, 1915. Full descriptions and detailed plans will be found in these papers.

Both the lock and dry dock, and especially the gate mechanism, are built on bold and original lines, and after operating them six seasons it is possible to form a conclusion as to the value of the new forms of gates and appurtenances, hitherto untried, so far as the writer knows.

The general view of the whole group of works, Fig.

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1, shows the power-house and dam, in their general relation to each other. The only access to the power house from the Iowa side is across the lock and dry dock.

Upper Gates

At the upper end of the lock the problem was to build a gate and a bridge that would allow loaded railroad cars and locomotives as well as foot traffic access to the site of the extended power house when it came time to install the second set of 15 turbines with their accessory machinery. Fig. 2 gives a view of the foundations for these units, extending north from the lock site.

The use of ordinary mitering lock gates would have required in addition the construction of two bascule bridges crossing the openings at the head of the dry dock and lock. To combine the functions of gate and bridge was of manifest advantage. This led to the design of floating gates to serve both as gate and bridge. It was also found that by making the guard gate, the upper-lock gate, and the dry-dock gate interchangeable, any one of them could be taken out and docked for painting and repairs when necessary, without unwatering the lock. Fig. 3 shows the upper gate of the lock in dry dock for painting.

The floating submersible gates, three in number, consist of trusses framed vertically for carrying a loaded train of heavy cars and horizontally to resist the thrust of the water. The skins of the gates are on the downstream side. The lock being 110 feet wide and the depth of water on the sill being 14 feet, the horizontal thrust amounts to 340 tons.

To float the structure there are five tanks enclosed in the lower half of the gate. Two of these at the ends, with a displacement of 4,600 cubic feet, are always empty, and are insufficient alone to float the gate. Two tanks 3 feet deep with open bottoms below these, and a larger one in the middle, all three connected, with a combined displacement of 5,990 cubic feet, receive air from below when the gate is to be raised and are emptied of air as necessary when the gate is to be lowered. The air pressure in these three tanks determines the amount of water in the gate and hence its buoyancy.

The inlets for air are in the bottom of the lock under the gate, and consist of four short pipes opening upward and discharging air into the water through which it bubbles up and enters the open bottoms of the three gravitating tanks. To raise the gate the operator opens a valve on the air line connected to the storage tanks and as soon as air enough has escaped into the three tanks the gate begins to float and ascend.

It was soon noticed that this ascending movement accelerated as the gate moved up. The lessening pressure allows the air to expand on nearing the surface and it expels part of the water from the tanks. The combined weight of water and gate thus become less and less, the buoyancy of the gate increases, and if allowed to continue it would finally rise until it had attained equilibrium. On emptying enough air to start the gate downward the reverse occurs. The gravitating tanks admit more water as the pressure increases, which accelerates the downward speed and, unless prevented, the gate would settle on its supports at the bottom of the lock with a very considerable shock.

The air for supplying the gate passes through controlling valves in the lock operator's house at the upper end of the lock. (Fig. 6.) The air discharge valve connects by a flexible metallic hose 6 inches in diameter with the top of the gravitating tanks. This hose unwinds from a drum or reel on the lock wall as the gate descends, and by means of counterweights winds up as the gate rises.

At the opening of the lock, June 12th, 1913, on account of the number of boats below waiting for pas-

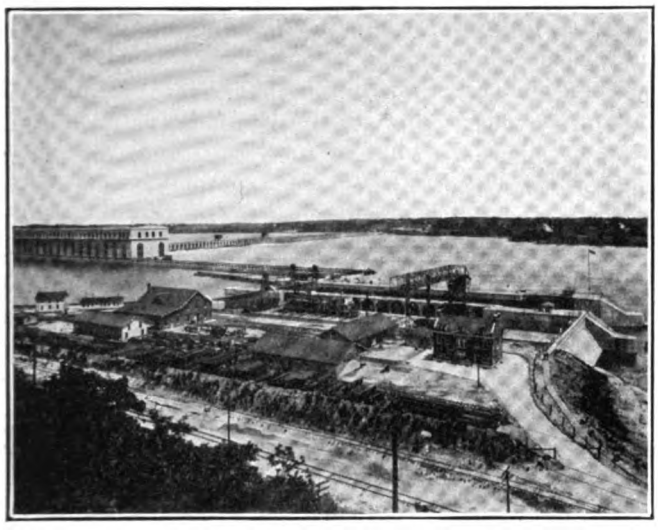


Fig. 1. General view of power house, dam, lock and dry dock

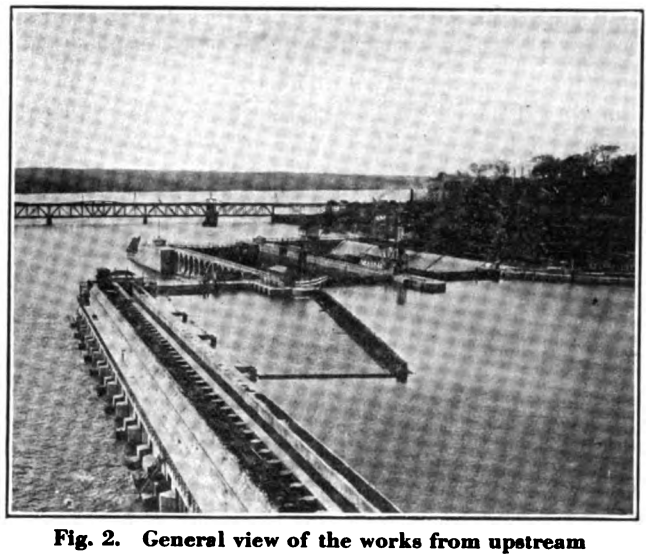


Fig. 2. General view of the works from upstream

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sage, no proper opportunity was had for getting practice in the operation of the machinery, which was an experiment at best. When the first boats entered the lock and the lower mitering gates had been closed, the floating gate which had been raised to position, suddenly started lifting again and to the consternation of the engineers the bottom of the gate rose 6 inches or more above the miter sill. A sheet of water escaped under it and passed over the sill into the lock chamber. Up to this time no stops had been provided to limit the upward travel and the operator, inexperienced of course with this particular gate, had allowed air to accumulate so that the flotation became enough to lift the gate against all the friction generated by the 340 tons of water pressure against it. The gate, however, was easily lowered by exhausting the air, and no damage ensued. Stops were of course at once provided.

This experience, however, was in a way a happy one. It tested the gate to an extent never contemplated, as the sill was supposed always to take the thrust at the bottom, and the strength of the structure was thoroughly demonstrated. Also it showed that should the miter gates be carried away by a boat entering the lock from above, as has sometimes happened at other locks, it would still be possible to raise one or both floating gates and so shut off the flow of water, making the upper gate a true guard gate.

Since this occasion, the two floating gates at the lock and the gate of the dry dock have given no trouble whatever. Small adjustments have been required occasionally, when concrete expanded and pinched the sliding latches, but they have been of minor importance and easily made. One rocker arm of cast iron, operating the gate latch, broke and had to be replaced, a simple matter. Once the gate after being lowered suddenly rose again just as a boat started to leave the lock. This was because the operator failed to blow out enough air to keep it down. The boat struck the gate with some force, but fortunately little damage was done to either, and it was a lesson the operators will not forget.

The gate operates easily and smoothly and the lock men like it better than mitering gates, to which they were long accustomed. They have learned to give it excess air as it nears the bottom and thus settle gently on its seat. Likewise, they have learned with little trouble to raise it smoothly until it touches the cushioned stops without shock. In short, it operates perfectly and more cannot be said.

For locks of great lift where the height of the upper sill above the lock floor is sufficient to provide for lowering it, the writer would recommend this type of gate and prefer it to mitering gates for the following reasons:

1. It requires much less length of lock wall than mitering gates.

2. At Keokuk, with a dry dock close by, it can be docked in summer and properly painted and cared for. Those who are accustomed in our northern latitudes to clean and paint their gates in winter weather after the close of navigation, will appreciate this advantage.

3. It makes an excellent bridge of ample width for all traffic, much preferable to the narrow, indirect track across the tops of mitering gates. At Keokuk the gate is used by perhaps 150 employees of the lock and power house. In addition, there are visitors who come from great distances to see the power house and lock. According to the records the number of such visitors is from 25,000 to 30,000 per annum.

4. Either floating gate can be lifted should the lower gates be carried away and no collapsible or other cofferdam above them will ever be necessary.

5. The gate can be operated even under a considerable head of water due to leaky valves in cases where mitering gates could not be opened (see post).

Mitering Gates

These gates are of novel design and have always operated perfectly. The miter posts were built plumb and when first swung on their pivots by removing the blocking underneath they hung less than ⅛ of an inch out of vertical. This small variation was corrected later by adjustment of the anchors, so that the gates mitered to within one-tenth of an inch. This close adjustment has been maintained up to the present time. The only trouble in operation was with the upper pintle. Some difficulty was experienced in properly lubricating it, as is often the case with pins that revolve through only part of a circle. The difficulty was overcome by providing a grease cup that is operated with a long wrench and gives enough pressure to force grease (mixed with graphite) between the surfaces to be lubricated.

The design of this gate is unusual but it has demonstrated its success. The distortion common in circular gates, due to hanging a curved shape on one edge, is entirely absent in the Keokuk gates, which are stiff and miter perfectly at all times. (See Figs. 4 and 5.) The principal dimensions of the gate are: height, 49 feet; length, 66 feet 4¾ inches; depth in middle, 11 feet.

On unwatering this gate in the winter of 1915-16, a very rapid corrosion was noted at the heel of the quoin due to the bronze bearing which carries the weight of the gate and on which it turns. This should have been provided for by attaching zinc to the iron parts, as is done in the navy next to all bronze attachments to the skin of the vessel, and in the neighborhood of a bronze propeller, where such is used. It is proposed to do the same thing at these gates.

The air chambers in these mitering gates are not, at lower stages, fully submerged. Some water leaks in and has to be pumped out once in two months or so. It keeps the inside of the tanks damp and promotes corrosion. The experiment is being tried of protecting the steel inside the tanks with whitewash.

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At present this practice, after two years, seems to be perfectly successful.

The swinging of the gates is done by a bull-wheel and strut, in principle the same as used at Panama. This gives a strong thrust to put the leaf in motion, a swift movement at the middle of the swing and a slow, powerful closure at the end. The bull-wheel is operated by gears connected to a double reversing engine operated by air pressure. It is so arranged that overrunning is prevented by a self-reversing mechanism connected with the bull-wheel. A cam on the wheel turns a cock at the end of a stroke and reverses the engine. If the operator fails to shut off the power the engine keeps reversing itself and turns the bull-wheel back and forth, about 10 inches of travel. This travel, being at right angles to the strut at either end of its stroke, communicates no appreciable motion to the gate.

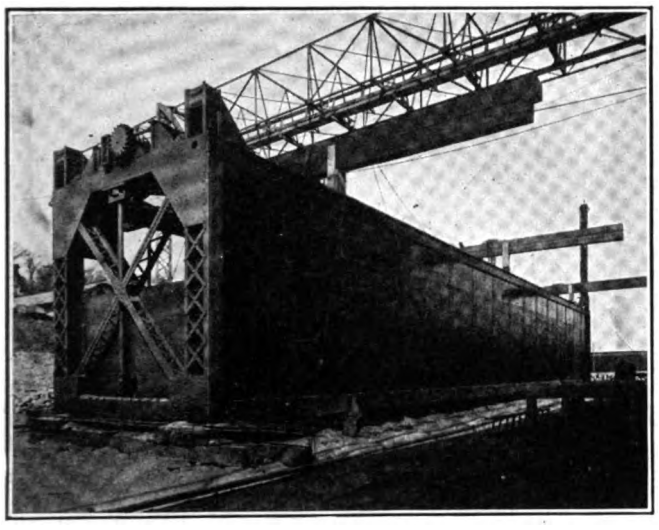


Fig. 3. Guard gate in dry dock for repairs

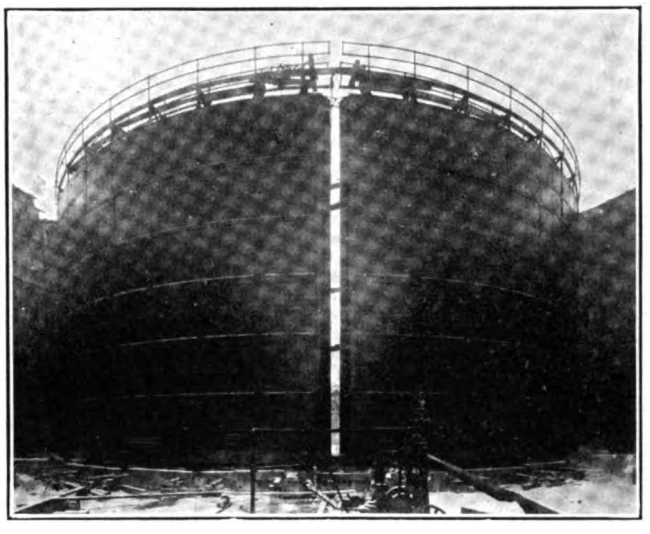


Fig. 4. The mitering gates

Air Control

The gates are all controlled from the operator's house at the upper end of the lock. The air is introduced into this house in a header from which branches run to all gates. The operator has before him an inclined table with the handles of all the valves grouped together for each gate. (Fig. 6.)

The groups are: Lower gates, upper gate, guard gate, dry dock gate. Separate valves control the two leaves of the miter gates, the bull-wheel engines and the miter forcing machine on top of the west gate. Similarly, the floating gates have one valve for admitting air, one for discharging it, and two for the cylinders that operate the latches on which the gates hang in the raised position.

In addition, there are panels and valves for the intake and discharge valves. All the operations of these various engines, etc., are made visible on the board by miniature electric bulbs—red, white, and green. These light-up in succession as each movement takes place, and tell of the progress and completion of each movement. No interlocking system was attempted or has been found necessary. Besides the lights on the board, visible signals turning from white to red are provided for the floating gates to show when the latches are out or in, as these gates are being operated.

Filling and Discharge System

The lock is filled and emptied by means of a steel penstock or tunnel buried in concrete under the toe of the east wall. This tunnel is 13 feet in diameter to the discharge valves on top of it, and tapers thence to 8 feet at the farther end. The water is delivered to the lock by means of 8 cross conduits of steel, 6 feet in diameter, buried in the lock floor, each one carrying 7 openings, 3 feet in diameter, discharging vertically. There are 56 of these 3-foot openings. The greater part of the head in the lock or tunnel is taken by the steel of the penstock since there is not concrete enough around the outside of this penstock to sustain the pressure due to 40 feet of water. Since it withstood the shock of a water hammer that broke all the discharge valves, as hereafter related, it is apparently strong enough, though only 3/8-inch thick.

The filling valves are not placed as is usual, on both sides of the entrance to the lock, but all on one side. This arrangement has a distinct advantage in that it tends to draw all drift, of which there is a good deal, away from the entrance to the lock, and facilitate its removal through a drift gate located in the cross wall joining the lock to the power house.

Both admission and discharge valves are situated on the axis of the 13-foot penstock or tunnel. There are four admission and four discharge valves, each 7 feet in diameter. They are exact copies of the

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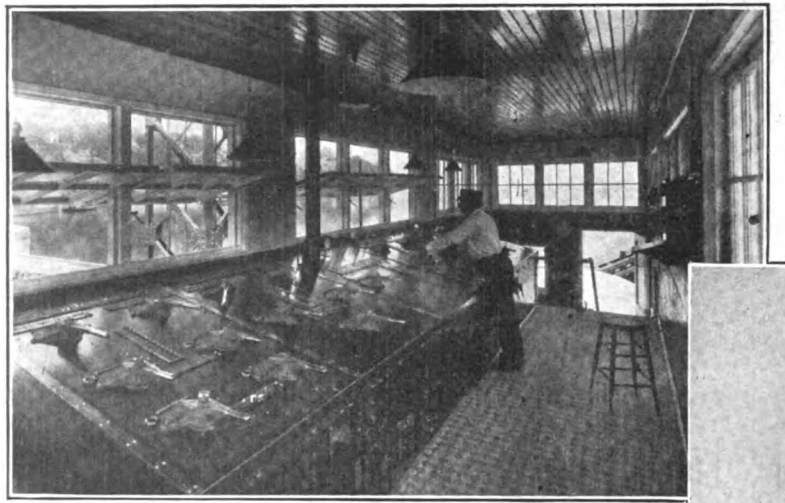


Fig. 6. Lock operator's table and controlling valves

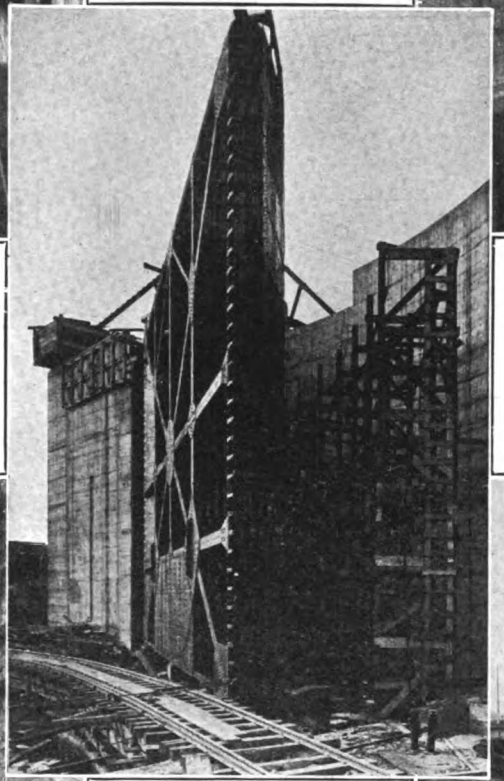


Fig. 5. West leaf of mitering gate

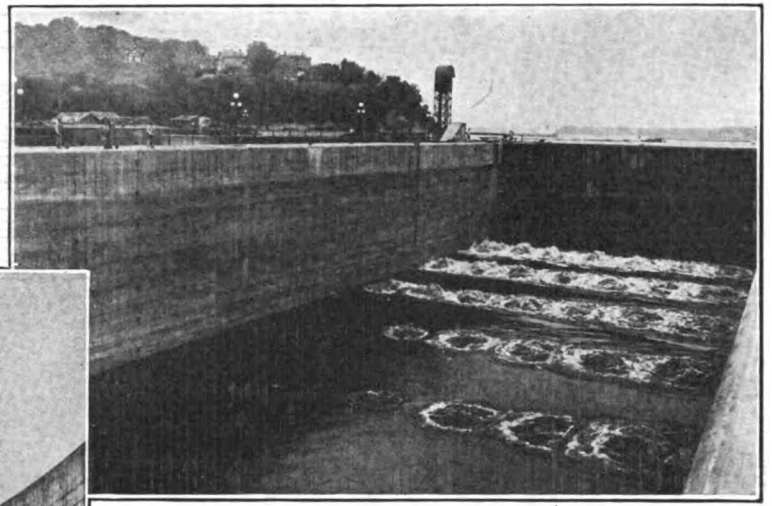


Fig. 7. Interior of lock chamber; inlet valves opened



Fig. 8. Rock excavation for tail-race of power house

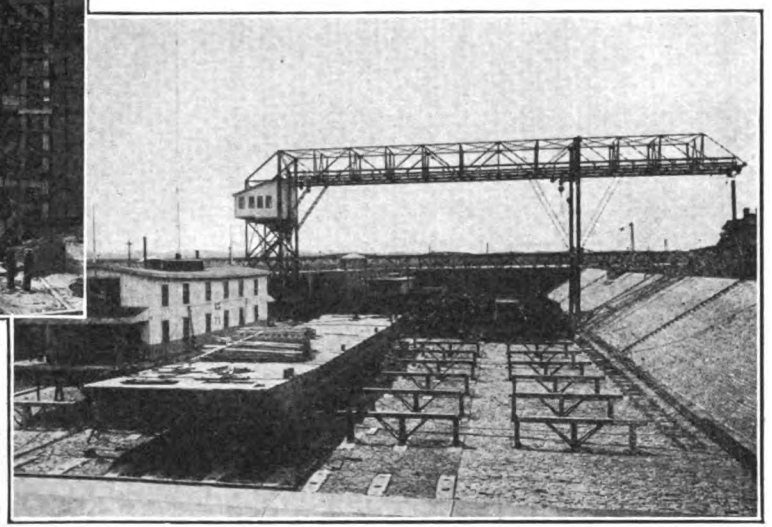


Fig. 9. Dry dock entrance, showing cantilever crane and steel cradles

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Panama valves and were specified by the Board of Engineers, U. S. A. They are of the balanced sleeve type, consisting of a cylindrical drum with closed top suspended above a 7-foot circular shaft communicating with the main 13-foot penstock. The drum sits on four legs or pedestals, leaving an opening the height of the legs for the passage of water. Sliding vertically inside the legs and drum is a sleeve of proper diameter open at bottom and top. This sleeve is raised or lowered by a stem that connects it to the piston of an air cylinder, 15 inches in diameter, on the lock wall.

This valve is a variation of the familiar bath-tub stopper, which acts as stopper and overflow at the same time, except that in this case the drum takes the place of the long pipe that would be necessary to reach above the water level. Objections to the bath-tub form of stopper for a lock inlet are that it is very heavy and that it sucks in enormous quantities of air with the water. On the drainage canal at Lockport, Ill., is a lock with 40-foot lift contrived on this plan, and when the valve is raised to its full height it takes in so much air with the water that, on the lock filling and the velocity of the intake falling off, the air returns to the uptake and spouts large volumes of water 20 to 30 feet in the air, endangering the lock men.

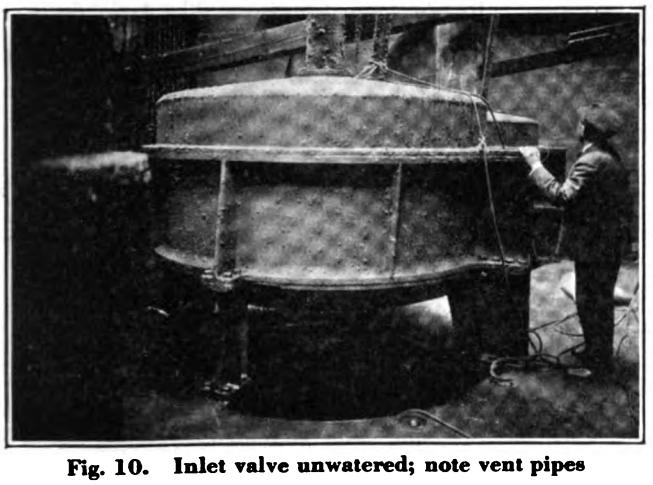


Fig. 10. Inlet valve unwatered; note vent pipes

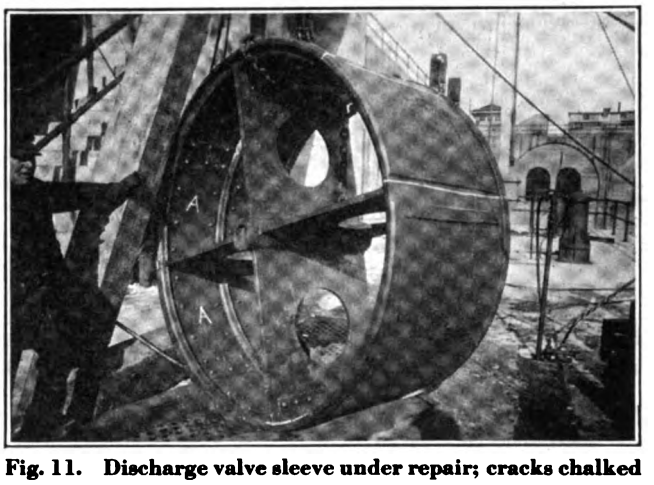


Fig. 11. Discharge valve sleeve under repair; cracks chalked

At Panama the locks are operated entirely by electricity, but at Keokuk the motive power is compressed air. The cylinders are 15 inches in diameter with 31-inch stroke, and are piped top and bottom to the table in the lock operator's house at the upper end of the lock.

An interesting experience was had with these valves soon after the lock was put in operation in June, 1913. One night the lock operator in raising the valves to fill the lock heard a loud noise like an explosion from the neighborhood of the valves, followed by the sound of falling water. Nothing further happened and the valves closed properly but the same thing continued to happen at intervals and was the cause of much speculation. It was finally discovered that the valves, while deeply immersed, nevertheless entrain more or less air by way of the grating protecting the valves from drift. The air collects in the tunnel at the far end and is held there by the rush of water until its velocity falls off. It then comes stealing back along the top of the tunnel and collects in the first uptake, that of valve No. 4. It there forms a partial vacuum under the valve. If the other valves have solid water under them, as soon as the valves lift, especially if the other valves lift before No. 4, the downrushing stream meets inert water in the tunnel and shoves the slug of water in No. 4 against the dome of the valve, constituting water hammer of the most serious kind. The valves are of semi-steel like those at Panama, and of considerable tensile strength. It has been calculated that the pressure against the top of the valve must have reached 500 pounds per square inch to break the pedestals as it did. On unwatering the valves after navigation closed it was found that this water hammer had broken 15 of the 16 pedestals of the four valves. Fortunately, the shape of the fractures was such that the dome or cover of the valve after lifting returned to its place so accurately that the valves continued to function. The covers acted as check valves. Nevertheless, it was thought best to renew the pedestals and this was done. This trouble was overcome by venting the valves to the air, so that no vacuum could form. Accordingly, two air inlet pipes were added by drilling through the top of the dome and the valves have since performed without trouble of any kind. The writer was a little afraid of the effect on the tunnel of letting a mass of water 7 feet in diameter fall 40 feet into the tunnel, but on applying a gauge to the interior of the tunnel fluctuations of only 5 pounds were indicated. The cure has been complete. Fig. 10 (valve unwatered).

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Outlet Valves

The outlet valves sit directly on top of the main penstock and are also of semi-steel and otherwise identical with the intake valves. These valves, however, receive the pressure on the inside instead of the outside, and discharge outwards. After three years of successful operation there was an accident to valve No. 4. The operator started to empty the lock by raising the valve, when there was a sound like a heavy explosion that rocked the lock to its foundation. When he started to fill again there was a considerable leak from valve No. 4 and the lock did not fill completely by 6 inches. Examination by a diver showed the valve closed but a piece was gone from the movable sleeve amounting to about ⅛ of the circumference of the valve. It is worthy of note that it was possible to operate the upper floating gate even with this 6-inch head and the friction caused

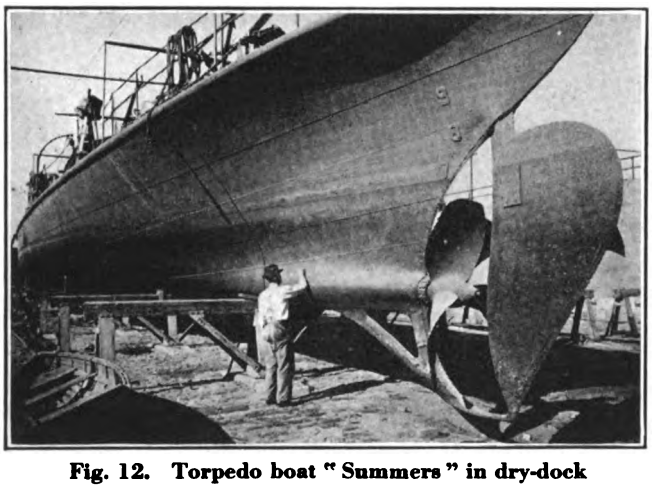


Fig. 12. Torpedo boat "Summers" in dry-dock

thereby, so that no boat was delayed. Under the same circumstances it is very doubtful if ordinary mitering gates could have been opened at all until repairs were made. In this lock the mitering gates have very powerful machinery which will open them against a 16-inch head.

Repairs were at once made to the valve by closing the gap with 4-inch by 6-inch needles put in place by the diver, though that particular valve was for the rest of the season out of commission. Later the same explosion occurred in No. 3 and No. 2 valves and they were repaired in the same way by a diver, leaving only one valve for use.

On unwatering the valves at the close of navigation it was found that all four were broken. No. 3 was minus a piece amounting to one-quarter of the circumference, No. 4 had lost one-eighth of its circumference, No. 2 was cracked and swelled under pressure so that it could not be used, and No. 1 was cracked but *could* be operated. The cause of these breakages was the shocks resulting from the dropping of the sleeves closing the valves suddenly when letting water out of the lock. In one valve the nut had come off the stem allowing the sleeve to drop, another had the stem broken just at the top of the sleeve, another had the stem pulled in two where the two pieces of pipe that connected with the piston rod of the operating cylinder were united at a screw joint.

To unwater the lock the trestles of the collapsible dam were raised, the needles placed and a large sheet of canvas spread over the needles to make them water tight. The drainage pump provided for such occasions (located in the gallery under the power plant) was started under air pressure and soon the lock and valves were dry.

The first thing done was to take out the stems. These consisted of double-strength 6-inch pipe in two lengths coupled together. The sleeve uniting the two pieces was a bronze casting and it was found, as is often the case where bronze and steel are in contact under water, that the threads of the steel pipes had corroded away (from galvanic action) allowing the pipes to pull apart. In making repairs extensive resort was had to acetylene welding. The two pieces of pipe were thus united, and a weld was made between the pipe and the steel bar or spindle which connected the stem to the sleeve of the valve. The pipe and the cap which connected it with the piston rod of the air cylinder were likewise welded together. Where the bar or spindle passed through the spider of the sleeve it was found there was no fillet under the 6-inch portion of the bar and all were filleted at this point to avoid breaking at the right-angled joint where the spindle reduces from 6-inch to 4-inch diameter.

To repair the sleeves a rig was built and the sleeves hoisted to the operating deck above the valves. (See Fig. 11. The cracks are chalked.) This was a matter of some difficulty, as the sleeves weigh 5,000 pounds each. The work was carried on under great difficulties because of the extremely cold weather of December, 1917.

That winter found all the large machine shops loaded up with war work. The patterns from which the valves had been built had been burned. The Panama valve patterns had been shipped to Panama, and to be ready for navigation in the spring it was decided to repair the old valves, since new ones could not be built in time. A diver was used to recover the pieces broken out of the valves, and after examination it was thought best to replace the fragments and hold them in place by riveting them to boiler plate properly shaped and placed on the inside of the sleeve. The plate was riveted with many rivets countersunk on the outside to give a smooth surface and the ends of the plates were bent at right angles and also riveted to the spider connecting the sleeve and stem.

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Fig. 11 shows one of these valves in process of repair. The cracks where the piece came out are marked with chalk and can be seen in the picture. It was evident on examination that the water hammer was most severe, for every valve was cracked in several places. Originally an effort was made to construct the Panama valves of steel, but after losing many castings it was decided that it was impossible without enormous wastage to obtain perfect results and accordingly they were cast from semi-steel, not so strong, but, with some thickening of the parts, strong enough for their purpose. The Keokuk valves are of the same material.

Before the winter was over the main tunnel was nearly full of ice and great trouble occurred from small leaks that froze and had to be constantly chopped and removed. The work too was deep down in a damp hole, and caused a good deal of suffering to the men, but the opening of navigation found the valves replaced and they have functioned for two whole seasons since. It takes air pressure of about 55 pounds to lift the valve off its seat when the lock is empty. When filled it takes from 75 to 90 pounds. The operation of these discharge valves has not been as satisfactory as that of the inlet valves. If the water which is inside these valves, with a bursting pressure, entered and left the valve vertically and unimpeded on all sides they would probably have operated satisfactorily. But the water which flows toward the valve horizontally is turned upward through a very short connecting piece or saddle. Consequently the flow is angular or oblique, and the water striking against the sides and the spider of the valve, sets up tremors and oscillations that are undoubtedly the cause of their failure. There are grooves in the outside casing or drum of the valve in which certain guides slide to keep the sleeve from rotating, but these grooves are very shallow and the guides too small to take care of the work they have to do. For outlet valves these grooves and guides should be much enlarged and more powerful in controlling the movements of the sleeve. (See Fig. 11, at right.)

The water leaving the lock goes through the same tunnel as the water entering. The valves being located about 300 feet from the lower end of the lock do not quite unwater it because of the slope in the river, and in emptying the lock there always remains a head of about 3 inches on the mitering gates. This gives no great trouble as there is power enough to open them against a head of 16 inches, the operating mechanism being so designed. The lock fills in 15 minutes.

Spouting

At low water with a water cover over the inlet holes in the bottom of the lock of only 7 feet, there is naturally some spouting. Jets rise to a height of 5 feet. But here again the delivery of water, from one side of the lock only, proves an advantage in the handling of river boats. This comes from the fact that the holes nearest the tunnel spout but little water and leave that side quiet, so that a boat strains but little at her moorings. The water spouts highest from the last hole of the cross conduit. This is due to the effect of velocity, as is pointed out in an admirable contribution to the International Marine Congress by Mr. Whitehead, U. S. Asst. Engr. at Panama, who discusses mathematically the flow of water in the Panama conduits, and shows that given head enough and length of cross conduit enough it is perfectly possible that several of the holes nearest the entrance from the main tunnel would pass no water at all.

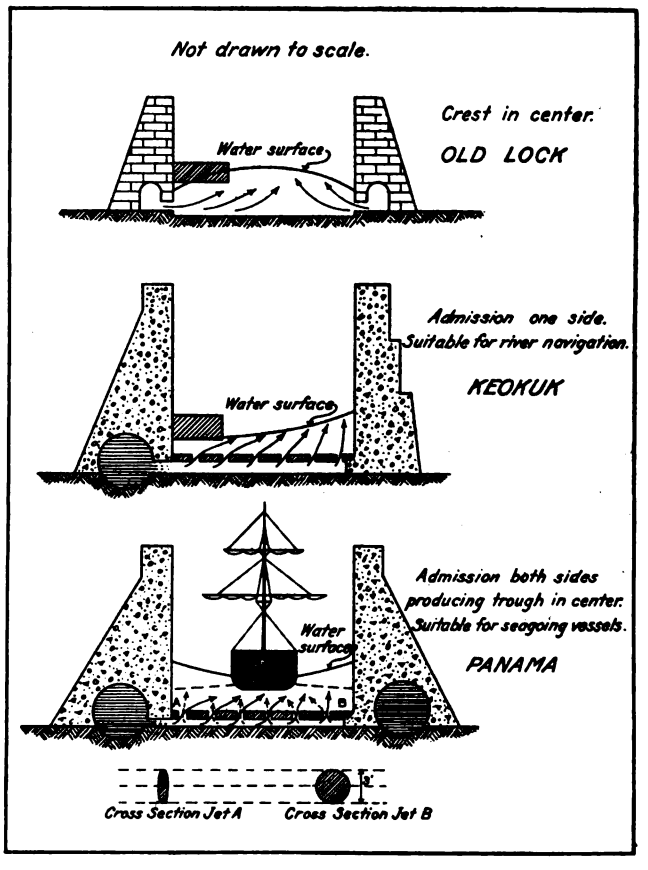


Fig. 13. Methods of filling lock

In plain language, the entering water moves so swiftly that it cannot make the turn. The circular openings, on account of the very oblique approach of the water become elongated ellipses with but small cross-section, while at the end the water flows vertically utilizing the full section of the aperture. At Panama the conditions are different. From Keokuk, sea-going ships cannot lie along a wall without damaging gear of all sorts that projects from their sides, hence they must be held in the middle, clear of the walls. At Panama they open the valves on both sides at once and the stronger spouting of the last holes raises the level of the water at the sides of the lock, keeping the boat in a trough in the middle.

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But in providing quiet water for river steamers and barges the entrance on one side has advantages. (Fig. 13.)

Steamboat men have learned not to tie their boats on the west side of the Keokuk lock when they are to be lifted to the upper level.

The Lock

The lock is wholly of concrete except that occasional "plums" were introduced in the heavier parts to save expense ("cyclopean" concrete). The forms were of wood, in sections of about 5 feet in height. Every 40 feet there is an expansion joint toothed into the adjacent section of the wall. The walls were built in alternate sections. Tarred paper was used in the joints and the cracks were filled with tarvia. The walls are of gravity section, except that there is a top 20 feet wide, the overhang being carried on arches. This liberal width is a great advantage since it affords plenty of room on top of the walls for all purposes. At times as many as 2,000 excursionists disembark from a river steamer to visit the power house. As many as 30,000 have visited the power house in one year and most of these came by water. Such crowds if allowed to spread all over the lock wall would make the work of the lock crews almost impossible, and it was found necessary to place a low rail 6 feet back of the face of the lock chamber with trespass notices thereon, to secure room for the lock men to do their work unhampered. This rail has been extremely useful and has no doubt prevented some accidents.

The concrete in the lock walls is of 1:3:6 proportions. This seems to have given good results. The work was prosecuted winter and summer, being suspended only on the coldest days. At such times the aggregate and the water and the sand were heated and the concrete when placed was protected by tarpaulins. That laid in winter seems to be as good as any and there are very few blemishes in the work which has now been exposed for six seasons.

The bottom of the lock is not concreted, as the natural rock was quite good enough and nearly level. The side conduits for filling were channeled out so as not to disturb the bottom. No fissures were found in this rock except one small crevice which was filled with grout. No leaks have been discovered.

The walls are about 53 feet above the lock floor and have 5 feet freeboard at highest water in the pool. The depths are 14 feet on the upper sills and 7 feet on the lower sill. There is a collapsible set of trestles at the lower entrance to the lock. When raised the trestles carry a girder against which needles are placed and water-tightness is secured with a sheet of canvas. This dam has been used twice and performs well.

There is a service and a guard gate, both of the submersible type. As the guard gate can be taken out and floated to the dry-dock for overhauling, the need of a cofferdam above the lock is avoided. It would naturally be very difficult to put one in in 40 feet of water.

When the new lock was being planned it was proposed to alter the old lock and strengthen it so as to make it serve. It was soon found, however, that this was impracticable, the old lock being too small and having only 6 feet on the sill instead of 7 feet. A number of public meetings were held and river men pointed out that several boats built on the upper river had been too large for the old lock and had been obliged to go through unfinished to be completed below, or had gone over the rapids. Now that the rapids would be closed forever, they thought the lock should be large enough to accommodate anything that might come along. The power company through Mr. Cooper, the Chief Engineer, offered to make the lock 110 feet wide (like the Panama locks) and 400 feet long, or 50 feet longer than the old lock.

The extreme lift of the lock at low water is 40.4 feet. The dam has formed a lake above, which backs the water up to Keithsburg, some 64 miles north.

Very few locks have been built on better foundations than that obtained at Keokuk. The limestone ledges are fairly hard and vary from two to four feet thick. They are nearly horizontal and seem not to have been disturbed since they were laid down. Only a few cracks were found during the construction of the power dam and lock and these were easily closed by grouting and tested by air pressure. Fig. 8 shows the nature of the foundation.

Lighting

By the terms of the contract with the Power Company the only electricity they are to furnish the U. S. is for lighting. The 400-horsepower compressed-air plant makes other power unnecessary. A set of special transformers in one of the galleries of the lock walls furnishes electricity for all lights. The lock is lighted by 8 ornamental posts on each wall, each post supporting three globes. This gives ample illumination of the walls and is far preferable to arc lights for the purpose on account of the blinding effect of arc lights on approaching boats. There are signal lights at each end of the lock and all the pipe galleries and stairways thereto are well lighted. In addition to this the office and all the lock buildings and grounds are well lighted. (Fig. 2.)

Compressed Air Plant

This plant was built and turned over to the Government (with the lock and dry dock) for its exclusive use. It consists of two 200-horsepower turbines with horizontal shafts belted to two compound-air compressors with intercoolers. The compressors have 16 and 22-inch cylinders—16-inch stroke, and are provided with governors. The two turbines are

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independent and either or both compressors can be used. The governors start the turbines whenever the pressure in the tanks falls off a few pounds, and they operate perfectly. Either or both machines are used according to the demand for power, and are completely automatic, but of course an attendant is required. This plant furnishes air for all the operations of the lock and dry dock, even to blowing the blacksmith's fire and siphoning out leaky barges.

While it is estimated that air plants deliver only 40 per cent of the effective energy put into them, there has always been a surplus of power for use at this plant. It has proved most economical and satisfactory in every way.

Ice Pressure

It is a matter of common knowledge that the ice sheet on a lake of any size grows through the winter by reason of its shrinkage in cold weather and the freezing up of the cracks, and expansion of the ice when warmed. Stone buildings which were partly submerged by the formation of the lake above the dam were shorn off at the water level the first winter. Light piers that had been built for the light-house service were also pushed over and destroyed.

Steamboat men have long known that a barge tied up for the winter crossways of the river has its sides caved in. It is probable that many dams in northern latitudes have been injured from this cause, so it was desirable to contrive some way to relieve the pressure on the 110-foot floating gates of the lock exposed to 7 miles of ice sheet expansion. Relief is sometimes given to barges that are being squeezed by cutting a trench alongside. This seemed to be at most a temporary expedient. From this came the idea of making an artificial air hole in the ice and it was tried with complete success.

A small air-pipe was led down to the bottom of the lake in front of the gate and the warm bottom layers thus drawn to the top. It takes very little air to do this and the relief is complete.

The Power Company has now adopted this plan for relieving the strain on their 119 flash-gates which are all supplied with air pipes in front of each and they say it takes very little air to keep a good air hole open. The ice remains thin for quite a long distance around the air hole.

It looks as if this idea might be usefully applied at high dams in northern latitudes.

The Dry Dock

This dock is so placed that it fills and drains by gravity. It replaces an older one of somewhat smaller dimensions on the old canal. It is 140 by 450 feet on the bottom. One side to the east is formed by the land wall of the lock, the other is a paved slope of 1½ to 1. Stairs are built at intervals to afford access to the dock grounds. The slope and bottom of the dock are paved with rubble blocks like the stone pavements in city streets. The dry dock occupies part of the site of the old lower lock of the abandoned canal, the old lock being filled to the depth of about 25 feet. The dock grounds stand about 26 feet above the top of the old lock walls, making a total fill of 51 feet. The settlement of the floor of the new dry dock has been less than expected. As seen in Fig. 9 the dry dock is furnished with steel cradles for carrying the boats when docked. At the old dock the cradles were of wood and consisted of solid blocking. The new cradles are a great improvement as their open work construction permits a free flow of water and they do not collect dirt. The floor of the dock is built on a slope of one-half per cent, so that all dirt is carried towards the outlet valve at the south end. The boat cradles have wooden caps to which any blocking necessary may be spiked. Each trestle or cradle rests on three concrete blocks embedded in the floor and these blocks are furnished with iron stirrups by which they can be lifted should they settle, and levelled by pouring grout under them. The trestles can be moved sideways to allow of calking the block spots, but it is generally easier to partly flood the dock and move the boat to a new position.

The half per cent slope of the dry dock floor is found very convenient when docking barges or boats. The tops of the cradles are all in one plane since nearly all the river boats and barges are built with flat bottoms. Some ocean-going boats have been docked, however, one of which, the navy torpedo boat *Summers,* was of thin plating and 20 years old, and required special arrangements. As will be seen in Fig. 12, bilge blocks were made in this case to fit the hull of the boat. These slid on the tops of the cradles and were pulled against the hull by ropes passed under the bottom of the boat. When the water was drawn off and the boat had settled firmly on its keel these ropes brought the bilge blocks against the hull and docked the vessel very securely.

The inlet and outlet valves of the dry dock are of the butterfly balanced type, are two at each end. They operate by a rod and screw stem with a stand and handwheel on the dock wall. It was soon found that the operation of this screw was slow and at full head it took five or six men to operate the outlet valve. Both valves were, therefore, fitted with small engines driven by air pressure and now operate quite easily. The valves are screened. It takes about one hour to dock a boat, not because it requires that time to fill the dock chamber, but because of the difficulty of holding the boat in place when the currents are too strong.

The cradles are 16 feet long and 4 feet high. They are spaced 16 feet apart along the dock and 3 feet apart endways, making a platform 73 by 368 feet on

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which boats may be placed. There are 96 cradles in all. When the construction of the power house and dam were finished there remained four cantilever cranes which would just fit the dry dock. One of these was bought and re-erected in the dry dock where it has proved invaluable. It picks up material delivered on cars at the side of the dock and delivers it to the work. It has two-trolleys, each of 5 tons capacity.

The dock yard has a complete saw mill, with a large beveling ship saw that has proved most useful; also a planer, a jointer, a cut-off saw, a sawing table to trim the edges of bottom plank for calking seams, and the usual automatic saw and knife sharpeners. There is also a good machine and blacksmith shop. It has the usual lathes, planer and shaper, grinding tools and a light steam hammer. Much use has also been made in the last years of the acetylene torch, which has become invaluable for repairs of all sorts.

Standard gauge track reaches all parts of the dry dock grounds. The shifting of cars is by haulage from three air-driven capstans suitably located. This system has worked well, and while slow, appears much cheaper than to maintain a yard engine which would be idle most of the time.

The air supply from the lock power house is piped all over the grounds, and replaces steam everywhere except for heating. Extensive use is made of this power for driving hand-boring machines, hammers, etc. A useful tool lately added is a hand air-planer. This tool is driven by a turbine in the tool, and is used for outgauging plank, for which it is most effective. It operates at 100 pounds pressure.

The work at the dock consists mostly in construction and repair of the extensive fleet of boats which are used for river improvement in the upper Mississippi River. Much plant has also been built for the Mississippi River Commission. Under certain restrictions the dock is available for the use of commercial boats. The old dock, which this one replaced, could be used only to repair boats damaged in going over the Des Moines Rapids, a matter of frequent occurrence. Since the decline of steamboating the private yards have fallen into disuse and there are only one or two docks, both at a great distance from Keokuk, that can accommodate the largest boats. It has been found helpful, therefore, to dock these big boats for extensive repairs when it could be done without interfering with government work. Permits must be secured from the Chief of Engineers in every case, and evidence furnished that no other dock is readily available. The boats must furnish their own materials and pay dockage fees according to tonnage. They also pay all labor at a somewhat higher rate than prevails locally, being the scale rates at larger places, like Davenport, Iowa. The instructions in force are to make the rates such that vessel owners will not choose the U. S. Dry Dock for repairs solely for economy and thus do an injustice to private boat-yards. There is also a price scale for the use of all tools operated. This covers air tools, saw-mill tools, blacksmith's forge, steam hammer and the like.

Regulation of the River

In such a power plant as that at Keokuk on a large navigable stream, it is easy to see that interference with the natural flow may easily occur, leading to trouble with the navigation interests. When the power company applied for a permit to place a dam across the Mississippi River this difficulty was foreseen, and under authority of an act of Congress, rules were promulgated by the Secretary of War which it was thought at that time would obviate trouble from fluctuations of river level that would be hurtful to navigation. The original regulations provided for water storage in the pool at night, during low water, provided no less than the normal flow was passed down the river in any one day.

The first attempts to regulate the flow were to keep the pool above the dam at all times at a certain designated height. If its height did not change, the flow through it was normal.

This was done by opening and closing the flash gates on the dam as occasion required. It was soon found, however, that this method led to varying levels below, for the lake surface is sensitive to wind effects and often the mistake was made of shutting down the gates when the lake level fell, when the fall in the pool was due, not to lessened water supply, but to an upstream wind. Similarly, floods below were occasionally the result of downstream wind effect being mistaken for increased flow from above. The third year of the operation of the power plant the complaints of the steamboat men became loud and finally resulted in a suit for damages against the power company for interfering with the natural flow of the river. The suit was never tried, but the whole subject of regulation was reconsidered, and a new method proposed for insuring the natural flow and avoiding the fluctuations complained of.

Copies of the new and of the old regulations are appended. The new method consists in predicting the proper flow at Keokuk from a gauge at Keithsburg at the head of the pool, and beyond the influence of the dam. There is no tributary of any size between Keokuk and Keithsburg, except Skunk River, and at low water when the flow of the river is small and the necessity for regulation is great, Skunk River is almost dry, being like all the streams in this region, a mere sluice that flows only when there is a rainfall.

The system operator, as he is called, at the power house, has a daily record of the gauge at Keithsburg from which the proper gauge height at Keokuk is calculated. This record he plats on a sheet before him, together with the wind velocity, temperature,

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kilowatts delivered, number of flash-gates open, etc. As the flow through the wheels varies he opens or closes flash-gates so as to keep the gauge reading correct for normal flow. This record is from hour to hour, and at the end of a day there is a complete power-house history of the day. The aim is to make the gauge readings below the dam conform to the predicted stage as nearly as possible.

There are 119 flash-gates on the dam which are 11 feet high and 30 feet long. The normal height of the pool is elevation 525.00 Memphis datum.

The system operator can open as many of these gates as he wishes. They are manipulated by two electric cranes, and there is a steam locomotive crane that can be used in emergencies. Sometimes there are as many as 60 flash-gates open, somtimes only one. After navigation closes all the flash-gates are sometimes closed for a day or two, and at this time the discharge of the river is less than the needs of the power plant, and the level of the pool falls to rise again when the water arrested by ice gorges above is released.

The post of system operator requires considerable judgment in predicting the proper gauge height at Keokuk to pass the normal flow. It is filled by a special engineering assistant.

When the original permit for the operation of the dam and power house was granted (see Appendix A), it was thought that it might be permissible to vary the normal flow for a few hours of the day, provided the daily total was maintained. This permission has never been used, however, for the needs of the power house up to the time the regulations were changed were always such that no advantage could be taken of it. Still there were fluctuations of the water surface that were directly traceable to the dam, and steamboat men, when they ran aground during low water, always blamed the dam. The new set of rules has now been in force for two seasons, and has given much better satisfaction. Gauge records kept for some years at various distances below the dam have shown that waves of 12 inches at the dam diminish to 0.2 foot at Canton, 23 miles below. Also the speed of the crest of the wave is found to be three miles an hour. It requires just 13 hours to travel to Quincy, 39 miles downstream.

The new regulations (Appendix B) have almost entirely done away with any fluctuations of river level which interfere with navigation. As the height of a wave rapidly diminishes as it moves downstream and practically disappears at 23 miles below, it is only near the dam that it is felt at all. Of late there have been no complaints on this score from the navigation interests.

After the close of navigation regulation is not attempted; in fact, with the spillway gates frozen in they can be operated only with great difficulty, and after thawing out.

A reference to the table of discharges at Keokuk (see Appendix C) and a calculation of the water horse-power, gives the following for stages at lower lock river gauge:

Gauge height 0.1 ft. Discharge 20,000 sec. ft. Water horse-power 72,500.

Gauge height 3.0 ft. Discharge 36,500 sec. ft. Water horse-power 144,700.

The water is lowest at about 5 a. m. and highest about 6 p. m. This results from the nature of the load at the power house, which is mostly absorbed by public utilities in St. Louis—street cars and lighting. The power delivered averages about 79,400 K. W. per day.

Close regulation of the flow can be attained only by the greatest care and attention, but it is possible and is at present attained at Keokuk. In the figures above, the head at stage 0.1 ft. of the gauge was 38.3 ft. but that at the 3-ft. stage was only 35.8 ft., due to the drawing down of the pool temporarily. The draft on the pool served to tide over a shortage of water during the period of ice formation on the river and was made good a few days later when the normal flow was resumed. Such drawing on the pool is not permissible in summer or during the season of navigation. But it is very seldom that the pool is drawn on or that the power house has had to buy power owing to deficient stream flow, and then for only for a few days at a time.

The power company has encountered much hostility from certain people and interests. It must be said, however, that in the conservation of natural resources going to waste, it has been a success.

This was never better demonstrated than during the late coal strike when it was furnishing power the equivalent of 6,100 tons of coal daily, or six trainloads of 21 40-ton cars.

To sum up the subject of the lock and dam at Keokuk, the writer thinks the government made a good bargain in exchanging the old Des Moines Rapids Canal with its three small locks of but 5-foot depth and maintained by constant dredging, for the one lock of liberal size and most modern construction. In addition, it obtained a new and larger dry dock supplied with abundant compressed-air power generated by water turbines at no cost. It also obtained an improved river with deep water for at least 40 miles, all at no cost to the United States.

As happens constantly in all industrial enterprises, the wisest procedure is frequently to scrap machines that when built were considered the last word in progress, and in scrapping the old canal this wisest course was followed.

General A. Mackenzie was Chief of Engineers when the project for the dam was approved by Congress,

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and saw most of the construction. The District Engineer, during the preliminary studies of the project, was Major (now Colonel) C. S. Riché. The building of the lock and power plant was under the supervision of Major (now Colonel) Charles Keller. Since the operation of the lock began Colonels George M. Hoffman and H. Burgess have had charge. During all this time the writer has had local supervision on behalf of the government.

It was an experience of the greatest engineering interest to see this important work proceed to completion in the short space of two and one-half years. The chief engineer, Mr. H. L. Cooper, had opportunities such as fall to few men in unrestricted authority and unlimited means, the only thing asked of him was results. The methods employed and the morale of the working force were also matters of the greatest interest. The power was turned on one day sooner than the date set at the inception of the work and this, too, was no small matter. It showed what unlimited means and undivided authority can do when combined on a project like this.

In conclusion, the writer thinks that the whole plant has operated for six years with remarkable success. In all that time no serious accident has occurred and all the machinery has given full satisfaction except the discharge valves of the lock. As now vented to the air the inlet valves cannot be improved on. The outlet valves, when rebuilt, should have some changes made in better guides for the movable sleeve, which involves only slight alterations in the present design.

That all this intricate machinery of novel type should have operated so well is a high tribute to the chief engineer, Mr. H. L. Cooper, and his mechanical assistant, Mr. B. H. Parsons. In six years no boat has been denied passage, though for a month or two it was slow when but one valve was available for unwatering the lock.

APPENDIX A

Original Regulations Governing the Operation of the Power Dam in the Mississippi River at Keokuk, Ia., by the Mississippi River Power Company.

Approved March 26, 1903.

1. During the hours of daylight, during the navigation season, between sunrise and sunset, the Power Company shall not store water behind the dam.

2. During the navigation period and during the hours of darkness between sunset and sunrise, the Power Company may store water behind the dam provided that during at least two hours of such interval of darkness the power house shall not pass water at less than an average rate of flow of 15,000 cubic feet per second, and during at least six other hours of the period of darkness referred to in this paragraph, the power house shall pass water at an average rate of not less than 10,000 cubic feet per second, and for the remaining hours of darkness the power house shall discharge not less than 5,000 cubic feet per second.

3. That when the flow of the river is not greater than 20,000 cubic feet per second, the Power Company shall pass through the dam during the daylight hours in addition to the then flow of the river, an additional quantity of water equal to that stored during the next preceding hours of darkness from sunset to sunrise.

4. That at any future period if the flow in the Mississippi River should fall below 20,000 cubic feet per second and the Power Company should not be passing water through the dam for power purposes equal to the total average discharge mentioned above, the Power Company shall be required to draw from its storage in aid of navigation, under stipulations to be specified from time to time by the engineer in charge of the district, that amount of storage that exists behind the dam above elevation 519, which is equivalent to drawing the pond 4 feet in aid of navigation during the time when discharge of the river might be less than 20,000 cubic feet per second.

APPENDIX B

Regulations to Govern the Operation of the Power Dam in the Mississippi River at Keokuk, Ia., by the Mississippi River Power Company.

Approved January 12, 1918.

1. All previous regulations of the Secretary of War relating to the use of the Mississippi River for the generation of power by the Mississippi River Power Company, including the Memorandum of March 24, 1908, approved by the Secretary of War March 26, 1908, are rescinded and the following regulations will govern the operation of the dam until further orders.

2. Excepting as herein specially provided, the normal flow of the river shall be discharged below the dam at all times of day and night.

3. The Mississippi River Power Company shall not, during the period of navigation, raise the level of the pond behind the Keokuk dam when the natural flow of the Mississippi River is falling, or when such natural flow is less than approximately 64,000 cubic feet per second, which corresponds to a normal stage of 6 feet above low water at Keokuk, Iowa, except upon the written permission of the United States District Engineer in charge at this locality, such permit to state the period which such ponding may cover and the maximum variation in stage below the dam which may be caused by such ponding.

4. The granting of permits by the District Engineer shall be governed by the provision of the law authorizing the construction of the dam and its accessories, as follows:

> "Section 2. That the withdrawal of water from the Mississippi River and the discharge of water into the said river, for the purpose of operating the said power stations and appurtenant works, shall be under the direction and control of the Secretary of War, and shall at no time be such as to impede or interfere with the safe and convenient navigation of the said river by means of steamboats or other vessels, or by rafts or barges."
>
> . . .

5. The Power Company, when proposing to raise or lower the pond either under general authority or special permission, shall give due notice to the District Engineer or his authorized agent, of its intention.

6. The Power Company shall hold all records relating to operations affecting the river discharge open to the inspection of the District Engineer or his authorized agent.

7. It shall be the duty of the District Engineer or his authorized agent to observe closely and carefully the operations of the Power Company and to maintain, in addition to such as may be maintained by the Power Company, such river and pool gauges as may be advisable, and make from time to time such examinations as may be necessary for determining the effect of the operation of the power dam and accessories on the river channels.

8. The War Department approves the method of regulating the flow below the Keokuk dam by estimating the flow 24 hours in advance and maintenance of the stage corresponding to such flow as indicated by the river gauge at U. S. Lock. (The method employed during 1917.) The general rules above stated are not intended to apply to unavoidable small compensating variations in pond level behind the dam, inherent in such method of regulation.

War Department:
Approved, January 12, 1918.

B. CROWELL,
Assistant Secretary of War

APPENDIX C

Discharge of the Mississippi River at Keokuk, Ia.

By stages on the lower lock gauge.

Gauge height	*Sec. ft.*	*Gauge height*	*Sec. ft.*
1 ft. below	14,000	6 ft. above	64,000
Zero	19,000	7 ft. above	75,100
1 ft. above	23,600	8 ft. above	87,000
2 ft. above	29,600	9 ft. above	100,500
3 ft. above	36,500	10 ft. above	114,000
4 ft. above	44,500	18 ft. above	230,700
5 ft. above	54,000		

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CURRENT NEWS

NOTE.—This department will include news items of professional or personal interest concerning individuals and organizations in the Army, National Guard, Reserve Corps, Reserve Officers' Training Corps, the Service Schools, the U. S. Engineer Department, other departments or bureaus of the Government, and other related activities, both civil and military.

In the PROFESSIONAL NOTES section will appear news items, short articles and digests on matters relating to current developments in engineering and allied sciences and the art of war—of special interest to the military engineer.

Contributions to these columns, whether from original sources or from other periodicals, are solicited from all our readers. Such contributions should be submitted in time to reach our office not later than the 15th of the month preceding each issue of THE MILITARY ENGINEER.

News of the Services

Engineer Districts

BOSTON DISTRICT.

Col. F. R. SHUNK.

The construction of emplacements for two 12-inch long range rifles at Nahant, Mass., has attained 40 per cent completion. A channel and turning basin have been dredged to wharf site at Hog Island, Boston Harbor, Mass. The wharf is 60 per cent completed and it is expected that construction of the emplacements of two 12-inch rifles will be begun in the early Spring of 1920.

The project for a 24-foot channel, 200 feet wide from that depth in the bay to Quincy drawbridge, Quincy, Mass., is assisted by contributory funds from the State of Massachusetts, the City of Quincy, Mass., and the Fore River Shipbuilding Corporation. The entire project is 30 per cent completed and it is expected that contract for the completion of the dredging will be made in December.

FIRST DISTRICT, NEW YORK CITY.

Col. EDW. BURR.

Dredging economics.—The district is continuing a series of test loads with seagoing dredges to ascertain the correct time for loading, and the proper load, analyzed as to costs, all as a part of current dredging operations. The work described herein was done by the dredge *Raritan* in the Weehawken-Edgewater Channel, Hudson River. This channel is about four miles in length on the west side of the river from 60th to 150th Streets, Manhattan. The material is a clayey mud, which does not settle well in the bins, and which, after pumping a partial load, runs away in the overflows, so that full bins can not be retained. The round trip to the dump and return is about 60 miles.

The prime object of the tests is to ascertain the economical time of loading: this is independent of the cost of dredge per working hour, which cost can be taken from any convenient data. The costs below were taken from those for the month of October, 1919, as follows:

Cost of *Raritan*, including field cost, plus rental and office supervision____$14,108.32
Total capacity of dredge, cu. yds.__2,884
Hours dredging, turning, going to and from dump ----------372.1
Cost per hour worked ----------$37.92
Cost of disposing of one load------$241.17

Example, 1st load, supposing loading to stop after two hours pumping:

Pumping and turning----------$ 75.84
Disposing of load----------241.17
Result: 1301 cu. yds. at 24.37c per cu. yd.

The data in the table herewith were determined as above.

		Pumping and turning.					
Hours	2	3	3.5	4	4.5	5	5.67
1st load, cubic yards	1,301	1,744	1938	2,084	2,461	2,513	2,578
Differences		443	194	146	377	52	65
Average cost, cts	24.37	20.35	19.29	18.85	16.73	17.14	17.65
2nd load, cubic yards	938	1,562	1,744	2,017	2,315	2,467	2,552
Differences		624	182	273	298	152	85
Average cost, cts.	33.80	22.72	21.44	19.48	17.79	17.46	17.38
3rd load cubic yards	933	1,374	1,944	2,296	2,473	2,558	2,596
Differences		441	570	352	177	85	38
Average cost, cts.	33.98	25.83	19.23	17.11	16.65	16.84	17.57
Average cubic yards per minute	8.9	8.7	8.9	8.8	8.9	8.4	6.1

The figures in the table indicate that the proper economic time to stop pumping is 4½ to 5 hrs., when the dredge has a load of about 2,500 cubic yards.

The loads were measured with a sounding pole with a wooden disc about 8 inches in diameter attached. Soundings were taken in bins and when pole met with about the same resistance as when sounding similar material in the river, measurement was recorded and contents of bins taken from tables.

Results vary with the character of material and distance to dump and must be determined by experiment in each case. The foregoing statement applies to the dredge *Raritan*, pumping soft mud, with a distance of 30 miles to the dump.

Results of dredging in Ambrose, Gedney and Coney Island Channels.—Ambrose Channel, the main entrance to New York Harbor from the sea, was dredged 2,000 feet wide, 40 feet deep, at mean low water for a length of 7½ miles: completed in April, 1914, with total excavation of over 66 000,000 cubic yards. Immediately after completion, one of the dredges worked a few months deepening the edges of the channel where shoaling was anticipated. Since December, 1914, no dredging for maintenance has been needed.

Examination of the channel, in 1915, showed no filling. The last examination, in the summer of 1919, showed not only no filling, but a slight increase in depths, both in the channel and in the shoal banks on either side.

The last part, about 71 per cent. of the excavation, was done by U. S. self-containing seagoing hydraulic dredges. The same dredge deepened Coney Island Channel: work suspended since 1913. The 30-foot Gedney Channel was dredged, 1884 to 1891, by dredges of similar type. Neither Ambrose Channel nor Gedney Channel yet show any tendency to shoal. Coney Island Channel has shoaled very slightly, in the same place where dredging done by a clam-shell dredge in 1907, and wholly filled in by June, 1908.

These seagoing dredges plane off the bottom in small furrows, 3 to 6 feet wide and 2 to 6 inches deep. It seems probable that, on bars of this kind, the gradual deepening of the entire channel way induces a modification in the regimen of the currents, which tends towards permanence.

PHILADELPHIA DISTRICT.

Lt. Col. W. B. LADUE.

Work of dredging in the Delaware River below Philadelphia under contract, in prosecution of the 35-foot channel improvement; and maintenance work on the 30-foot channel with government plant, was suspended for the season during December on account of cold weather, accompanied by heavy running ice in the river, and the plant removed to Philadelphia for overhaul.

The sea-going dredges *Delaware* and *Manhattan* will be overhauled at the Philadelphia navy yard. Fuel oil tanks and oil burning appliances will be installed, fitting these dredges to burn oil during the coming season.

The large bucket-ladder dredge *Corozal* was purchased from the Panama Canal in the fall of 1919, and brought to Norfolk, Va., in tow of the U. S. navy collier *Vulcan*, arriving December 25, 1919. After minor repairs, the dredge sailed for Philadelphia under her own steam on January 6 and tied up at the dredge depot below the mouth of the Schuylkill River, January 8th. She is now being overhauled.

A contract was made on November 3, 1919, with the Arundel Corporation, of Baltimore, Md., for repairing the dike at Bulkhead Bar. The estimated expenditure under this contract is about $45,000.

Bids will be opened on February 18, 1920, for dredging to a depth of 35 feet in Philadelphia Harbor, from about Jackson Street to about Queen Street, along the front of the city south of Market Street. About $400,000 is reserved for payments to the contractor for this work.

The project channel along the city front of Trenton, between Lalor Street and the upper railroad bridge, was practically completed in November, when work was suspended due to exhaustion of fnuds. A few small rock shoals in the channel and a small area in the northwest corner of the turning basin, remained unfinished. These rock shoals in the channel will be removed in the spring under an allotment recently made.

Work on the Schuylkill River is still in progress, not having been stopped by ice as on the Delaware. It is expected that this project will be finished by midsummer of 1920.

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JACKSONVILLE DISTRICT.

Lt. Col. W. J. Barden.

Reducing current velocities through New Cut entrance Miami Harbor.—Work on the New Cut entrance to Miami Harbor was begun in 1902. Prior to that time access was had by a dredged channel entering the Bay south of Biscayne Key, this channel being about 10 miles long. The new project provides a short, straight channel giving direct access to the wharves at Miami. Jetties 1,000 feet apart have been constructed extending from the shore into the ocean, and a navigable channel, 300 feet wide, was cut through the key. The City of Miami has dredged a channel connecting the new cut with the city water front. The dredged material was used to form a causeway on the north side of this channel, this causeway be-



Miami Harbor, Fla. New Cut Entrance

ing connected by bridges with the land at each end.

The tides flow through the various openings in the keys into Biscayne Bay. The velocity of the tidal currents in the New Cut reached a maximum of 5½ miles per hour, which seriously interfered with navigation, and a reduction of this velocity was imperatively necessary. Authority was granted for the removal down to rock, of the points extending into New Cut Channel between the shore ends of the jetties. This work was completed January, 1920, by the removal of about 147,000 cubic yards under contract with the Bowers Southern Dredging Co., following which the maximum velocity of tidal currents through the cut does not exceed 3.5 miles per hour.

The impounding of the tidal waters north of the causeway also operates to reduce velocities by limiting the area from which water is discharged through New Cut.

MONTGOMERY DISTRICT.

Maj. W. A. Johnson.

Artificial rubble for jetty construction.—A novel method is being used in this district for providing stone filling for jetties on the Alabama River in localities where the distance from stone quarries renders the cost of hauling prohibitive. The coarse gravel and sand bars are utilized for making artificial stone by spading or loosening the gravel over a small area of the size of the stone desired. A cement grout is then poured into the area, reaching all parts of the mass. Upon setting the artificial stones are removed and successfully used for filling jetties.

MOBILE DISTRICT.

Maj. R. S. Thomas.

Mobile outer bar.—Authority was granted by the Chief of Engineers, December 4, 1919, to shift the Mobile Outer Bar Channel westward of present location in order to avoid the encroachment of the bar upon the channel from the east, to locate the channel in the natural deep water over the bar, and to avoid an angle in the channel at the north and leading into the deep water. These objects were accomplished by shifting the south end of the channel about 1,700 feet to the west and keeping the north end at practically the same location. The change was made preparatory to beginning work on the enlarged channel of the existing project adopted August 8, 1917, which provides for increasing the depth from 30 to 33 feet, and the width from 300 to 450 feet. The change is due to the rapid westward movement of the bar in recent years.

Work on the new channel was begun December, 1919, and will be finished by the end of 1920. Mobile Outer Bar is in the Gulf of Mexico about five miles south of the entrance to Mobile Bay and the channel through it is about one mile long.

Fuel-oil burning equipment on dredge "Wahalak."—An installation of fuel-oil burning equipment of the low-pressure steam atomizing type was recently completed on the 20-inch hydraulic pipe-line dredge *Wahalak*, which operates in Mobile Bay. This equipment consists of Hammel burners, extension fronts to the boiler furnaces and a Worthington Duplex oil pump set, 4 by 2¾ by 4 inches, with heater. The dredge is equipped with four Scotch marine boilers of approximately 250 horsepower each, but when operating three only are used. This fact made it possible to change the dredge from coal burning without losing any time from dredging operations.

It is intended to install oil and hot water meters for the purpose of obtaining records of oil and boiler feed water consumption, and when the crew becomes accustomed to burning oil a series of boiler efficiency tests will be made to compare the results obtained with the two kinds of fuel. It was intended to convert two other dredges in the district to oil-burning, but the recent advance in the cost of fuel oil makes it advisable to defer these installations for the present.

Ship building and commerce on Black Warrior, Warrior and Tombigbee Rivers.—The Chickasaw Shipbuilding Company, on Chickasaw Creek, about five miles above Mobile, recently launched its first steel vessel of 9,600 tons displacement, and expected to follow with others at a rapid rate as it has a very large plant thoroughly equipped with modern facilities for building steel ocean-going vessels. This is of considerable significance because of the fact that the company will use the canalized Black Warrior, Warrior and Tombigbee Rivers for transporting steel from its plant at Fairfield, Ala., in the Birmingham District, to the shipyard, which will add appreciably to the traffic on these streams. The shipments of steel began last December, and during the month amounted to 600 tons. There was an increase of nearly 100 per cent during January and the shipments are estimated to reach 3,000 tons during February. This includes steel rails shipped from the Birmingham district for export from Mobile.

NEW ORLEANS DISTRICT.

Maj. E. J. Dent.

South Pass, Mississippi River.—A contract was entered into January 9, 1920, with Lester F. Alexander, of New Orleans La., for constructing a stone breakwater along the sea side of the outer portion of the inner east jetty at the South Pass.

The breakwater will be of rip-rap stone, ranging from 75 to 10,000 pounds, brought to an elevation of 2 feet above mean high water, crown width of six to eight feet, side slopes of one on two on the sea side, and one on one on the river side. The breakwater will rest on a substructure of willow brush brought to elevation of mean low tide.

The outer portion of the main east jetty has subsided to such an extent as to no longer afford protection to the inner east jetty, which is constructed of willow brush held in place with small rip-rap and round piling. The breakwater is for the purpose of protecting the inner east jetty against the heavy seas which sweep over the submerged main jetty.

A wireless station has recently been installed by this office at Port Eads, South Pass, for handling Government business only. The first message sent was on March 1, 1920.

Intracoastal Waterway.—Bids were opened January 29, 1920, for dredging a portion of the Intracoastal Waterway from Mermentau River to Calcasieu River. The contract will be awarded to the Lake Arthur Dredging Co., of Beaumont, Texas, 12 cents per cu. yd., place measurement. The estimated quantity to be removed with the funds available is 1,200,000 cu. yds. A party is now in the field staking out the right-of-way.

The bucket-dredge *Grossetete* began work on February 20, 1920, in Bayou Black, Terrebonne Parish, deepening and widening it where necessary to provide a channel 5 feet deep at mean gulf level and 40 feet wide on bottom. This will form a portion of the Intracoastal Waterway from the Mississippi River to Bayou Teche.

Bayou Teche.—The pipe-line dredge *Delatour* began work on February 21, 1920, at Shadyside Bridge, about 8½ miles above the mouth of Bayou Teche, to provide a channel 8 feet deep at mean low gulf level and 80 feet wide, up to New Iberia, 54½ miles above the mouth. The lower 8½ miles already has sufficient depth and width. This project was authorized by the river and harbor act of March 2, 1919.

The dredge *Captain Huston*, recently purchased at New Orleans by the Porto Rico District, was taken to Mobile, Ala., and placed in dry dock where it was overhauled and bulkheaded, preparatory to going to sea, under the supervision of this office. The dredge is now awaiting the arrival of the tug *San Luis* from New York, which will take it to San Juan, P. R.

The dredge *H. S. Taber* arrived in New Orleans on February 28, 1920, and will be overhauled at the naval dock here, after which it will be bulkheaded and taken to the Norfolk district.

Mr. Arthur McFarland, Assistant Engineer of this office, has just returned from the office of the Chief of Engineers, where he had been for nearly two weeks in consultation as to the standardization of the design of seagoing-hopper and hydraulic pipe-line dredges.

Lieut. Col. Herbert Deakyne was relieved from the charge of this district on March 1, 1920, by Maj. E. J. Dent, who was relieved from the Fourth Mississippi River District on the same day.

GALVESTON DISTRICT.

Lt. Col. Spencer Cosby.

There have been a number of flashy rises in the Brazos River that have rendered difficult keeping open the channel at the mouth of the

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jetties at Freeport Harbor, Texas. These rises have brought down a considerable quantity of silt from the interior of Texas, and deposited it in the turning basin and between the jetties. This river is unique on the coast of Texas in that it empties directly into the Gulf of Mexico. All other Texas rivers, except the Bernard, empty into lakes or bays.

The tugboat *Major R. C. Smead* was launched on January 31, 1920. This boat is being constructed by hired labor at the U. S. Engineer Department shops at Fort Point, Tex. Its dimensions are 75 feet 6 inches by 17 feet 2 inches by 7 feet 2 inches, with 5-foot draft. It is twin screw, the motive power being two 100 H. P. Fairbanks-Morse crude oil engines. It is expected that the vessel will be completed by March 1, 1920.

ST. LOUIS DISTRICT.
Maj. W. WILLING.

Steel barges and towboats Upper Mississippi River.—This district has charge of the design and construction—now well under way—of a fleet of very large steel barges and towboats for towing iron ore on the Upper Mississippi River from St. Paul to St. Louis, for the increase of production of pig iron in the middle west. In order to balance the traffic, coal and fuel oil are carried on the upstream trip between those cities. As this is to be entirely through traffic in bulk freight of low "tariff" grade, the barges have been designed in extreme size for that river section and will carry a maximum load of 3,000 tons each.

These vessels are being built under an allotment of $3,860,000 made during the war by the Emergency Fleet Corporation.

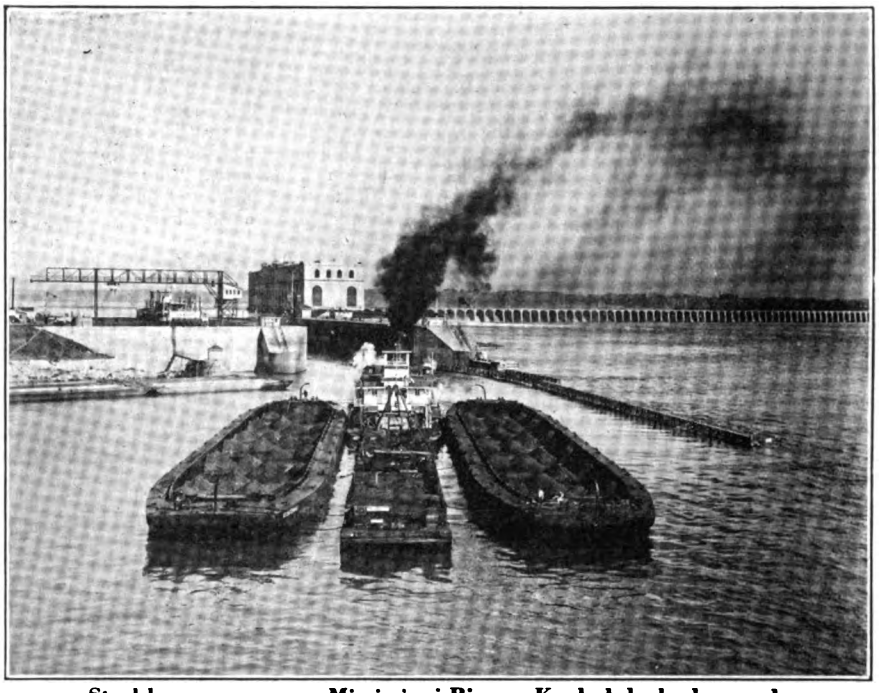
Three barges will constitute a tow, and the tow boats are to be in size comparable to the largest stern paddle-wheel steamers that have yet been built, and equipped probably with more powerful propelling machinery (about 2,000 h. p.) than has ever been installed on such boats.

The design of the whole fleet and its various power installations has presented many difficult problems in order to attain power with the least possible weight, as an over-draft of the boats in so shallow a stream would be fatal to the enterprise, which was begun as a war measure and is now being carried to completion and into operation under a lease of the fleet by the Government to private parties operating the furnaces at St. Louis.

Of the many problems, the propelling wheel presented one of the most serious difficulties. The river is too shallow during long low-water seasons to permit the use of propellers of sufficient size to develop the power required. The stern type paddle wheel, long characteristic of river navigation, was therefore decided upon, and, because of its greater weight, the feathering type of paddle wheel, with its intricacy of moving parts, was rejected, and the usual fixed radial paddle wheel was chosen; but even at that, the great size of wheel required will result in an overhanging or cantilevered weight of fully 60 tons at the stern of the boat, nearly one-third of which will be absorbed in the great shaft.

The shaft of nickel steel, double annealed, will be over 46 feet in length, 25 inches in outside diameter, and bored or forged hollow, to an interior diameter of 19 inches. The ends, at the cranks and journals, will be thickened to 6 inches gradually tapering in a length of 3 feet to 8 inches.

The finished weight of the great shaft will be 18 tons, although it will take an ingot of about 50 tons to produce it. Each crank, with its wrist, will weight over 2 tons, and each flange will weigh about 1 ton, the combined weights of these parts of the wheel being nearly 30 tons.



Steel barges on upper Mississippi River. Keokuk lock, dam and power-house in the background

The problem of forging and finishing these large and heavy shafts is a serious one for the forges, of which there are probably less than half a dozen in this country adequately equipped to handle the work.

These barges and steamboats were designed by Mr. W. S. Mitchell, U. S. Assistant Engineer, while he was in charge of the St. Louis Engineer District during the war period.

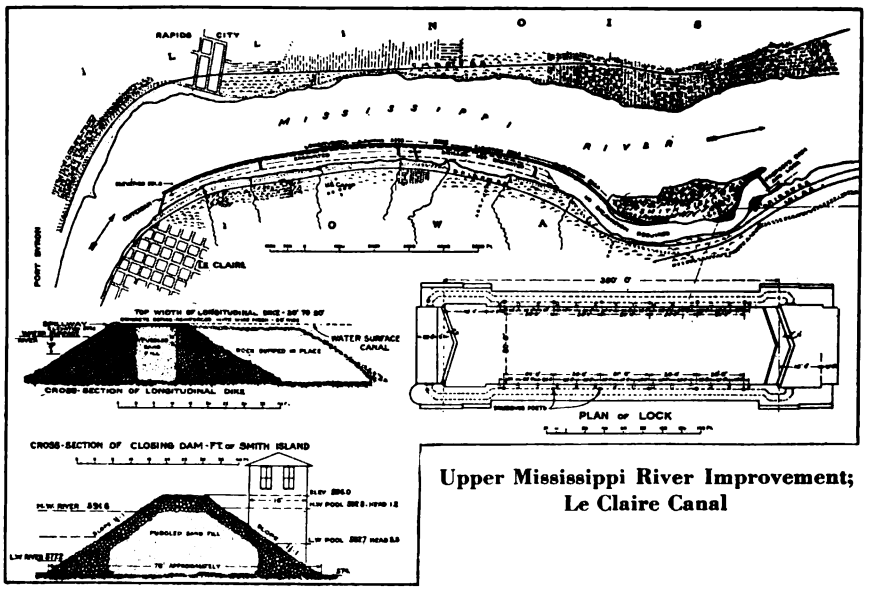
The dimensions of the barges are 300 by 48 by 10 feet, they weigh 500 tons, and will cost, under contract, about $110,000 each. which is 11 cents per ton of metal, and $37 per ton of ultimate carrying capacity. The barges may be unloaded by clamshell or Hulette machine. Their carrying capacities at different drafts are:

3 ft. draft, 475 tons.
6 ft. draft, 1,660 tons.
9 ft. draft, 3,000 tons.

The photograph shows two barges loaded with 650 tons of ore each, leaving the Keokuk dam in tow of the *Taber*.

ROCK ISLAND DISTRICT.
Lt. Col. H. BURGESS.

Lateral canal at LeClaire, Iowa. The most important work under way in the district is the construction of the lateral canal at Le Claire, Iowa, for the purpose of surmounting the upper Rock Island rapids. This portion of the rapids is about 3½ miles long, and has a maximum fall of about 5½ feet. The canal lies along the Iowa bank, and is formed by a longitudinal dike or dam, beginning at LeClaire and extending downstream approximately parallel to the right bank of the river as far as the head of Smiths Island.



Upper Mississippi River Improvement; Le Claire Canal

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This island then takes the place of the dike, and upon it there is to be constructed in prolongation of the dike a levee to prevent flow across the island during high stages of the river.

At the lower end of the island chute is a lift lock and a closing dam. The project includes the construction of a longitudinal dike about 2½ miles long; the excavation of about 253,000 cubic yards of ledge rock to form the canal prism; the construction of about ¾ of a mile of light levee on Smiths Island; the excavation of about 60,000 cubic yards of rock on the shore of Smiths Island and on the Iowa shore to straighten the channel; and the construction of a lock and closing dam from the lower end of the island to the lock. In addition some rock excavation in the upper and lower approaches is necessary to provide unobstructed entrances for navigation.

Work was started in 1915, but the progress has been seriously handicapped by lack of funds. To date, the work done consists of the construction of the longitudinal dike with a concrete paving on the greater part of it (all that part which will be overtopped by high water in the canal); the drilling and blasting of ledge rock in the canal prism, and the removal by steam shovel of 190,000 cubic yards, place measurement; the construction of about 70 per cent of the levee on Smiths Island; the construction of the cofferdam closing the island chute just above the lock site; the construction of the puddled sand core of the closing dam; the removal by dipper dredge of the soft material overlying the rock at the site of the proposed lock; and the drilling, blasting and removal of about ¾ of the rock in the upper approach to the lock.

The program for the current year, so far as funds are available, contemplates the completion of the Smiths Island levee, the drilling, blasting and excavation of about 40,000 cubic yards of ledge rock on Smiths Island for widening and straightening the island chute; the construction of the lower cofferdam for the lock; the filling of the low area on the Iowa shore adjacent to the lock, by use of suction dredge; and the removal by dipper dredge of the blasted rock in the canal prism which cannot be conveniently removed by the steam shovel. Actual work on lock construction will also be started if the pending river and harbor bill provides sufficient funds.

The total estimated cost (preliminary) was $1,283,000; but because of the delay in prosecuting the work, and the extraordinary increase in prices of labor and material which has taken place in the past few years, the present estimated cost is $1,800,000. The total amount expended to date is approximately $934,000; and the amount available for the current year, unless additional funds are provided, is about $123,000. With ample funds at hand the entire work should have been completed within five years, and at a cost considerably less than will be required in the eight or nine years over which the construction will extend.

KANSAS CITY DISTRICT.

Maj. R. T. Ward

In making repairs to Chittenden drum weirs at Lock and Dam No. 1, Osage River, great difficulty was encountered in raising the weirs. The automatic device did not function in many cases and the weirs were lifted by means of hydraulic jacks aided by a derrick boat. Great quantities of sand were found in the drums.

FLORENCE (ALA.) DISTRICT.

Lt. Col. Lytle Brown.

Progress on Wilson Dam.—The Wilson Dam, at Muscle Shoals on the Tennessee River, will soon be ready for the major concrete operations. Practically all the equipment for placing 900,000 cubic yards of concrete is now on hand. The preparations at the north and south abutments and on Jackson Island in mid-stream are well advanced.

On the north shore of the river the mixing equipment, including conveyors, bins and warehouses, with two two-yard concrete mixers, is in readiness for work. The two four-yard concrete mixers, the 48-inch rock crusher, with its additional battery of six 14-inch crushers, will soon be erected on Jackson Island A cement shed, capacity 20,000 barrels, has been built for the island mixing plant. On the south side of the river, a coffer is being constructed at the site of the power house. When completed, four turbine generators, each of 30,000 H. P. net, will furnish Nitrate Plant No. 2 with the bulk of the electricity thus generated. Emplacements will be provided for eleven other similar generators which, when installed, will bring the aggregate to 375,000 H. P. for some ten months of the year.

Two large air compressors are now in operation, furnishing the driving power for forty air drills and jack-hammers. Transformers have been installed to furnish the dam with light and power, the electricity being transmitted at 13,000 volts from the power plants of the Alabama Power Company on the Warrior River.

The material for seven traveling tower derricks has been received. These will operate on a four-track railroad construction bridge built alongside the dam just below the structure proper.

The 12-inch suction dredge *Indiana*, and towboat *Scioto*, transferred from the Cincinnati district, together with the 15-inch dredge *Pettus* from the Montgomery district, will supply sand and gravel from the Tennessee River for concrete.

Construction railroads on both sides of the river connect the two abutments with Florence and Sheffield, respectively. About fifteen miles of track have been constructed, including yards. A boiler shop, machine shop, blacksmith shop, and several warehouses are in operation along the north shore railroad contiguous to the dam site.

The heel trench for a cut-off wall along the upper side of the dam has been carried to full depth in coffer No. 1, and the stone thus exposed has been found to be of satisfactory quality.

The removal of 250,000 cu. yds. of overburden from the lock site at the north abutment, is nearly finished.

A motor transport section operating twenty-six trucks, two 26-passenger busses and twenty automobiles covers a monthly mileage of about 40,000 miles in the transport of labor, employees and supplies. About five miles of road have been built and metalled for this traffic.

The population of about 3,000 at the construction camp on the north side of the river constitutes a community independent of the adjoining towns of Florence, Tuscumbia, and Sheffield. Thirty permanent dwellings have been erected for the employees who will eventually operate the dam and lock. Between four and five hundred buildings have been erected since the commencement of the work. These include many temporary dwellings for employees who could not be housed in any of the crowded towns nearby. There are mess-halls, and entertainment halls, stores, offices, dormitories, and hospital. Sanitary conditions are excellent, and the health of employees at the camp is very good.

PITTSBURGH DISTRICT.

Lt. Col. H. B. Ferguson.

Bids for the construction of Lock and Dam No. 4, Allegheny River, about 24 miles above Pittsburgh, have been requested and will be opened February 14, 1920. The usable dimensions of the lock are 56 by 360 feet. It is similar to the newer ones constructed on the Monongahela River. The dam is 889 feet long. All walls, including the abutment and dam, will be placed on rock and will be of concrete.

WHEELING DISTRICT.

Lt. Col. G. P. Howell.

This District covers the Ohio River from Steubenville, Ohio, to a point six miles above Huntington, W. Va., a stretch of river 224 miles long and comprising Dams Nos. 11 to 27, inclusive. All the locks and dams are completed and in operation except Nos. 23, 25 and 27, on which work is in progress. Three dams, Nos. 21, 22 and 24, were operated for the first time last summer. Dams Nos. 23 and 25 are being constructed by contract, and No. 27 by hired labor. It is probable that No. 23 will be placed in operation in 1920, and Nos. 25 and 27 in 1921.

LOUISVILLE DISTRICT.

Lt. Col. G. M. Hoffman.

Lock and abutment No. 45. Ohio River, at Addison, Ky., twice advertised for construction by contract during 1919, and no bids received, was again advertised in January, 1920, bids to be opened February 28, 1920. Again, no bids received.

Navigation on the Ohio was interrupted by running ice for only ten days this winter, though boats had some difficulties on this account for about twenty days. The Louisville and Portland Canal was used during this time as an ice harbor by most boats in this vicinity, and some from Cincinnati.

Construction on Lock and Dam No. 48, Ohio River, will soon be started for the season.

The contractors, the MacArthur-Hanger Co., have opened up their quarry on the Green River, and begun work of towing riprap to the site. The project, started in 1912, will probably be completed in 1922.

Levee Districts have been organized on both banks of the Wabash River, Indiana and Illinois, for the purpose of building levees to protect crops from damage by flood. No levees exist on the Wabash now, and serious damage has been done by the floods of the past two seasons.

Assistant Engineer Frank I. Louckes, in charge of the Louisville and Portland Canal, resigned on December 9, 1919, and is now in the sand and gravel business at LeMars, Iowa. During the war Mr. Louckes served in France as Lieutenant Colonel of Engineers.

MILWAUKEE DISTRICT.

Lt. Col. E. H. Schulz.

Milwaukee harbor.—The Board of Harbor Commissioners presented to the District Officer plans for an outer harbor, to be forwarded to the Chief of Engineers, with survey report. The plans contemplates a series of wharves and slips for passengers, general merchandise, and car-ferry vessels, extending about 4,800 feet from Wisconsin Street south

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to harbor entrance; and a series of coal, ore and grain wharves about 8,500 feet, extending from the harbor entrance south to Russell Avenue. The wharves are to have a length of 700 feet each and belt line connection with all railroads. To carry out this work, an extension of the north breakwater and a new south breakwater are requested by the Harbor Commission.

The extension of caisson construction, wharf and plant at root of north breakwater, is in progress by the Engineer Department. It is contemplated to double the capacity of the plant and to construct during 1920, 30 caissons, each 54 feet long, 8 for Indiana Harbor, and 22 for Chicago Harbor all pertaining to the Chicago District.

Ludington Harbor.—Severe damage was done to the south breakwater during fall of 1919. It is proposed to issue specifications next month to reconstruct 1,000 feet of same by placing a new concrete superstructure, by contract, work to be done during coming season.

Wreck of the steamer Muskegon.—Work has continued on the wreck of the *Muskegon* at Muskegon Harbor. The wind, cold and ice, have been unusually severe, frequently delaying, holding and endangering vessels a week at a time. The contractor, Mr. T. L. Durocher, has cut down the wreck to a least depth of 10 feet, and the work (now temporarily suspended) will be finished as good rarily suspended) will be finished as soon as good weather allows.

Captain F. S. Skinner, Corps of Engineers, reported on November 20, 1919, for duty as assistant to the District Officer.

Lieut. Col. Arthur P. Christophel returned from overseas, was mustered out of the military service Oct. 7, 1919, and re-employed in this district Oct. 27, as inspector.

Captain Sidney R. Hartwell, who returned from service overseas on May 30th, 1919, was re-employed as inspector in this district on July 25, 1919.

CHICAGO DISTRICT.

Col. W. V. JUDSON.

Two very important improvements will be shortly undertaken, one by the State of Illinois and one by the City of Chicago.

On recommendation of the Chief of Engineers, the Secretary of War recently approved general plans for the "Illinois Waterway" and for reclaiming certain submerged lands along Chicago's water front.

Illinois waterway.—Under this permit, the State of Illinois has been authorized to construct, operate and maintain a deep waterway from the water power plant of the Sanitary District of Chicago at Lockport, Ill., to a point in the Illinois River at or near Utica, Ill., a distance of about 64 miles.

The fall between the two points named is about 140 feet and will be overcome by locks and dams at Lockport, Brandon Road, Dresden Island, Marseilles, and Starved Rock.

The locks are of the same general type, the dimensions of the chambers being 600 feet by 110 feet, with 14-foot depth over the lower miter sills. The channel is to be not less than 150-foot bottom width, with a minimum depth of 8 ft. in earth and 10 ft. in rock sections.

The lifts vary, that at Lockport being 41.4 feet and that at Starved Rock only 19 feet. The improvement confines itself to the present river bed except at one place, opposite Marseilles. There it is proposed to dredge a canal about three miles in length

This improvement is to be carried out by the State of Illinois under a bond issue of $20,000,000. The permit "does not authorize the construction of any power development works, nor the appropriation and use of any water power that may be incidentally created or developed by the navigation structures." Such construction, development, appropriation and use of water power must await the action of Congress. Work will commence in the near future.

Reclamation of submerged lands, Chicago waterfront.—Under this permit, authority is granted to the City of Chicago, the Illinois Central Railroad Co., and the South Park Commission, to fill in and reclaim certain submerged lands along Chicago's lake front.

The tract to be reclaimed covers an area of about 1,600 acres about one-half mile wide. Its northern boundary is the center line of East 11th St. (extended east) and it extends south to the south line of East 67th street (extended east) a distance of about 5 miles. The object of the improvement is to allow the extension of the park system and the addition of track and other facilities to the Illinois Central Railway, the City of Chicago having placed upon this company the duty of providing a great Union Passenger Terminal at 12th Street, which will accommodate some 15 railways and constitute the principal passenger terminal of Chicago and one of the great terminals of the world. One provision of the permit reads as follows:

> "That, the eventual need being foreseen for the use of purposes of commerce and navigation, of a part or the whole of the lands hereby authorized to be used for park purposes, the South Park Commissioners shall on demand of the City of Chicago, or of its municipal authorities, grant, convey, or release any of the lands, whether then filled or submerged, covered by this permit and under the jurisdiction of the said Commissioners, to the City of Chicago, under such compensation for the filling when accomplished as shall be just and equitable."

After a decade of negotiation between the City of Chicago, the South Park Commission, various railways and the War Department, an arrangement has been made which is satisfactory to all concerned. As an issue of bonds to the amount of $20,000,000 was approved by the voters of the South Park District at a recent election, the dream of a quarter of a century bids fair to be realized. The total cost of the improvements proposed may reach $100,000,000.

Deepening Calumet River rock cut.—Specifications have been recently approved for deepening the "rock cut," so-called in Calumet River, Ill. This rock section extends over a length of about 1,700 ft. and it was deepened in 1907 to about 21 ft. The project for this river provides for a navigable depth of 20 ft. and this has been construed to allow an actual depth of 21 ft. While this depth is sufficient in soft material, it is considered that an excess of at least two feet must be provided over a rock bottom to insure safe passage of vessels with 20 ft. draft, and the specifications provide for that increase to the limit of available funds, which will probably allow at least the completion of the west half of the 200 ft. channel. Calumet River, being at the South end of Lake Michigan, is subject to sudden oscillations, in extreme instances reaching several feet in magnitude, known as seiches, due to wind and barometric conditions. The possibility and frequency of these oscillations have prevented vessels loading to their usual depth with grain, great quantities of which are housed in elevators above the rock cut.

Assistant Engineer Geo. W. Freeman, late District Engineer, St. Paul, Minn., District, has been transferred to this district.

CLEVELAND DISTRICT.

Lt. Col. R. R. RAYMOND.

Cuyahoga River straightening. — The straightening of the Cuyahoga River is the most interesting and difficult problem connected with Cleveland harbor to-day.

This extremely crooked stream is navigated by large lake freighters, and along its bank are numerous important industrial plants. Thus the growing demands of business and the increase in size of vessels, make the straightening of the river, to facilitate commerce and to protect the industrial plants from flood damage, at once imperative and costly.

The federal government admits only a partial interest in the matter, and the burden of the improvement is thus placed chiefly upon the local community.

The local government is unable to appropriate funds sufficient for so large a project, and recourse has been had to the formation of a "flood conservancy district." Under the laws of Ohio, such districts are created as needed in order to finance and execute projects for protection against floods and for certain other purposes.

Technical difficulties are now in process of settlement in the courts; and when final agreement has been reached, the formation of a plan of co-operation between the federal and local authorities will be undertaken. Funds for this purpose are available.

Captain Geo. V. Sage, Master of the U. S. seagoing dredge *Burton*, died at Toledo. Ohio, on the 23rd of February, 1920.

BUFFALO DISTRICT.

Lt. Col. C. S. SMITH.

Erie Harbor, Pa.

Under contract with the Great Lakes Dredge and Dock Co., of Cleveland, Ohio, dated August 7, 1919, operations begun October 6, 1919, were continued with hydraulic dredge *Chicago*, until December 11, 1919, when owing to ice and weather conditions, work was suspended for the winter. An estimated quantity of 10,000 cu. yds. of sand was placed during December, 1919, between stations 26 and 47, and a total of 150,000 cu. yds. to date.

Buffalo Harbor, N. Y.

Weather conditions prevented work during December, 1919, in redredging the Buffalo River entrance channel, under contract with the Empire Engineering Co., and dredging in area at the junction of the Buffalo River and Black Rock Channel and two areas in the outer harbor, under contract with the Great Lakes Dredge and Dock Co.

Black Rock Canal was open to navigation and the lock in commission until December 31, 1919, when the guard gates were closed and operating discontinued for the winter, 47,410 short tons of freight having passed through the lock during December, 1919.

Oswego Harbor, N. Y.—Dredging the eastern part of the outer harbor to a depth of 21 feet at low water datum in anticipation of the completion of the enlarged Welland Canal by the Dominion of Canada, was begun October 27, 1919, and continued until November 28, then suspended and the dredging plant laid up for the winter. A total of 22,748 cubic yards, scow measure, sand, mud and clay has been dredged to date at a field cost of $3,539.59, or 15½ cents per cu. yd. The dipper dredge *Sodus* and attending plant was used in this work.

Ogdensburg Harbor, N. Y.—Dredging under contract with William J. Daly of Ogdensburg, N. Y., began October 6, 1919, and was continued with the dipper dredge *Lincoln* un-

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til suspended for the winter, December 16, 1919. The work comprises the widening and deepening to 19 feet at low water datum, of part of the city front channel, the upper entrance channel, and easing the bend at the junction of these channels, also re-dredging of shoaled portions of channels. A total of 141,578 cu. yds. scow measure, sand, mud and clay, has been dredged to date, at a field cost of $27,300.04. The unit price is 18.7 cents per cu. yd., scow measure.

LOS ANGELES DISTRICT.

Maj. F. B. Downing.

A contract was entered into January 20, 1920, with the United Dredging Company of Los Angeles, Cal., for dredging to 32-foot depth, Areas A and C, and to 35-foot depth the Middle Ground Channel at San Diego Harbor, Cal. Areas A and C lie southerly and northerly, respectively, of the entrance channel to the municipal pier at San Diego, and are estimated to contain 307,000 and 1,077,000 cu. yds., respectively, of material. The Middle Ground Channel lies just within the entrance, and is estimated to contain 200,000 cu. yds. of material. The prices to be paid for this dredging are 24.25 cents per cu. yd. for Area A and the Middle Ground Channel, and 26.8 cents for Area C. Work will probably begin in April.

SEATTLE DISTRICT.

Lt. Col. J. A. Woodruff.

Lake Washington ship canal.

The navigation through the Lake Washington Ship Canal continues to increase. The total number of vessels passed through the locks during the calendar year 1919, was 24,636 while the number through the St. Marys Falls Canal Locks was 15,537 in 1918.

The freight tonnage increased from 765,429 tons in 1918 to 1,020,710 tons in 1919. This of course does not compare with the tonnage through the St. Mary's Falls Canal—72,758,680 tons in 1918.

Plans are now being prepared for an emergency dam for the Lake Washington Canal locks. It will be of a type similar to that used on the Panama Canal. The main lock is 80 ft. wide and 825 ft. long and has a lift of 25 ft., with a depth of 25 ft. on the lower and 36 ft. on the upper mitre sill at extreme low water.

Port of Seattle.

The Port Commission of Seattle has recently completed pier "B" at Smiths Cove, which is one of the largest commercial piers in the world. It is 2,530 feet long and 397 feet wide, with a water depth at fender line of 35 feet at extreme low water.

Pier "A" which is adjacent, is of the same length but is 310 feet wide. Each of these piers provide about 4,000 feet of berthing space.

Pier "B" is to be equipped with a 100-ton stationary revolving crane and two 10-ton portable gantry cranes. Pier "A" is equipped with a travelling gantry crane, two locomotive cranes of 15 and 35 tons each and a stationary shear leg derrick of 100 tons capacity.

Bids were opened in December for dredging about 2,000,000 cu. yds. in Willapa River, Washington, over a length of about 9 miles, in the channel to Raymond, Washington. Only one bid was received which was rejected as informal and in excess of the available funds, amounting to about $400,000.

HONOLULU DISTRICT.

Col. H. C. Newcomer.

Kahului Harbor, Island of Maui, Hawaii.—The approved project for this harbor was completed November 6, 1919. It consists of two rubble mound breakwaters, each having a length of about 2,000 feet, and a partially protected basin having a width of about 900 feet, with a minimum depth of 35 feet.

Honolulu Harbor, Hawaii.—Dredging in "Reserved Channel" was begun on October 14, 1919. This is an extension westerly from the main harbor basin, which will add about 22 acres to the harbor area when it is completed as far as authorized under the present project.

FIRST AND SECOND MISSISSIPPI RIVER DISTRICTS.

Maj. J. N. Hodges.

Tower excavators for levee construction.

With a view to decreasing the cost of levee construction in these districts, four tower excavators have been purchased. Two of these machines are of steel construction, both head and tail towers with caterpillar traction, and operate a 6 cu. yd. bucket on a drag-line with a maximum span of about 650 feet. The bases of the head towers are constructed on a slope of 1 in 15, in order to operate on the inclined slope of the banquette while placing an enlargement on the levee front. The other two machines have wooden towers; the head ower being constructed on four 4-wheel trucks and moved on track sections which are shifted and placed by light cranes attached to the machine. The tail tower is of a very imple wood construction which is skidded back and forth by the use of dead-man anchorages and electric motor, the power being supplied from the head tower.

The main principles of operation are the same in all four machines except that in the case of the first two mentioned the bucket is carried back to the pit by a back-haul line passing over a sheave on the tail tower, while in the case of the other two machines the bucket is carried back to the pit by gravity. The capacity of all of these machines is about 50,000 yards per month, single shift.

There is every reason to believe that, when all of these machines have been erected and are in operation, the cost of levee-building in these districts will be greatly reduced.

Caving in the vicinity of Wyanoke Landing, Ark., having reduced the margin between the river bank and the controlling levee to such narrow limits as to endanger same, it became necessary to construct a new levee loop or install bank protection work at this point. The estimated cost of the new loop was $180,000, while that of the necessary bank protection work was $120,000. In view of the fact that the St. Francis Levee Board of Arkansas proposed to contribute $60,000 toward the latter project, it was decided to install bank protection work. Operations were, accordingly, begun on November 1st, 1919, and will be pushed to an early conclusion.

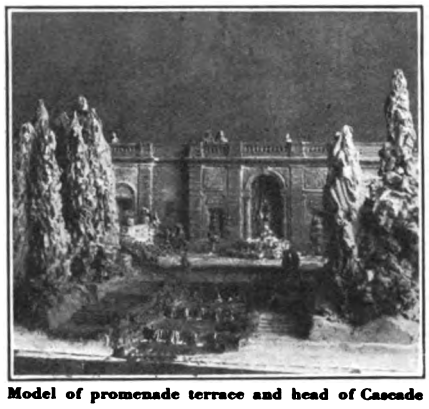
PUBLIC BUILDINGS AND GROUNDS DISTRICT OF COLUMBIA.

Col. C. S. Ridley.

The Meridian Hill Park Development.—Washington, D. C.

This office has had under development since 1912 a tract of high ground lying along 16th St. between W and Euclid, extending east to 15th St. It contains about 15 acres, two-thirds of which are fairly level with the balance sloping to the south. The side toward 16th St. had been left, in the process of street construction, with a sharp cut averaging thirty-five feet in height. From its relation to the meridian of Washington, the place was named Meridian Hill Park.

The development of this park contemplates having in the capital of this country a public



Model of promenade terrace and head of Cascade

garden which shall be in every way comparable to the great formal parks of Rome, Paris and other foreign capitals, a park which shall serve as a model for other American cities. On account of similar needs resulting from similar climatic conditions, inspiration has been sought in the old garden types of the Italian Renaissance.

The features of the design are the maintenance of the maximum level area by double retaining walls along Sixteenth Street and the construction of a great promenade terrace, sixty feet wide and three hundred feet long, across the park from east to west,—a platform developing the unique panoramic possibilities and the decided advantages of unimpeded southern breezes. The balance of the design is accessory to this one feature. Directly north of it is a concert pavilion and grove; viewed from Euclid Street, one sees a broad grass mall flanked with hedged walks leading to the pavilion. South of the terrace feature through the wooded hillside, bordered with hedges of ilex and lines of cedars, will be a series of pools carrying the water from the terrace fountains to a broad receiving basin on a lower level. On the outskirts of the park are to be heavy tree plantations and winding walks.

Work on the project has been carried on with limited appropriations but enough has been accomplished to give a fair idea of the effect to be attained—except that due allowance must be made for the effect of great trees both in front of and above the masses of masonry, and for its further reduction in importance by the use of heavy shrubbery and overhanging vines. A new type of decorative concrete has been one of the interesting developments of the study to date. A steady improvement in quality is demonstrated from year to year, and an adaptability to architectural detail has warranted its introduction on the market as a new medium of construction in any color combination or surface texture, in poured, precast or stucco form.

In England, gardening developed ideally from a domestic point of view. In France, great effects and display carried to the opposite extremes. In Italy, the gardens of the nobility, developing from climatic conditions and social requirements during a period of unparalleled culture and wealth, resulted in an intermediate type combining in a remarkable way the broad, logical plannings of the French parks and the informal livable qualities of the English gardens.

The translation of the spirit of these old gardens, with their lavish display of water, their studied relation of light and shade, and their happy combination of architecture and planting will demonstrate the adaptability of the types to modern materials and American conditions.

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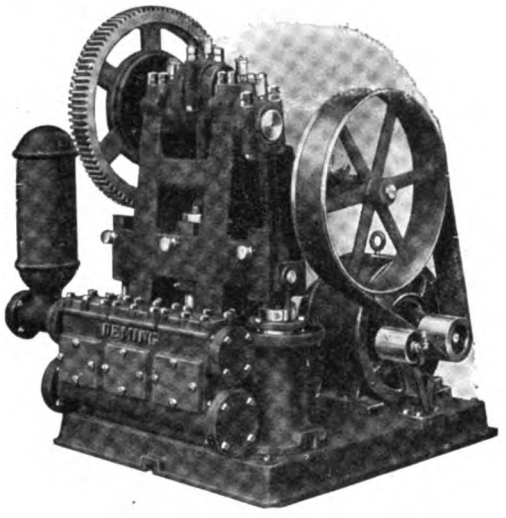


Fig. 50. Single-Acting Triplex Pump 5 1-2 x 8 Type, "C" Drive

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Engineer Troops

1st ENGINEERS, CAMP TAYLOR, KY.
Col. J. J. Loving, *Commanding.*

Every available man is out on the recruiting drive. There are parties at Indianapolis, Cincinnati, Louisville, Huntington, Knoxville, Nashville and Greensboro. Recruits are beginning to arrive, and good results are expected before the end of March.

The division has not forgotten the great usefulness of a regiment of engineers, as evidenced by the frequent calls for the performance of numerous constructions jobs. These are generally accomplished in good order notwithstanding the handicap of limited personnel and other obstacles, and provide excellent training for the regiment.

The morale of the regiment is splendid in spite of rather trying conditions, as shown by the very infrequent need for disciplinary action, and by the fine spirit displayed in every undertaking.

The combined regimental mess won first place in a recent competition between unbrigaded units for the best kitchen, and there is every reason for a spirit of optimism in the camp competition now going on. A similar competition to determine the best corral is also in progress, and there, too, we have "great expectations."

A coat-of-arms for the regiment has been tentatively adopted, and forwarded to Bailey, Banks & Biddle for completion.

The officers of the regiment are enthusiastic over the prospects for polo. A number of likely ponies have been received, and are being trained for the game. It is expected to develop a first-class engineer team.

During the recruiting drive, which ended Mar. 31, practically nothing could be undertaken in the way of training except for recruits. However, a plan for intensive training is being worked out, including general service and engineer instruction, and training for specialists. It is expected before the end of the coming summer to produce an efficient engineer regiment.

The division has entered upon an enthusiastic and energetic campaign for the purpose of raising a fund to erect a monument in memory of its members who died in France. The objective is $100,000. Every member of the regiment at this camp has subscribed at least one day's pay. Plans are under way to organize in each a committee of ex-members of the division, to aid in the drive. It is planned to erect on a suitable site in Washington, or in Arlington, a monument similar to the Battle Monument at West Point.

Citations have recently been issued by the Division Commander, Maj. Gen. C. P. Summerall, commending the regiment for gallantry in action and efficiency under fire, both as infantry in the line and as engineers, during the operations near Soissons, under command of Col. L. V. Frazier, and in the Meuse-Argonne Offensive under command of Col. F. B. Wilby. Also, by authority of Lieut. Gen. R. L. Bullard, the regiment has been cited for the conspicuous part borne by it in the capture and defense of Cantigny, under Col. Frazier.

The regimental colors were decorated with the Croix-de-Guerre by Marshal Petain in Coblenz, on July 18, 1918.

It is especially gratifying that the First Engineers has won honors for its conduct and action, not only in its special mission, but also as infantry, fighting in the line. Every member now with the regiment is impressed with its gallant record, and is determined that the standard established during the war shall be always maintained during peace.

2nd ENGINEERS, CAMP TRAVIS, TEX.
Col. G. E. Egerton, *Commanding.*

The schedule of instruction at Camp Travis has been changed to provide for general military instruction by organizations from 7:30 to 9:30 a. m.—elementary educational and business schools from 9:30 to 11:45 a. m., and advanced educational and vocational schools from 1:00 to 4:30 p. m. Only men not desiring to attend any schools and not required to take elementary educational instruction or duty after 9:30 a. m. From 3:30 struction or duty after 9.30 a. m. From 3.30 to 4:30 p. m. all administrative offices are closed and all officers and men not attending schools are required to spend the period in athletics.

A short course in road construction for all men in the regiment covering 2½ hours daily for four weeks, was completed on February 19. A course in photography for selected men only has been added to the regimental schools for enlisted men. The first course in mining, demolitions, and explosives was completed about the middle of Feb. On Mar. 1, the regimental schools took over the drafting classes of the Educational and Vocational Schools of Camp Travis.

The officers' class in military law, under divisional schedule in which the officers of the 4th and 5th Machine Gun Bns. were attached to the 2nd Engineers, completed their final examinations Feb. 13. A new class in military administration began Feb. 16. For this class the officers of the regiment are attached to the Field Artillery Brig.

The regiment was represented at the San Antonio motor show by a booth containing a terrain board showing in miniature features of engineer construction. The exhibit also contained the more unusual items of engineer equipment and trophies captured from the Germans. Master Engineers Senior Grade Maurice Long was on duty at the exhibit to explain its features to those interested.

Capt. T. H. Nixon, Corps of Engineers, reported for duty Dec. 22, 1919, and has been assigned to command Co. "E."

Capt. Fernando T. Norcross, Corps of Engineers, reported for duty Jan. 8, 1920, and has been assigned to command Co. "D."

2nd Lieut. D. A. Newcomer, Corps of Engineers, left Camp Travis on January 20, 1920, with a recruiting party consisting of Master Engineers Jr. Gr. Thomas Hinton and George A. Wilkinson, Sergeant 1st Class Earl V. Cullar, and Sergeant Harry Atkinson, 2nd Engineers. This party is operating in the vicinity of Dallas, Texas. Capt. F. H. Norcross relieved Lieut. Newcomer in charge of this party on February 11, when the latter joined the regiment.

Capt. Peter E. Bermel, Corps of Engineers, in charge of a recruiting party consisting of 1st Sergeant Fred Fenner, Stable Sergeant Harold Davis, Sergeant Dwight M. Fowler, and Corporal Wilbur F. McCarty, 2nd Engineers, left Camp Travis on January 28, 1920, and is operating in Oklahoma.

Capt. Thomas H. Nixon, Corps of Engineers, in charge of a recruiting party consisting of Master Engineers Sr. Gr. Thomas F. Burke, Sergeant 1st Class Nelson J. Moore, Sergeant Daniel J. Madison, and Corporal Fred J. Watters, 2nd Engineers, left Camp Travis January 31, and is also operating in Oklahoma.

4th ENGINEERS, CAMP DODGE. IOWA.
Maj. S. L. Scott, *Commanding.*

After fifteen months' service in France and Germany the regiment returned to the United States July 29th, 1919, arriving at Camp Dodge August 4th.

The first work of any importance after arrival here was strike duty in Gary, Ind. This regiment furnished one company for the Provisional Regiment of the 4th Division. Capt. A. B. Skoien, Lt. W. J. Lamon and 2nd Lt. B. C. Parr were detailed for duty with the company and the engineers proved that they were capable of performing any duty assigned them.

Twenty-six men of this organization are on duty with recruiting parties making the drive in the states allotted to the Division.

Lieutenant Lamon has arranged a very attractive display of engineer equipment in a Des Moines shop window for recruiting purposes.

2nd Lt. I. C. Lawrence who went to New York for examination for promotion has returned to duty.

Lt. Bruce C. Hill is on temporary duty with the Motor Transport Corps of the 4th Division. He commands Company 131.

A regimental exchange has been opened under management of Lieutenant Parr.

Major Scott is conducting a school for regimental officers.

The enlisted men's mess has gained quite a reputation since the return of the men from Gary. The santitary inspector has given it the highest grade in the camp. The menus are excellent.

A very enjoyable smoker was given for the men of the regiment February 21st. A good program was arranged by Chaplain J. L. Blakeney. Refreshments were served.

5th ENGINEERS, CAMP HUMPHREYS, VA.
Colonel Richard Park, *Commanding.*

The regular training schedule was carried on until the 19th of December, when inclement weather forced the abandonment of outdoor engineer drill. During the winter the following schedule was followed:

7:30-8:30 a. m.—
Physical drill, boxing and wrestling, and infantry drill.

9:00-1:00 a. m.—
Small problems in infantry tactics for all men, conducted by the officers of the regiment, using a large scale reproduction of the Hunterstown sheet on the blackboard. Men were called upon in turn to give their solutions of the various situations.

10:00-11:30 a. m.—
Regimental schools, each in charge of an officer, as follows:
Mondays—Model bridges;
Tuesdays—Model field fortifications in sand box;
Wednesdays—Military sketching and map reading;
Thursdays—Topography, elementary study of drainage and contours;
Fridays—Military roads and railroads.

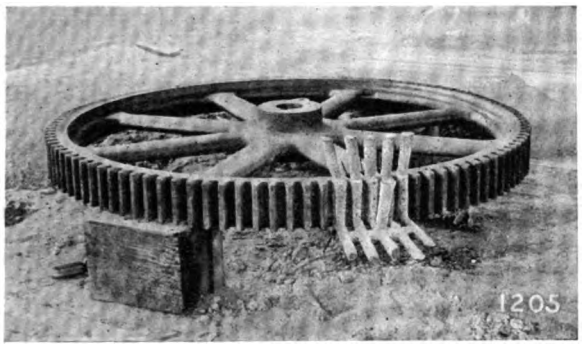
All men of the regiment, with the exception of those on special duty, attended these drills.

Afternoons from one to four, except Wednesday, were given over to vocational schools. Wednesday afternoons were devoted to athletics.

On February 4th sixty eight men of Company "B," First Engineers, who had been atached to the Fifth for training for one to two months, were sent to Germany to join their organization.

Recruiting—Recruiting has engaged the serious attention of the regiment during the entire winter. Fifty seven of our best men have been sent on this duty in the eastern states and in the divisional recruiting area, which includes Kansas, Nebraska, and Minne-

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sota. The 7th Division, to which the 5th Engineers belongs, is stationed at Camp Funston, Kansas.

Lt. O. G. Hoaas has been traveling in Virginia with a motor party of four men and has had good success.

Portable machine shops, mounted on Mack five-ton trucks, each with a crew of four men, were sent to Harrisburg, Pa., Huntington, W. Va., Richmond, Va., and Cleveland, Ohio. These trucks have proved very valuable for recruiting as they draw an interested crowd wherever they are set up, and so furnish opportunity to approach many men who would not otherwise be reached.

Parties of two men each are working under the direction of the Recruiting officers at Wichita, Kan., Omaha, Neb., Minneapolis, Minn., all of which are in the divisional recruiting area. Outside of the divisional area, partes of two men each have been sent to the following cities: Albany, Buffalo, New York, N. Y.; Baltimore, Md.; Scranton, Pittsburgh, Philadelphia, Pa.; Springfield, Boston, Mass.; Newark, N. J.; Portland, Me.

In January Colonel Park visited the 7th Div. at Camp Funston, and inspected the work of the recruiting parties at Wichita, Omaha, and Minneapolis. Maj. H. V. Pittman has just returned from a visit of inspection of the eastern cities. The men on recruiting duty are interested and are working well; they have sent in more than fifty recruits to date, all good, clean-looking youngsters, who will make good soldiers.

At the same time a campaign has been carried on in the regiment itself to induce men to re-enlist as their time expires. The results have been encouraging, both among the old soldiers and among the emergency men who enlisted for one year in the spring of 1919.

Future Plans—The present plan of the War Depart. is to recruit the regiment to full strength, and divide it beween Camp Humphreys, Va., and Camp Funston, Kans.; one battalion at each. At Camp Humphreys the troops will be engaged in administrative duties for the camp and in engineer drills and demonstrations for the Engineer School. At Funston there will be opportunities for training of a broad, varied, and interesting nature in connection with divisional maneuvers. At both camps there are good facilities for the vocational training of the men, not only in the technical branches necessary for the engineer service but also in general education and in agriculture. Camp Funston has a model farm now under operation by the vocational schools and Camp Humphreys is making arrangements to start one.

6th ENGINEERS, CAMP PIKE, ARK.

Col. C. L. STURDEVANT, *Commanding.*

The 3rd Division has recently organized the 3rd Division Horse Show Association, with May 15th set for the first show, and preparations are well under way to make it a big success. The purpose of the show is to bring the people of Little Rock into closer touch with the division and to promote interest in horses, horsemanship and animal transportation. Maj. Henry Hutchings, Jr., 6th Engineers, is treasurer of the association. The horse show will be an all-day affair, with special encouragement given to civilian entries; mounts will be furnished them if desired. Arrangements are being made in the officers' messes to serve a buffet luncheon to the many guests expected.

Two officers and a large percentage of the enlisted men are engaged in the general drive for recruits. While the results are not up to expectations, recruits have been coming in at the rate of about one per day and that rate has been increasing recently. All recruits are being assigned to Co. "E", which boasted 63 members on March 1st.

Several of the officers are training polo ponies and it is expected that the regiment will be represented by a team in the Camp Pike Polo Association, recently organized.

ARMY ENGINEERS IN GERMANY.

Lieut. Col. B. A. MILLER, *Chief Engineer, American Forces in Germany.*

The phenomenal rise of the Rhine and Moselle Rivers during the month of December has greatly interfered with road work in the occupied areas and has placed considerable additional work upon the engineers in maintaining the operation of the public utilities and insuring the safety of government property threatened by rising water.

A large percentage of Company "A" has been engaged in the above work.

Company "B," 1st Engineers (railway operating unit), arrived December 30, 1919, and will be transferred to the engineer compound upon completion of quarantine required of all arriving troops.

Company "D," 1st Engineers (Silesian expedition), operates the engineer dock at Andernach, care and maintenance of all buildings of the Silesian expedition, and has also assisted in moving government supplies threatened by the rise of the river, to places of saftey.

A great lumber dock at the junction of the Rhine and Moselle has been moved to a point adjacent to the engineer dock on Moselweisserweg.

A great shortage of supplies in local markets has compelled purchases at distant points. Great difficulty has been encountered in obtaining necessary supply of fuel.

Transportation needs have been met by the continuation of shuttle trains to Essen and Hamburg and the commandeering of barges designated for other points.

Conferences of all Allied representatives were held at Weisbaden on December 8th, and Cologne on December 15th.

The engineers erected and wired the "Christmas Tree of the American Forces in Germany" in front of Headquarters and placed an electric star on the heights of Ehrenbreitstein.

An engineer lithographic equipment (regimental) has now been installed, with which the engineers can meet all requirements of the American Forces in Germany.

Service Schools

ENGINEER SCHOOL, CAMP A. A. HUMPHREYS, VA.

Post Graduate Section; Col. W. T. Hannum, Assistant Commandant.—During the months of Jan. and Feb., 1920, instruction has been carried on in the following subjects:

Field fortification,
Military art,
Bayonet training, hand to hand fighting and boxing,
Hygiene and sanitation,
Hydraulics,
Military law,
Contracts, specifications, estimates and accounts,
Equitation.

The course in field fortification started the first of the year and is to continue until Mar. 5, 1920. It is under the direction of Maj. F. C. Harrington with Capt. W. E. R. Covell and Capt. T. B. Larkin as assistants. The basis of the course is a series of practical problems, as follows:

Four on organization of the ground,
Two on construction of trenches and obstacles,
Two on shelters,
Two on military roads,
Two on light railways,
Two on demolitions.

All the problems were co-ordinated and tied into the same general tactical situation. The course was rounded out by many discussions of problems, conferences, demonstrations and lectures. The latter have proved most interesting and instructive. There follows a list of the lectures given during this course:

Objects and scope of course, Maj. Harrington.
Lessons of the World War as affecting field fortification, Col. Wilby.
The Hindenburg line, Col. Pillsbury.
Camouflage, Lt. Col. Bennion.
Military roads, Col. Graves.
Light railways, Maj. Peek.

The course in military art under, Maj. L. M. Adams with Maj. O'Connor and Capt. Styer as assistants, was continued through the last two months. This course consists of a series of map problems, war games and terrain exercises with the addition of several conferences and lectures. In general, it is similar and preparatory to the course at the Army School



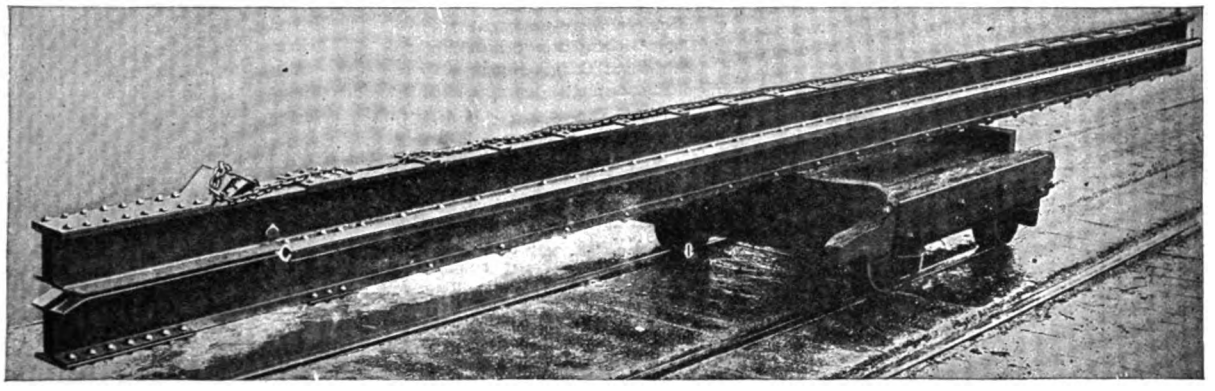
of the Line at Fort Leavenworth, Kans., though being limited in extent and in size of units handled.

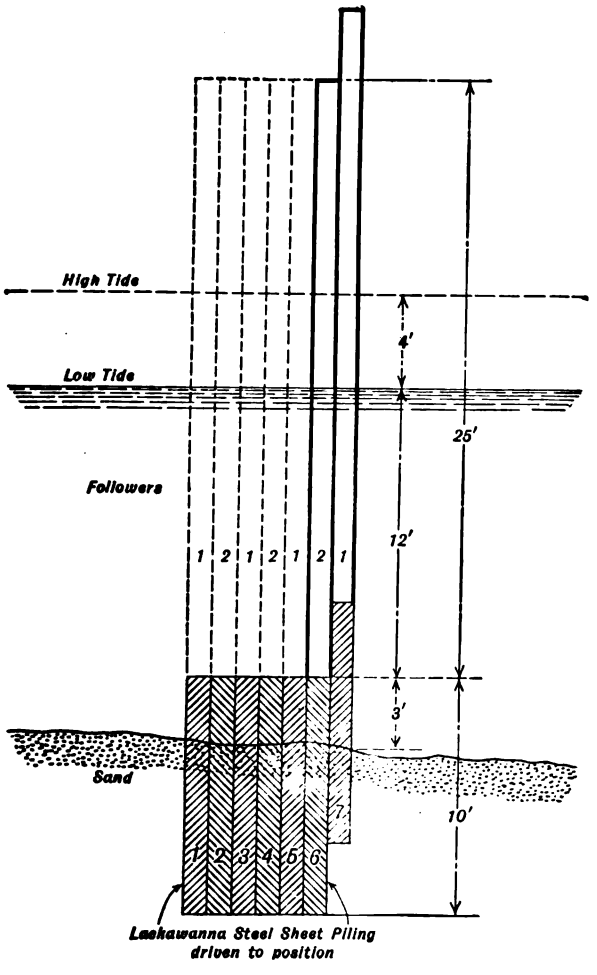
The courses in hygiene and sanitation under Col. Schriener of the Medical Corps, in hydraulics under Capt. Bond, in contracts, specifications, estimates and accounts under Capt. L. W. Miller, and in military law under Capt. Arthur, consisted in conferences on these subjects conducted by the officers in charge.

The course in bayonet training, hand to hand fighting and boxing, and in equitation were practical in nature, and were conducted by Capt. Davison and Capt. Bock, respectively.

The Post Graduate Section began the year with thirty students. During the months of Jan. and Feb. five were lost to the school. Maj. Gillette was ordered to England as assistant to the Military Attache at London. Capt. Heavey was assigned as instructor in the Undergraduate Section. Maj. Robb was detailed as Provost Marshal of the camp. Captains Love and Curry resigned.

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Several officers of the Corps of Engineers who have not finished the course at the Engineer School are being given some of the subjects by correspondence. In the two last months study in reinforced concrete construction with the University Extension Division, University of Wisconsin, was carried on. There were ten officers enrolled in this course all of whom were on duty at points other than Camp Humphreys.

Under Graduate Section; Col. V. L. Peterson, Assistant Commandant.—During Jan. and Feb. instruction in the following subjects was given:

Reinforced concrete design,
Water supply,
Building construction,
Electrical and mechanical engineering.

Under the first of these subjects, instruction covered the design of columns, girders, cross beams, floor slabs, walls and retaining walls. The course was completed Mar. 1, 1920.

The course in water supply consisted of investigation and design of the water system of this camp, including storage reservoir and the main pipe line. A trip was made to Washington, D. C., to inspect the aqueduct system; the pumping plant, laboratories, filters, sand washers, etc.

In building construction the methods of design and construction of an office building in New York City, of a lock tender's dwelling for Lock and Dam No. 29 on the Ohio River, and of a temporary timber warehouse to be erected in time of war at Camp Humphreys were all studied. During the trip to Washington mentioned above a visit to the Union Station was made to study the roof trusses, suspended ceiling, roofing, ventilation, power plant, kitchens and lighting system.

The electrical and mechanical engineering course, made up largely of experiments, continued during this period. Since the first of Jan. student officers have finished the following experiments:

Resistance,
Electrical rotating machinery phenomena,
Motor starters,
Controllers,
Direct current motors,
Steam indicators,
Simple engines,
Direct current generators,
Storage batteries,
Boiler testing,
Flue gas analysis.

There are two directors, fifteen instructors and eighty-six students in this section of the Engineer School. Nearly all of the students at some time since Jan. 1st have been preparing for promotion examination and have been allowed one week off for study. In this connection, in order better to prepare the officers in river and harbor work, which they have not yet studied, two lectures were given, one on "River and Harbor Improvement" and one on "Administration of a Typical District Office."

One of the existing large buildings of the camp has been completely remodeled into a riding hall, with several indoor practice cages for polo.

Vocational School; Capt. B. C. Dunn, Assistant Commandant.—The Vocational School for enlisted men of the camp, which is the third division of the Engineer School, is giving instruction in the following:

Elementary reading, writing and spelling,
Blacksmithing,
Welding,
Machine shop,
Automotive,
Sheet metal,
Electrical,
French and Spanish grammar.

The school had originally seventy-five men enrolled, but due to recruiting duty, shipment of men over seas, and other causes the number has been reduced to fifty-one.

Engineer School Library.—A branch of the Washington Barracks Engineer School Library has been established at Camp Humphreys and is in charge of Mr. Langdon, former A. L. A. Librarian at the latter place. The collection now consists of about 2,000 books, with more being added daily. It is planned to increase this number to 8,000 volumes from the stock at the main library.

The technical portion of the former A. L. A. library, consisting of some 3,500 books, largely on engineering subjects, is being transferred to the Engineer School library and will prove a valuable addition.

A collection of lantern slides, the property of the Engineer School, is being catalogued, indexed and arranged by the librarian; work has also begun on organizing an extensive map library for the use of the school.

A complete file of the courses of the Army Service Schools in the various camps throughout the country has been compiled and indexed by the librarian and a catalogue has been issued on this collection; supplements are added to this bi-weekly.

ARMY SERVICE SCHOOLS, FORT LEAVENWORTH, KANS.

"Leavenworth" vindicated itself during the great war. Leavenworth ideas and methods and Leavenworth spirit were pitted against the best that Europe could muster, and proved their superiority on the field of battle over all the world. It was Leavenworth that "leavened" the great forces America sent over to win the war, and the nation may justly regard those who founded and developed our service schools as the saviors of civilization. Burning the midnight oil on the outskirts of a little town in Kansas, earnest and patriotic American officers laid the solid foundations of the great victories of the Marne, St. Mihiel and the Meuse-Argonne. Here the American army outwitted the German great general staff, here years before the war the end of German militarism was in the making.

The Army Service Schools are again to-day, as they were before the war, the world's greatest university for the study of tactical science, and "the Frenchman" is still the tactical center of the universe. For the benefit of our new readers we should explain that "the Frenchman" is a little inn, at a cross-roads west of Fort Leavenworth, whence gallant (imaginary) troops, the products of the "brain-trust," sally forth on campaigns of conquest, whilst their commander, the unequalled General A, who never makes a mistake and never dies (continued life to the greatest of commanders), sips his beer (or near beer) inside the house.

Mailing List and Book Department.—The Service Schools maintain a subscription mailing list by means of which all officers of the army, national guard, reserve corps and R. O. T. C. may receive the instruction pamphlets and problems of the schools and follow the work which they are doing.

The purpose of this mailing list is to stimulate tactical study by all officers. It aims to keep those connected with the military service in touch with the work of the General Service Schools. Subscribers receive from time to time throughout the year problems and their solutions, lectures, maps and other matter prepared and used in connection with the regular work of the schools and in the several courses of instruction.

The quantity of matter sent out each year on this mailing list varies, depending upon the production of the schools. No regular schedule is maintained; subscribers are charged each year according to the amount sent out. To date the charge has never exceeded $1.50 per year. Bills will be rendered on July 1st. New subscribers are supplied with all matter for the current year in which they subscribe. A subscriber's name is removed from the mailing list only upon request, or for other sufficient reason. A simple request, addressed to the secretary of the schools, to be placed upon the mailing list is all that is required to secure this service.

This list now has approximately 13,000 subscribers, and will no doubt reach 20,000 by the end of the present school year.

All officers who truly desire to improve their knowledge of the art of war should place their names upon the mailing list without delay. The cost is nominal and the value beyond price.

In addition to the mailing list the schools maintain a Book Department, where all books on the art of war in all its aspects may be obtained at the lowest rates.

THE INFANTRY SCHOOL, CAMP BENNING, GA.

The Infantry School is at Camp Benning, Ga., nine miles south of Columbus, on the Chattahoochee River.

The school as now organized is comparatively new (April, 1919), but is a combination and combination in co-ordinated and amplified form of the old Infantry School of Arms and the Machine Gun School. The real forerunner of the Infantry School was the Musketry School, established by the War Department at the Presidio of Montery, Calif., in Feb., 1907.

The Infantry School is a special service school having a mission in relation to the infantry and the army generally, similar to that of the Engineer School in its field. The need for such a school in our service has existed, certainly, for a long time, but the experience gained in the recent war, together with the increased complexity and technical nature of infantry service, has made its development to its present form and position logical and essential.

The infantry is unquestionably the dominant arm in our service, not only in numbers but from the nature and importance of its functions in battle. Other arms and services are all auxiliary to the infantry.

Leadership is the most essential qualification of any infantry commander. But the ability to lead demands exact knowledge of many things; such as how to handle men in extended formations over varied terrain and the technique and coordination of many weapons. The infantryman may be called upon to fight any one or all of the following weapons: Rifle, machine gun, automatic rifle, one-pounder, light mortar, grenade and bayonet. The infantryman of to-day knows he must also be able to understand ground, read maps, follow a compass bearing, site trenches and construct them.

The Infantry School is organized into three divisions:

1. School,
2. Experimental,
3. Executive.

The Assistant Commandant is the direct head of the school division, which includes all instrumental work. Instruction is given directly in six departments:

1. Tactics,
2. Engineering,
3. Rifle and pistol,
4. Machine gun,
5. Miscellaneous weapons,
6. General subjects.

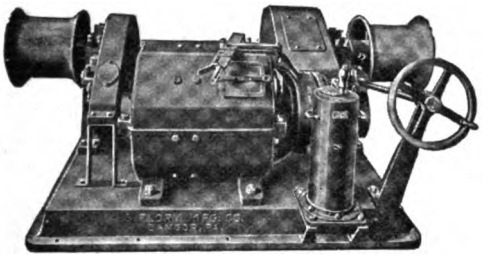
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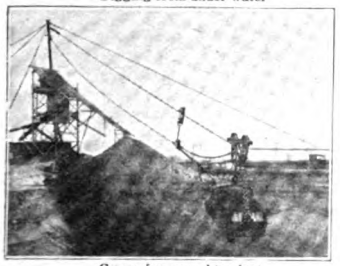
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"Camouflaged" houses on the battle-front at Camp Benning

The experimental division is charged with all testing and research work pertaining to infantry equipment and supplies, from the point of view of usefulness in actual service. It is an important agency of the Infantry Board.

The executive division is charged with general administration and control of all school troops. The 29th Infantry and a machine gun battalion are, at present, stationed at the school. It is planned to have also one battalion of artillery, one battalion of tanks, one aero squadron, one company of engineers and one of signal troops, with detachments of other services, for purposes of demonstration.

The courses in prospect, to be organized as rapidly as facilities become available, with number of students and length, are as follows:

1. Field officers, 20, 10 months,
2. Company officers, 110, 10 months,
3. Basic officers, 110, 10 months,
4. National guard officers, 120, 3 months (2 classes).
5. N. C. O. candidates for reserve corps commissions, 120, 3 months.
6. N. C. O. of rifle company, 210, 3 months (2 classes).
7. N. C. O. of machine gun company, 90, 3 months (2 classes).
8. N. C. O. of headquarters company, 90, 3 months (2 classes).
9. Scouting (enlisted men), 50, 3 months (2 classes).

The character of the instruction to be given in each course is indicated by its name. The "basic course" is for young officers of infantry upon their entry into the service. The instruction covers fundamentals and has for its purpose the creating of competent platoon leaders. With the present basic class (125 recent graduates of the Military Academy) the assignments of time to the various subjects are as follows:

Subject	*Hours*
Tactics	441.5
Infantry drill	59.5
Rifle and pistol	195.
Automatic rifle	74.
Musketry	78.5
Sketching and map reading	105.5
Field fortification	43.
Machine guns	25.5
Miscellaneous weapons	78.
Chemical warfare	5.
Administration	117.
Law	66.5
Hygiene	10.
Military courtesy	8.
Guard duty	7.
Psychology	12.5
Care of equipment	5.
Equitation	17.
Saber	2.

The instruction in the department of engineering has been planned and prepared to give the young infantry officer a sound knowledge of the fundamentals of sketching and map reading, a real understanding of distance, direction and relative elevation, followed by as much sketching and map reading as time permits, with a view to increasing the ability of the student to understand topography and show him the usefulness and application in practical infantry problems. In field fortification the work will cover the simple standard traces, profiles and accessories, handling of working parties, siting of trenches and elementary organization of ground.

The applicatory system of instruction developed at Fort Leavenworth is being followed, and the student will not go away with any false conceptions. He will take part in demonstrations with actual war-strength units, operating over varied terrain and using live ammunition.

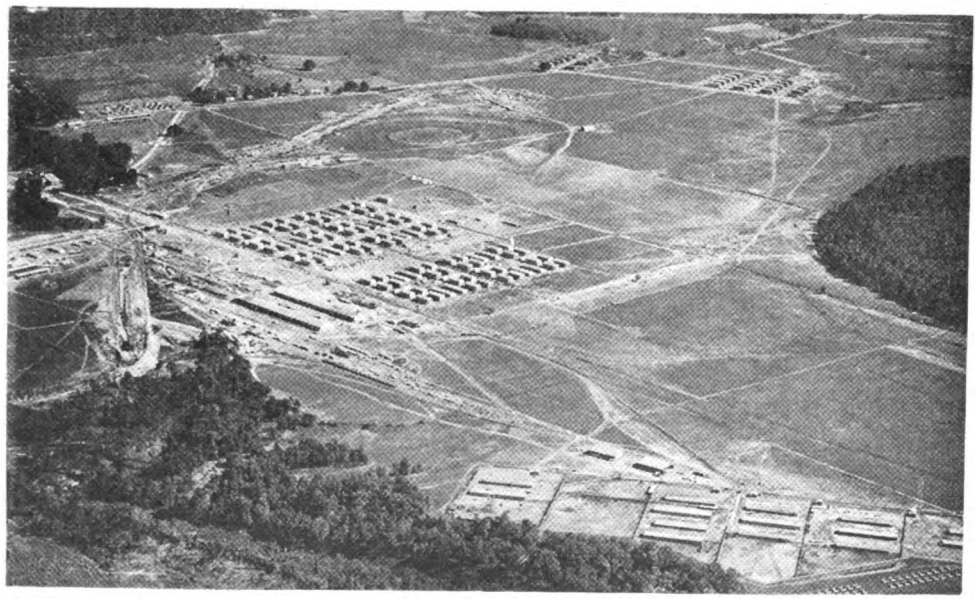
Camp Benning is most favorably situated for the particular purposes of the infantry school. It is in a mild climate, allowing work to be carried on ten months in the year. The reservation will ultimately contain some 97,000 acres of the most varied topography. The Chattahoochee River forms the western boundary. Many small streams, including Upatoi Creek, which is unfordable run through the area.

The main ridge lines vary in elevation from 400 to 500 feet (above sea level); the secondary ridge lines from 300 to 400 feet. The 300-foot contour outlines the secondary drainage system. The camp and target ranges are located on a large plain at an approximate elevation of 330 feet, 80 feet above the river.

Wooded and open areas are approximately equal in extent, but so interspersed as to make all terrain suitable for maneuvers and exer-



The Swimming Pool. Grenade tests under way



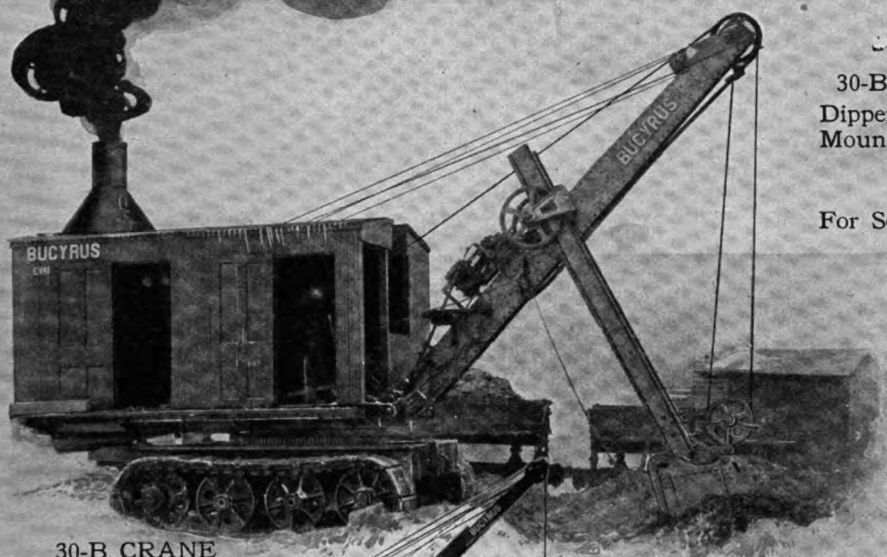
Infantry School, Camp Benning

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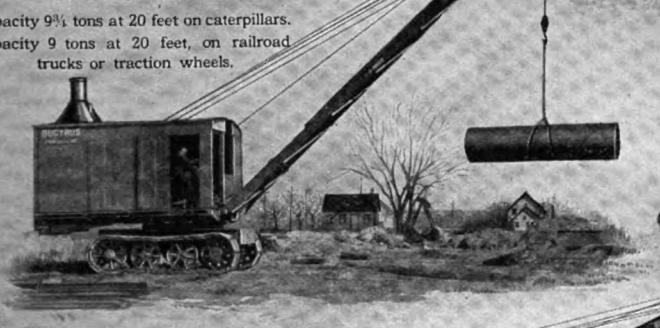
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¾ yd. dipper, 30 ft. handle, max. ditch 20 feet.
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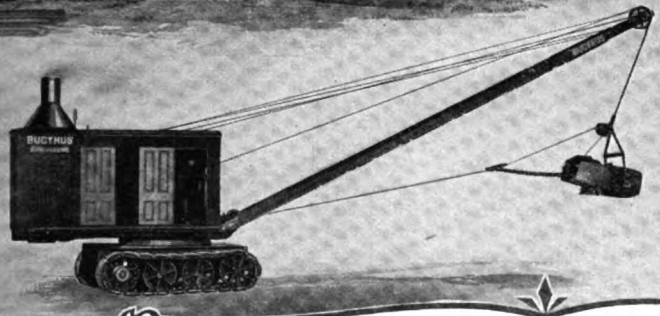
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1 yd. bucket, 35 ft. boom
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Any Mounting





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The Bucyrus 30-B is so designed that it may readily be changed, in the field from any of the above combinations to the other.

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cises. Oak and pine are the most common trees.

A complete system of roads and narrow-gauge railways will make all parts of the reservation available for instructional purposes. Some three miles of the narrow-gauge system is in operation, connecting the camp with the temporary target range.

Maj. Gen. C. S. Farnsworth, U. S. Army, is Commandant; Lieut. Col. L. M. Nuttman, Infantry, Assistant Commandant; Maj. H. B. Fiske, Infantry, Senior Instructor, Department of Tactics. Col. E. J. Atkisson, Engineers, is the senior instructor in engineering.

The infantry school serves an important purpose in our military establishment, and now that it is becoming a real institution, military engineers will watch its growth with interest and appreciation.

Officers' Reserve Corps

Strength of Reserve Corps, Jan. 31, 1920

Infantry	16,830	Med. Corps	5,973
Cavalry	463	Air Service	8,445
Field Art.	7,956	Sig. Corps	1,262
Engineers	3,432	All others	6,388
Coast Art.	2,430		
Q. M.	7,435	Total	60,614

Engineer Reserve Corps.—The total strength of the Engineer Reserve Corps by grade on Feb. 28, 1920, was as follows:

Colonels	32	Captains	1,274
Lieut. Colonels	118	First Lieuts.	1,360
Majors	460	Second Lieuts.	1,048

Total 4,292

Of this number approximately 80 per cent are officers who served during the World War with the Engineers and Transportation Corps, 10 per cent are engineers who served under commissions in other branches of the service during the emergency, the remainder being former enlisted men and civilian candidates who were examined and recommended for appointment during the emergency, but whose appointments were stopped by the armistice.

At the present time there are approximately 3,200 applications of discharged engineer officers awaiting action by the examining board for appointment in the Officers' Reserve Corps. An effort is now being made to increase the number of cases considered each day, and it is hoped that all applications for appointment now pending will receive early action.

The War Department has adopted a definite policy governing promotions in the Reserve Corps, as follows:

In general, discharged emergency officers are appointed in the Reserve Corps in the grade held at time of discharge. An advance of not to exceed one grade, and in no case account of special fitness, long and distingaccoun of special fi ness, long and dis'inguished service or because of recommendation for a promotion not received due to the termination of hostilities. Promotion received after Nov. 11, 1918, is considered to have been given under such special conditions that increase over grade held at time of disharge, in general, will not be given.

All data on file in the War Department pertaining to each applicant's record is carefully considered and appointments offered in conformity with the above policy. Appointees should accept the commissions as offered, for the above policy is prescribed in order to be fair and just to all, and such inequalities as may result therefrom will be eliminated by future promotions.

Training for Reserve Corps.—The following memorandum issued by The Adjutant General under date of Feb. 18, 1920, is published for the information and guidance of reserve officers:

1. The plans for annual training for reserve officers have not been perfected and must necessarily await the enactment of legislation reorganizing the Army. Since training is essential to fitness it is contemplated that such training will be provided, probably for a period of fifteen days each year during the months of July and August. The camps no doubt will be located at various places and reserve officers will be sent to the camp nearest their homes. Sufficient advance notice will be given in order to allow time for arrangement of private affairs and every effort will be made to cause as little inconvenience as practicable to reserve officers designated to attend. It is hoped that all reserve officers designated will be in a position to comply; however, where such attendance will work a serious hardship, an application to be excused will receive careful consideration, and unless exceptional circumstances intervene probably will be granted.

2. The desire of reserve officers for exact information concerning annual training is appreciated and the need for a definite policy is recognized. As soon as it is practicable to complete the plans, which is contingent on the enactment of pending legislation, immediate steps will be taken to give this question the widest publicity.

3. Notices in the press concerning R. O. T. C. camps, which will commence operation on June 17, 1920, do not concern members of the Officers' Reserve Corps. The camps in question are only for students who are members of R. O. T. C. units at various educational institutions and not for members of the Officers Reserve Corps.

The Military Point of View.—This journal has occasionally pointed out that, from a strictly technical point of view, there is little or no difference in the operations of civil and military engineering. The latter is merely a simplified and *accelerated* application of the former. The civil engineer, in applying his knowledge must learn the military point of view, which is that *something* must be done and done *quickly*. In war *time* is the all important consideration. This does not mean that cost is no consideration, but it does mean that time is relatively of vastly greater value than in the operations of peace and loss of time accordingly much more costly. The ultimate economic principle that the result must justify the cost is as applicable to military as to civil procedure. In peace the result sought is economical production. In war the result sought is *victory in battle*, which is worth so much that we should not stop to count pennies in making our estimates. The duration of military operations is so brief as to make calculations or refinements looking to the reduction of maintenance and operating costs a matter of little or no concern whatever. In this connection the following has been received from a former citizen-officer who went to France with the 24th (Mechanical) Engineers and has remained there since in a civilian capacity:

"I have been very much impressed over here by the inability of the average temporary officer to look upon war engineering problems from the point of view required by war operations. You, of the regular establishment, realize that the engineer officer must take up any kind of engineering problem at a moment's notice and immediately reach *some* workable solution. Many of our temporary officers were enthusiastic over undertaking problems along the lines of their previous civilian activities, but when presented with a problem along lines where somebody else had specialized, they were not trained so as to readjust themselves and in some instances did not seem to realize the imperative necessity of instant readjustment and consequently many very capable civilian engineers were not efficient in the engineer establishment of the A. E. F. because they only knew how to do one thing and did not happen to be placed where that particular thing was needed. It seems to me that personal contact between men who have been or may become temporary officers and the officers of the Corps of Engineers should bring about a better understanding of the war requirements of engineer officers and prepare the civilian engineers so that they could average more efficient and broad-gauged work in a future war.

There is also the personal element which must always be considered, and if the engineers of the temporary and permanent establishments are kept in touch with each other they will understand the others' point of view much better and in time of stress their combined efficiency would of necessity be much higher. There are ways in which the civilian engineer can help the regular officer and the converse is equally true."

It is the special purpose of the Society of American Military Engineers, and of this journal as the organ of that society, to enable the engineers in the military service and those in civil life to be mutually helpful in giving each other a better point of view.

Reserve Officers' Training Corps

Enrollment in R. O. T. C.—The total enrollment in R. O. T. C. units is about 117,000 cadets at 260 schools and colleges. Of these 51 per cent are in senior units. There are 392 army officers on duty as instructors, or about one to 300 cadets, and 900 enlisted assistants or one to each 127 cadets.

Yale University—The present enrollment is 130 Field Artillery, 98 Signal Corps, 49 Engineers and 25 Ordnance. All of these except the first have been enrolled this year.

In the engineer unit instruction includes lectures and two hours per week in the field. A museum of models of engineer equipment is being made up. A model in molding sand of a battle position, including trenches and accessories, has been completed.

Virginia Polytechnic Institute.—The college has allotted a building for the use of the Military Department, each unit having a room.





Virginia Polytechnic Institute
Above: Senior Class, Engineer Unit
Below: Sophomore Class, Engineer Unit

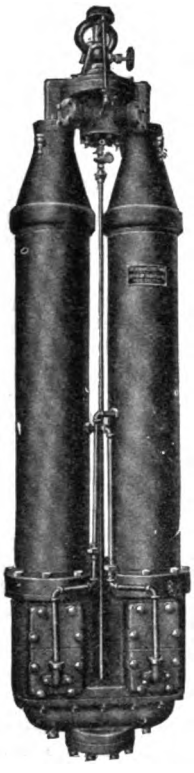
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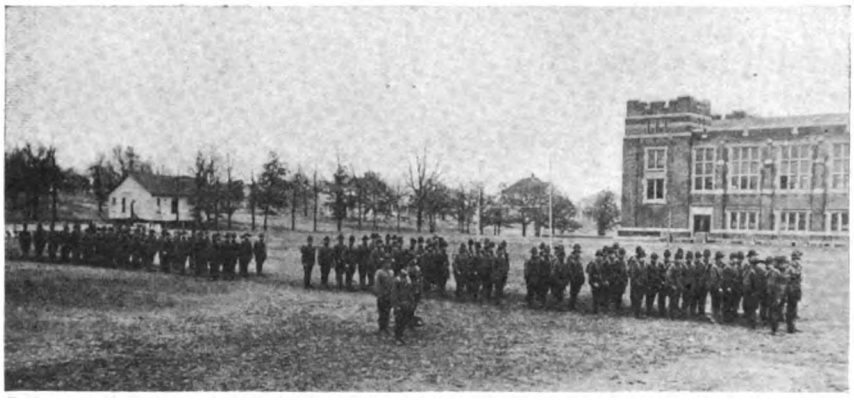
A museum of engineer models, including bridges, revetments, knots and lashings, sand-tables, etc., is being installed in the room allotted to the engineer unit. The engineer unit is the largest, and 6 of the 8 cadet captains belong to it.

The first illustrated lecture on military bridges was delivered by Lieutenant Ketchum to all the units. Moving pictures of ponton and spar bridge construction at Camp Humphreys, and lantern slides showing the famous bridges of the U. S. Army in the World War, were exhibited. The next illustrated lecture will be on road construction.

Missouri School of Mines.—The unit at this college is exclusively engineers. It was formed in January, 1919, and now numbers 104, of which 5 are in the advanced course. It is hoped to send about 15 men to Camp Humphreys in June.

The army personnel includes Maj. H. J. Wild, Engineers, Master Engr. Arthur Scott, and Sgt. Erskin James. Regt. Sgt. Major Rosenthal, tranferred to the unit, lost his life in a hotel fire at Hennessy, Okla., March 1st.

[We are glad to see these three hardy pioneers. They form a good advance guard. We hope soon to have "stories" from all Engineer units of the R. O. T. C. It is helpful and stimulating to know what our co-workers and rivals are doing. And to help the R. O. T. C. is one of the functions of this journal.—ED.]



Engineer Unit. Missouri School of Mines

National Guard

Progress in Re-organization of the National Guard.—During the month of January the gain in strength of the National Guard was 3,025. The organizations extended Federal recognition during the month were as follows:

Infantry.—New companies, N. Y. 15, Wis. 1, Va. 1, N. C. 1, Vt. 1, Ga 1, S. C. 2, Porto Rico, 1, H. T. 1.

Field Arty.—New batteries, N Y., 2, Utah 1.

Cavalry.—New troops, Wis. 2, N. C. 1, Utah 1.

In addition to the above the following units were inspected and will be extended Federal recognition as soon as minor irregularities are corrected: N. Y. 2 Batteries Field Artillery, 2 Companies Infantry, 1 Field Hospital Unit.

The States of New York, Oklahoma and Oregon have engineer units in course of organization. The Adjutant General of Arkansas has been authorized to organize certain national guard units under the provisions of the National Defense Act. Amongst these is included one battalion of engineers, replacing the former organization whose disbandment has been authorized. Included in certain new units of the national guard of Massachusetts authorized under the National Defense Act, is one divisional regiment of engineers, including headquarters and supply section of an engineer train, and one regiment of engineers or corps or army troops. This authority will afford opportunity for the rehabilitation of the 101st Engineers which, under the command of Col. G. W. Bunnell (U. S. M. A., 1899), rendered such excellent service as the engineer regiment of the 26th Div. in the World War. This regiment included the old Boston Corps of Cadets.

The following table shows by states the present status of the authorized and actual enlisted strength of the guard and the percentage of authorized strength attained.

State	Authorized	Actual	Per cent.
1. Minnesota	3,688	3,548	96
2. Oklahoma	3,339	2,585	77
3. Maine	1,361	1,046	77
4. Hawaii	546	368	68
5. Colorado	1,859	1,025	55
6. Washington	2,107	1,135	54
7. Utah	713	362	51
8. Oregon	2,152	1,096	51
9. Tennessee	2,294	1,148	50
10. Vermont	874	399	46
11. Kansas	4,043	1,719	43
12. Rhode Island	1,096	396	36
13. Missouri	4,429	1,458	33
14. Dist. of Columbia	801	218	27
15. New Jersey	4,030	1,074	27
16. South Carolina	1,727	475	27
17. Virginia	2,865	594	25
18. Iowa	4,580	1,124	25
19. Alabama	2,432	579	24
20. New York	20,497	3 735	18
21. Wyoming	560	92	16
22. Idaho	562	90	16
23. California	3,594	505	14
24. Arkansas	1,758	210	12
25. Ohio	13,221	1.284	10
26. Florida	1,563	146	9
27. Georgia	2,877	191	7
28. North Carolina	2,581	150	6
29. Porto Rico	1,888	109	6
30. Mississippi	1,879	100	5
31. Wisconsin	9,293	344	4
32. Texas	11,427	11,164	
33. Other States	47,665	0	4
Total	163,775	38,469	

Nineteen states have presented no units for recognition and are not listed.

The following states have not accepted the allotment of units for the fiscal year 1920: Delaware, Massachusetts, New Hampshire, Arkansas, Louisiana, Texas, Illinois, and West Virginia. New Mexico and Wyoming have partially accepted while the state of Nevada has declined to organize any National Guard.

Personals

Col. F. B. MALTBY, formerly Section Engineer, Base Section No. 1, under the Director of Construction and Forestry of the A. E. F. in France, was recently decorated with the Cross of the Legion of Honor by General Coldet of the French high commission at Washington, in recognition of his services in port improvement, water supply and general construction. Colonel Maltby had his headquarters at St. Nazaire while in France; he recently secured his discharge from the Engineers, U. S. Army, and takes passage this month for Liberia, where he will make harbor works estimates for J. G. White & Co., of New York City.

Dr. F. B. JEWETT, chief engineer of the Western Electric Co., New York City, has recently returned from an extended trip through the West, during which, as the guest of various technical and scientific organizations, he lectured on "Some Wartime Developments in Electrical Communication and Allied Fields." During the war Dr. Jewett held the rank of lieutenant-colonel and won the distinguished service medal, which, together with his position on the U. S. Naval Consulting Board, permitted him to speak authoritatively on the subject. In each city which he visited his address was received with great enthusiasm, and the opportunity to learn something at first hand of the invention of the submarine detector, perfection of wireless telephony and other developments was keenly appreciated.

Major EDWARD VAN WINKLE, formerly with the 24th Engineers in France, in charge of most of the layout and survey work for the depot, at Is-sur-Tille, has become associated with Frederick A. Waldron; and will have charge of the design and construction of the three million dollar office building for the John Hancock Mutual Life Company in Boston, also the cord tire plant for the Middletown Rubber Company of Middletown, New York.

Capt. R. A. LOVE, Corps of Engineers, resigned from the service, March 2, 1920, and enters the employ of A. G. McKee & Co., at Akron, Ohio.

Lt. Col. J. P. HOGAN and Major L. B. ROBERTS, Engrs., recently discharged, have accepted positions as division engineers with Parsons, Klapp, Brinckerhoff and Douglass, New York. During the war Col. Hogan and Maj Roberts served overseas with G-2-c (topography) G. H. Q., A. E. F. Col. Hogan was later Chief of G-2-c, 2nd Army.

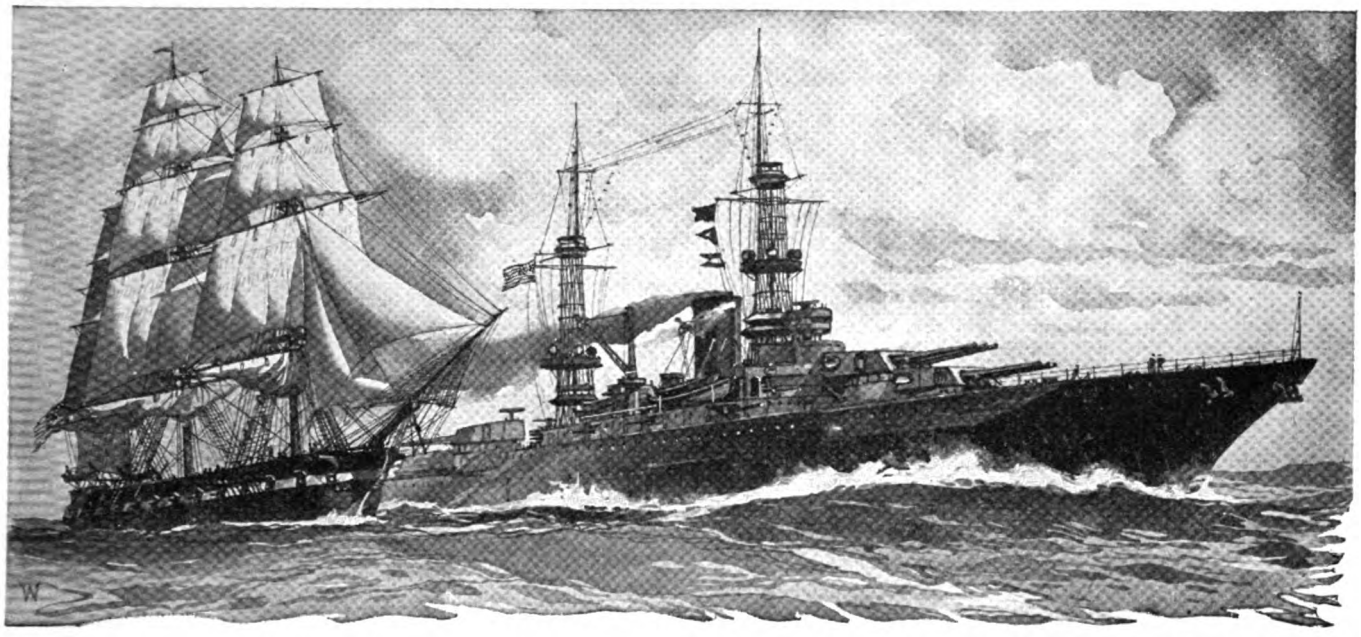
E. W. FASSETT, Assoc. M., Am. Soc., C. E. recently received his discharge as captain of engineers, U. S. A., and is now with the Midwest Refining Co., Casper, Wyo.

NATHANIEL O. GOULD, who was released from the Air Service, U. S. A., in June, 1919, has been appointed structural engineer for the firm of Aaron H. Gould & Son, architects and engineers, with offices in Detroit, Mich.

ALBERT L. UPHAM, recently honorably discharged from the 23rd Engineers, U. S. A., after fifteen months' service overseas, is now located at Hartford, Conn., as field engineer for Stone & Webster.

GEORGE R. PUTNAM, commissioner of lighthouses, and John C. Hoyt, of the U. S. Geo-

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logical Survey, both of Washington, have been elected president and vice-president, respectively, of the Cosmos Club, Washington.

The following changes of assignment of retained "emergency" officers have occurred since our last issue:

Major EDMUND J. BARRY, relieved from duty at Washington, D. C., and assigned to duty at Fort Leavenworth, Kansas, as Constructing Quartermaster.

Lieut. Colonel BOWYER B. BROWN, relieved from duty at New Orleans, La., and assigned to duty with the 318th Engineers, Camp Grant, Illinois.

Captain SAMUEL M. DAMON, relieved from duty at Fort Leavenworth, Kansas, and assigned to duty with the 2nd Engineers Fort Riley, Kansas.

1st Lieutenant EDGAR G. DAVIS, has returned from France and has been assigned to duty with the 6th Engineers at Camp Pike, Arkansas.

The following named emergency officers have been honorably discharged from the Service:

Lieut. Colonel WILLIAM O. HICKOK,
Major RAYMOND IVES,
Major EUGENE KELLY,
Captain WALTER H. ADAMS,
Captain DAVID T. BJORK,
Captain DURBIN H. BRADLEY,
Captain BENJAMIN COHEN,
Captain WILLIAM CROSS,
Captain JOHN H. DEVINE,
Captain JAMES M. FARRIN,
Captain ALBERT A. KEESLER,
Captain BERNARD LAMB,
1st Lieut. LEO J. DILLON,
1st Lieut. HEADLEY E. JORDAN,
1st Lieut. JACOB M. MERY,
2nd Lieut. GEO. W. EVANS.

Lieut. Col. ALLEN S. PECK, recently discharged from the 20th Engineer (forestry) has been appointed district forester for the mountain district of the U. S. Forestry Service. The district includes Col., Wyo., S. D., Neb., Mich. and Minn. Col. Peck served nearly two years with the A. E. F., and was awarded the distinguished service medal and made a Knight of the French Legion of Honor in recognition of his services.

Lieut. Col. W. P. WOOTEN, Corps of Engineers, has been named by the United States government as its engineering representative in connection with the investigation of the St. Lawrence river ship canal and power development project. The Canadian government has not yet appointed its engineering representative, but will do so at a very early date.

Losses of Personnel in the Corps of Engineers

During the months of January and February, 1920, the Corps of Engineers suffered a loss of seven officers, as follows:

Colonel C. McD. Townsend, retired; Colonel A. B. Barber, resigned; Major Joseph H. Earle, retired; Major Harold S. Hetrick, died; Captains T. M. Curry, Jr., and H. V. Fay, resigned; Lieut. R. C. Knight, retired.

Colonel MASON M. PATRICK, Corps of Engineers, has been assigned to duty as Assistant to the Chief of Engineers. Colonel Patrick went to France in command of a railroad regiment during the war, was promoted to the grade of Major General and served successively as Director of Construction and Forestry, and Chief of the Air Service, A. E. F.

Colonel EDGAR JADWIN Corps of Engineers, recently returned from overseas, has been assigned as Department Engineer, Southern Department, Fort Sam Houston, Tex Colonel Jadwin went to France as Colonel of the 15th (Railroad) Engineers and during the war was promoted to grade of Brigadier General and served as Director of Light Railroads and Roads, and of Construction and Forestry, A. E. F. He was later engineer member of the American Peace Commission to Poland.

Colonel THOMAS H. REES, Corps of Engineers, has been relieved from duty as Division Engineer, Southeast Division and assigned as Department Engineer, Western Department (Military) at San Francisco. Durthe War Colonel Rees commanded the 152nd Artillery Brigade, A. E. F., with the rank of Brigadier General.

Colonel H. DEAKYNE, Corps of Engineers has been assigned to temporary duty as Division Engineer, Gulf Division, and as a member of the Mississippi River Commission. He will be relieved of the District work at New Orleans by Major E. J. Dent, Corps of Engineers. During the war Colonel Deakyne was Chief Engineer of the 2nd Army, A. E. F. with the rank of Brigadier General.

Lieut. Col. W. J. BARDEN, Corps of Engineers has been assigned to temporary duty as Division Engineer, Southeast Division in addition to his duties as District Engineer, Jacksonville Fla. During the war Col. Barden served as Corps Engineer of the 6th and 9th Corps, A. E. F.

Brigadier General WILLIAM D. CONNOR, recently returned from oversease, was assigned to duty in the Office of the Chief of Staff. and subsequently to command Camp Humphreys, Va. General Conner served in France during the entire course of the war, and successively performed the following duties: Assistant Chief of Staff, A. E. F. (G-4); Chief of Staff, 32nd Division commanding 63rd Brigade, 32nd Division; Commanding General of Bordeaux, Chief of Staff, S. O. S.; Commanding General of the S. O. S.; and Commanding General of the American Forces in France after the departure of G. H. O. The office of the Commanding General of American Forces in France was closed on January 5, 1920, and the last American troops sailed on January 9th.

Lieut.-Col. S. A. CHENEY, Corps of Engineers, has been assigned to duty as Department Engineer, Eastern Department, relieving Lieut.-Col. John C. Gotwals, Engineers. Colonel Cheney has recently returned from overseas where he served as Director General of Transportation, A. E. F., with the rank of Brigadier General.

Lieut. Colonel WILLIAM P. WOOTEN, Corps of Engineers, has been relieved from duty in the Office of the Chief of Engineers and assigned to the charge of the Lake Survey at Detroit. Colonel Wooten served in France throughout the war, successively as Colonel of the 14th (Railroad) Engineers, Corps Engineer, 3rd Corps, and Chief Engineer, 3d Army, A. E. F.

Colonel WILLIAM KELLY, Corps of Engineers, has been assigned to duty in charge of the 3d Engineer District, San Francisco, and as Secretary of the California Debris Commission, relieving Lieut.-Col. L. H. Rand, Corps of Engineers. During the War Colonel Kelly served as Division Engineer, 42nd (Rainbow) Division, and Corps Engineer, 4th Corps, A. E. F., and later as commanding officer of he port of Antwerp.

Lieut.-Col. L. H. RAND, Corps of Engineers, has been relieved from duty in the 3d Engineer District, San Francisco, and assigned to the command of the 6th Engineers, Camp Pike, Ark.

Colonel T. H. JACKSON, Corps of Engineers, has been assigned to duty as Department Engineer, Northeastern Department. During the War Colonel Jackson served as Chief Engineer Advance Section, S. O. S., and Engineer Purchasing Officer of the A. E. F. He is now at the Walter Reed Hospital.

Major A. E. WALDRON, Corps of Engineers, has been relieved from duty in charge of the Mississippi River Dredging District and assigned to the command of the 8th Engineers at Camp Baker, Tex. During the War Maj. Waldron commanded the 35th Engineers.

Major E. J. DENT, Corps of Engineers, has been assigned to duty as District Engineer at New Orleans, relieving Lieut. Colonel H. Deakyne, Corps of Engineers. During the war Major Dent commanded the 4th, 26th and 104th Engineers.

Lieut. Col. JOHN C. G. GOTWALS, Engneers has been relieved from duty as Department Engineer, Eastern Department, and appointed President of the Alaskan Road Commission. During the war Colonel Gotwals commanded the 56th Engineers (searchlight) and was Chief of Searchlight Service in the A. E. F.

Captain J. E. HARRIS, Corps of Engineers, has returned to the United States from London where he was on duty in the office of the Engineer Purchasing Officer.

Major D. H. GILLETTE, Corps of Engineers, has been assigned to duty as Assistant Military Attache, American Embassy, London.

Lieut.-Col E. G. BLISS, Engineers, recently with the Transportation Corps in France, has been assigned to duty in the Office of the Chief of Transportation Service, Washington, D. C.

Captains H. H. POHL and G. H. COUNTS, Corps of Engineers, have been assigned to duty with the 6th Engineers, Camp Pike, Arkansas.

W. B. Greeley to Succeed H. S. Graves as Chief Forester

Colonel W. B. GREELEY, assistant forester in the U. S. Forest Service has been appointed chief forester by the Secretary of Agriculture to succeed Colonel Henry B. Graves whose resignation from that office becomes effective May 1.

Colonel Greeley is from California, a graduate of the University of California and the Yale Forest School, and has been in the Forest Service continuously since 1904 except for two years of military service with the American Expeditionary Forces. He has had long and varied administrative experience advancing through all the technical grades to his position as assistant forester.

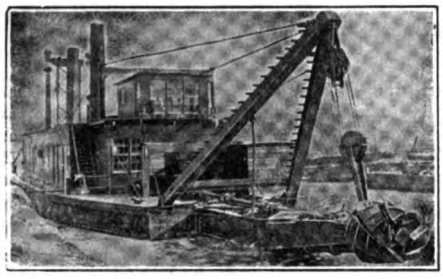
To prepare the way for American operations in the French forests, the chief forester, Colonel Graves, was sent to France in 1917. He sent for Colonel Greeley to aid in the work. Colonel Greeley finally became chief of the American Forestry section in charge of 21,000 forestry troops and 95 sawmills.

Colonel Graves' letter of resignation to the Secretary of Agriculture contained the following statement:

"Since the pecuniary return afforded professional and scientific men in the Government service inadequately provides against the exhaustion of their working powers which must inevitably take place in time, and entail sacrifices from which employment elsewhere is free, the only course consistent alike with self respect and a regard for the public interest seems to me to be retirement from office before efficiency has been impaired."

Albert F. Potter, associate forester tendered his resignation at the same time and for the same reason.—Eng. News-Rec.

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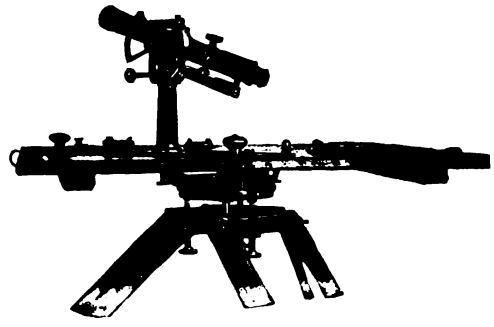
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Professional Notes

of Military and Engineering Interest

Shortage of Enlisted Personnel in the Army.—There is a shortage of enlisted personnel in the Army, which will soon be increased by the furlough to the reserve of men who have completed their period of active service. After March 1st, the one-year enlistments will also begin to run out, so the Army will be further reduced by losing all one year men who do not reenlist.

An Army recruiting drive was started with a view to securing 75,000 men before March 31, 1920. For recruiting purposes, the regiments of the various branches of the service have been allocated to states or groups of states, with the idea that men from the same locality may serve in the same organization, thus fostering local *esprit*.

The allocation of engineer regiments and mounted battalions within the continental United States is as follows:

1st Engineers,
  1st Division,
    Camp Taylor, Ky.
      West Virginia,
      Kentucky,
      Tennessee,
      North Carolina.
2nd Engineers,
  2nd Division,
    Camp Travis, Texas,
      Oklahoma,
      Texas.
4th Engineers,
  4th Division,
    Camp Dodge, Iowa,
      Iowa,
      Wisconsin.
5th Engineers,
  7th Division,
    Camp A. A. Humphreys, Va.,
      Minnesota,
      Nebraska,
      Kansas.
6th Engineers,
  3rd Division,
    Camp Pike, Arkansas,
      Missouri,
      Louisiana,
      Arkansas.
7th Engineers,
  5th Division,
    Camp Gordon, Georgia,
      South Carolina,
      Georgia,
      Florida,
      Alabama,
      Mississippi.
8th Engineers (Mounted),
    Camp Baker, Texas,
      Wyoming,
      Idaho,
      Montana,
      Oregon,
      Washington,
      North Dakota,
      South Dakota.
9th Engineers (Mounted),
    Camp Courchesne, Texas,
      California,
      Arizona,
      Mew Mexico,
      Nevada,
      Utah,
      Colorado.
318th Engineers,
  6th Division,
    Camp Grant, Illinois,
      Illinois.

The shortage of men in engineer units is particularly acute. Readers of this journal can assist in the vitally necessary work of building up our greatly depleted army by directing men who may be interested in the service to the nearest recruiting office, or advising them to write to the Chief of Engineers.

The army in future, will offer to young men opportunities for educational, including vocational training, far greater than those of the past.

Notes of the Regular Army.—Two thousand two hundred forty-two regular officers had resigned from the service up to Jan. 29, 1920, or 21 per cent of the total.

Between Feb. 28, 1919, and Jan. 24, 1920, 170,841 men were enlisted for the regular army.

Of 488 distinguished-service medals awarded to date to officers of the regular army, the distribution was as follows:

	Per Cent		*Per Cent*
Infantry	29.9	Gen. officers	5.7
Cavalry	19.9	Q. M. C.	2.8
Engineers	9.7	Ord. Dept.	1.6
Med. Dept.	9.7	J. A. G.	1.4
C. A. C.	8.8	Sig. Corps	1.2
F. A.	8.2	Others	1.6

The strength of the regular army on Feb. 1, 1920, was:

Officers	18,739
Men	221,674
Total	240,413

Of the officers 8,641 are "emergency."

Wireless Operated Airplane Bombs.—A. H. G. Fokker, designer of the Fokker plane, states that Germany was about to discard the long-range gun in favor of wireless-controlled aeroplane bombs. It was planned to use a very cheap plane, capable of about 4-hours travel, carrying a large bomb, and guided by wireless control. The control was to be exercised by a large control plane flying with the fleet of aerial bombers. The pilot of this fleet would guide the flock to its destination and then release the bombs, either singly or simultaneously. It was considered that this method would be cheaper and more effective than the long-range gun.

Changing a Frame House to Stucco.—A writer in *Concrete* describes an interesting case of an old frame house transformed into a stucco building. The work was done in truly American fashion with no unnecessary labor or cost. Tar paper was tacked to the old lap siding, ¼-inch furring strips were nailed on and a stiff wire mesh (1½ by 3¼ inches) was stapled to these strips. The stucco was then at once applied with a Hodges stucco machine (electric). A plasterer rough-floated the base course of stucco and the finishing course was applied with the same machine 24 hours later. The writer points out that hand-applied stucco would have required two and possibly three coats.

The result was to add several thousand dollars to the value of the house, to reduce insurance rates and the maintenance costs (especially painting) of a frame structure. Also, it is claimed the interior temperature in summer is reduced 18° and fuel costs in winter 20 per cent.

Ten per cent of hydrated lime was added to the mixture of stucco. The rate of application of the base coat was 18 square yards, and the unit labor cost 22 cents. The labor cost for the finishing coat was less than 7 cents per square yard.

Decrease in Building Operations.—Building operations in the larger cities of the United States for the year 1918 showed a decrease of 39 per cent as compared with 1917, and 59 per cent as compared with 1916. The figures of cost for 143 cities, having a population of over 35,000, are:

1914	785,525,746
1915	821,120,657
1916	1,046,276,549
1917	700,700,815
1918	430,014,365

When the increased cost of construction is considered, the shrinkage in building construction is even greater than would appear from the above figures.

The new buildings constructed in these cities in 1918 are of the following classes:

Wood	33 per cent of total cost
Brick or tile	50 per cent of total cost
Stone	1 per cent of total cost
Concrete	11 per cent of total cost
Steel skeleton	5 per cent of total cost
	100

The tendency toward economy as a result of the war is indicated by an increase in the expenditures for repairs, alterations and additions.

The University in Khaki.—Under the plans of the War Department the Army is to be a vast "University in Khaki" where men will be taught not alone the duties of the soldier, but will be given vocational training which will increase their earning power, industrial efficiency and moral training, which will make them better and more patriotic citizens.

The work is being conducted under great difficulties, as appropriations for the purpose are only $2,000,000. Nevertheless, the results that are being obtained are most encouraging.

This work will be a splendid demonstration of the educational possibilities of military training and will form a powerful argument in favor of making such training universal for the young men of America.

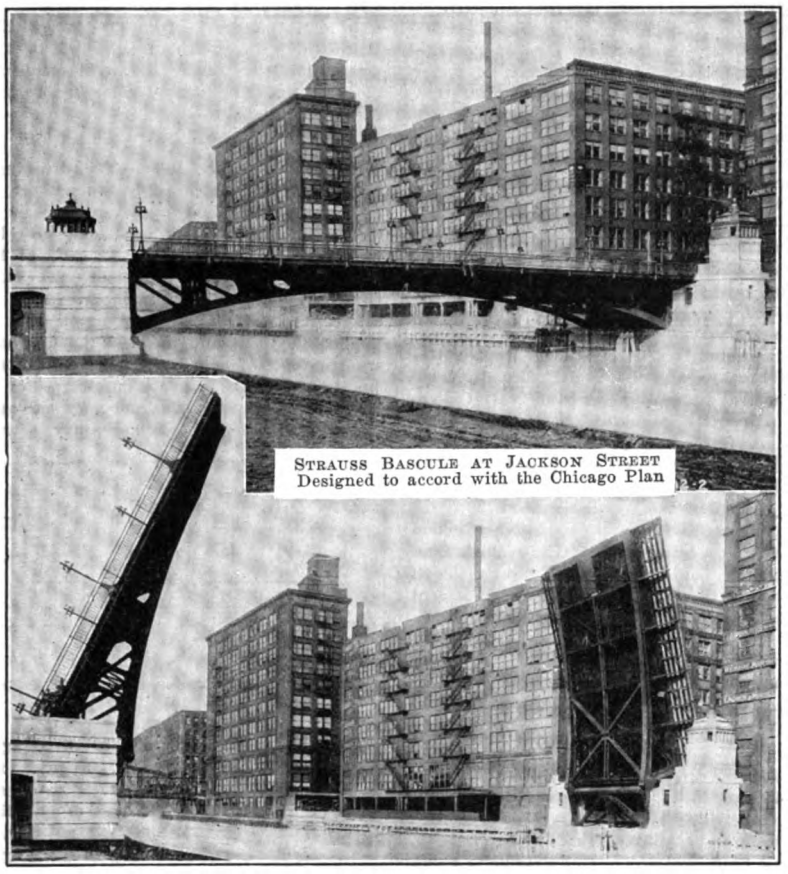
Among the subjects taught or to be taught are: Reading and writing, mathematics, geography, history, civil government and modern languages. Vocational instruction will include: Carpentry, blacksmithing, machinery, shop work, engine repair and operation, including motor vehicles; drafting, stenography, bookkeeping, telegraphy and telephony (including wireless), pharmacy, dentistry, truck gardening.

Upon completion of courses the men will be given certificates which will aid them in securing employment in civil life.

Education in the Army is in charge of Gen. W. G. Haan. Says Gen. Haan:

All training, whether purely military or educational, has as its main object the development of the soldier's mind to make him a responsible thinking human being. Every soldier, however poorly he may be educated, or however limited his experience, has still a thinking mind, and that mind is active practically all the time. Such a man is perhaps

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incapable at the moment of looking at affairs in a broad sense, but the object of all training must be to guide that mind in the direction of right thinking. In order to accomplish this the instructor himself must be able to estimate about what are the channels of thought in the mind of the man being trained in order that he may so conduct his own part of the work as to gain the confidence of the men he is instructing or leading.

In developing the soldier's mind the most rapid progress is made by placing upon the man, as early as practicable, as much responsibility as he can stand. This placing of responsibility on the man stimulates his pride, raises his self-respect and urges him to better effort. This is applicable in all kinds of training. It is character building, frequently called moral training, and the most effective means of stimulating self-development.

Importance of Construction Industry.—Construction industries in the United States furnish 27 per cent of all railroad freight. They employ more labor and produce more wealth than any industry except agriculture.

American Association of Engineers.—The A. A. E. now numbers over 13,000 members and is the largest engineering society in the United States.

What the Roads Have to Carry.—There are in the United States over 7,000,000 passenger automobiles and over 500,000 trucks.

Progress in Scientific Road Building.—A writer in *Engineering World* informs us that there are three standard classes of "durable" road pavements in common use, to-wit:

1. Bituminous concrete.
2. Cement concrete.
3. Brick.

The chief source of failures in the first class was lack of standardization in materials and proportioning. This has now been eliminated, chiefly as a result of the aid extended by the Federal government. The oil dropped from motor cars is relied upon to replace the evaporation of volatile oils in the bitumen.

The uneven surfaces formerly complained of in concrete roads were due to bad screeding and poor joints, also to improper proportioning.

Difficulties with brick pavements were due chiefly to the sand cushion between the bricks and their concrete base. The sand absorbed moisture which froze and heaved the brick, or it shifted and allowed the brick to settle. The "trouble maker" is now eliminated, the bricks being set in the concrete and grouted to form a monolith, or the sand cushion is solidified with cement. Further improvements is effected by better brick and by lugs to permit more effective grouting.

The areas of these different classes of pavements contracted for in 1919 are as follows:

1. Bituminous concrete, square yards, 50,000,000.
2. Cement concrete, square yards, 50,550,000.
3. Brick, square yards, 12,000,000.

Good alignment has a tremendous value in shortening distance and eliminating curves, saving time, money, life, limb and property. All curves are widened and banked and railroad grade crossings eliminated as rapidly as possible.

The large and responsible contractor employing an up-to-date plant is replacing the small, irresponsible, improperly equipped contractor.

The author believes that the weakest links in highway construction are the bridges, which are lacking the requisite carrying capacity.

Removal of Stumps from Cleared Land.—"Stumping" cleared land is a task of terror and uncertainty to the engineer and contractor. Difficult indeed is it to estimate what it will cost in time, labor and money even when done on a large scale. That our machines and methods for this work are very crude and inefficient is pointed out by John Swenehart in a paper read before the American Society of Agricultural Engineers. That we have by no means removed all the stumps is indicated by his statement that in Wisconsin alone there are some 600,000,000 of them still to be tackled.

The removal of stumps is a fine art, well worthy of study when we consider the frightful cost that may result if it is not efficiently done.

Character of soil and ground water conditions enter the problem. Some stumps rot after standing a few years and are easily removed. Others retain their tenacity for long periods. The application of chemicals to promote decay does not promise success.

Explosives having a slow, heaving action are preferable to those producing a quick shattering effect, both as to cost and results. T. N. T. produces excellent results, but under present market conditions cannot compete with dynamite.

For very tough stumps the best results are obtained by a combination of explosives and stump-pulling machines. The machine should be able to pile the stumps.

Chief of Engineers Designated as Custodian of Military Maps.—The following decision has been rendered by the Secretary of War:

(*a*) That the Military Intelligence Division, General Staff, will decide all questions of policy pertaining to the procurement, reproduction and issue of maps.

(*b*) The Chief of Engineers is designated as the custodian of all military maps based on surveys executed by the agencies of the Government, and intended for quantity distribution, including survey data relating thereto. He is also charged with the quantity distribution of such maps to the army, in accordance with tables of issue prepared by the general staff (M. I. D.).

(*c*) Based upon requirements announced by the general staff (M. I. D.), the Chief of Engineers will prepare programs for survey and map work which, upon approval of the Chief of Staff, will be carried into effect.

Permanence of Concrete in Sea Water.—The curious anomoly of wood substituted for concrete because of its greater durability is found in Santa Monica, Cal. Concrete piles are so badly damaged by sea water that creosoted wood piles will be substituted.—*Jour. West. Soc. of Engrs.*

German Submarine Construction.—During the war Germany constructed 372 submarines, of which 170 were in commission Nov. 11, 1918. The aggregate displacement of the undersea boats was 210,000 tons. The largest constructed had a displacement of 1,000 tons, but the average was about 800.

Toward the end of the third year of the war the rate of construction was two boats per week.—*Jour. West. Soc. of Engrs.*

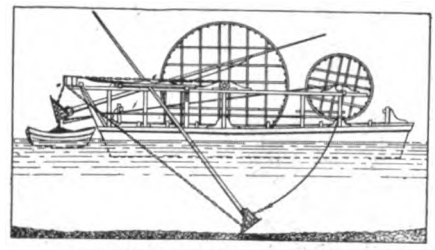
Public Works in France—Improvement of Rhone River.—The French government plans to expend in the Rhone River improvement 820 million francs for water power, 610 millions for navigation, 200 millions for irrigation and 150 millions for transport.—*Eng. News Record.*

The Victory Flagstaff.—The "Victory Flagstaff" erected in Kew Gardens, London, consists of a single Douglas fir presented by British Columbia. The tree, felled in 1914, was 220 feet in height, 6 feet in diameter at the base and 18 inches (under the bark) at the top—quite a tree.

Dredges of Other Days.—The dredging of rivers and harbors probably began when vessels were first used.

The earliest dredging was done with long-handled spoons or dippers. As early at 1586 a dredging machine was patented at Venice, consisting of spoons operated from two pontons lashed together. Horse power was first applied in 1685, and in 1708 the first crude machine of the chain-bucket type made its appearance. This was the prototype of the "ladder dredge," but was not very successful.

Early in the eighteenth century a really



The forefather of the dipper dredge

ingenious device was used for dredging the harbor of Toulon, France. Reference to the diagram herewith shows that it involves the essential principles of the present-day dipper dredge. The larger "squirrel wheel" furnishes the power for making the cut, there being two dippers, one on each side. The smaller wheel was used to draw the dipper back for another cut. As the dippers operated alternately, both wheels were continuously employed.

An improved type of ladder dredge, having buckets on an endless chain, was used at Orleans in 1750.

The first clam-shell type was used at Genoa in 1773. It consisted of two bucket leaves attached to pivoted arms like the legs of a compass, operated from a scow by means of hand winches.

In 1797 the first steam engine for use on a dredge was built by Boulton & Watt in England, and used in the harbor of Sunderland. It operated four dippers, each having a capacity of one ton.

The year 1811 witnessed the first application of steam power to the ladder dredge. In 1814 such a dredge was used on the Caledonian Canal. The ladder frame was 42 feet long with 25 buckets, driven by a 6 horse power engine. Steam ladder dredges were used on the Delaware and Raritan Canal in 1830-34.

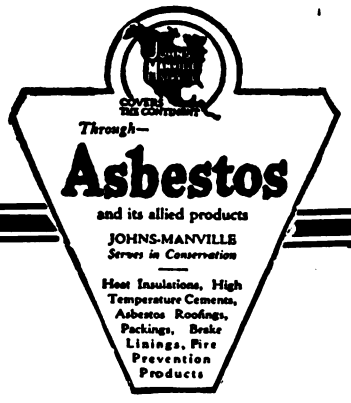
The first modern steam dipper dredge was patented in the United States in 1845. The hydraulic dredge was invented in France in 1867.—*R. L. Zimpel in Scientific American.*

The Concrete Ship.—The concrete ship program of the Emergency Fleet Corporation called for 42 vessels of this type. Of these 12 only remain on the program, of which four are actually completed and in service and three large tankers have been launched. In addition 21 500-ton concrete barges were built by the Railroad Administration, of which 20 are in service.

In carrying out the program all structural difficulties were successfully met, but the high speed of construction hoped for has not been realized thus far.

The vessels in service have proved them-

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selves very seaworthy, having less vibration than steel ships. No leakage whatever has been reported. Their greatest weakness is that actual impact against hard substances, which in the case of a steel ship would produce only a dent, is apt to cause shattering of the concrete shell. Repairs, however, are easily made, and it is believed that the danger can be greatly reduced by the use of oak fenders.

The cost of these vessels is from $210 to $300 per ton of deadweight capacity, which is approximately that of steel vessels.—*Eng. News-Record.*

Renewing Bridge Chords Without Interrupting Traffic Above or Below.—In *Proceedings Am. Soc. C. E.*, Feb. 1920, Mr. H. C. Keith presents an entertaining paper describing the methods of renewing the lower chord members of the 203-foot swing span of the Washington Bridge over the Housatonic River.

The method adopted after much study was the apparently simple expedient of carrying the stresses by temporary adjustable timber struts while the permanent chord members were being renewed. This resulted in "a very material saving of time and money, without impeding traffic." Half the width of the roadway was at all times available for traffic, and the span could be opened at all times for the passage of vessels.

There being no other bridge within a reasonable distance to which the traffic could be easily diverted, the first plan considered was to construct a temporary drawbridge alongside, open the draw to be repaired and block it up on the fender piers. This plan was very naturally abandoned on the score of expense.

The next idea was to employ false work on piles. Mr. Keith, with humorous sarcasm, explains that this plan was frowned upon by the Federal government, that jealous guardian of the rights of navigation, which will not for an instant permit the obstruction of even a "theoretically" navigable stream, however great the hardship imposed on the weary foot passenger or tired "strap-hanger" in a trolley car, who is compelled to cross the great highways of water transport. Of course the Government would permit obstructions in the river during the winter season, when it is closed by ice, provided they are promptly and thoroughly removed in the spring. However, the cost of this would have been so great that no such permission was sought.

We believe that Mr. Keith should be (and we have no doubt that he is) grateful to the Federal government for its wise restrictions, which induced the engineers in charge of this work to abandon several very expensive schemes and finally hit upon what was apparently the best plan from every point of view. It all goes to show that necessity is the mother of ingenuity, that overcoming difficulties strengthens our professional fibre and that we never know what we can do until the Government makes us do it, no less in peace than in war. At any rate it was a consideration of these facts, especially the attitude of the Government, that led to this "surprisingly economical solution." In fact, says Mr. Keith, with a most entertaining ingenuousness, the method adopted (under the restrictions of the Federal government) was so "decidedly economical" that there was "no hesitation in choosing safety" and "less incentive to reduce cost or to use *too delicate scales* in balancing safety against cost." In all respects this was apparently a most excellently conducted and highly successful piece of work.

The total cost was but $5,900, whereas a temporary bridge with draw span would have cost at least $100,000.

We commend this instructive and entertaining paper to the attention of all engineers who may at any time have chafed under governmental restrictions on construction. The author encountered these restrictions, refused to chafe and overcame them in most cheerful and intelligent fashion, did a better piece of work than he might otherwise have done and is a happier and wiser engineer in consequence. "Go thou and do likewise."

International Commission on St. Lawrence River Improvement.—Under the provisions of Article IX of the treaty of Jan. 11, 1909, between the United States and Great Britain, an international joint commission will consider certain problems with reference to the improvement of the St. Lawrence River in the interests of navigation and power development.

The specific questions referred to the commission are as follows:

Question 1. What further improvement in the St. Lawrence River, between Montreal and Lake Ontario, is necessary to make the same navigable for deep-draught vessels of either the lake or ocean-going type; what draught of water is recommended, and what is the estimated cost?

In answering this question the commission is requested to consider:

(*a*) Navigation interests alone, whether by the construction of locks and dams in the river, by side canals with the necessary locks or by a combination of the two.

(*b*) The combination of navigation and power interests to obtain the greatest beneficial use of the waters of the river.

Question 2. Which of the schemes submitted by the government or other engineers is preferred, and why?

Question 3. Under what general method of procedure and in what general order shall the various physical and administrative features of the improvement be carried out?

Question 4. Upon what basis shall the capital cost of the completed improvement be apportioned to each country?

Question 5. Upon what basis shall the costs of operation and maintenance be apportioned to each country?

Question 6. What method of control is recommended for the operation of the improved waterway to secure its mos beneficial use?

Question 7. Will regulating Lake Ontario increase the low-water flow in the St. Lawrence Ship Channel below Montreal? And if so, to what extent and at what additional cost?

Question 8. To what extent will the improvement develop the resources, commerce and industry of each country?

Question 9. What traffic, both incoming and outgoing, in kind and quantity, is likely to be carried upon the proposed route both at its inception and in the future? Consideration to be given not only to present conditions, but to probable changes therein resulting from the development of industrial activities due to availability of large quantities of hydraulic power?

Pending the receipt of plans, estimates and other engineering data necessary for the final consideration of this reference, the commission is requested to hold such public hearings as may be considered necessary or advisable in order to obtain all information bearing, directly or indirectly, on the physical, commercial and economic feasibility of the project as a whole.

To facilitate the preparation of the desired report each government will, from its official engineering personnel, appoint an engineer with full authority to confer with a similar officer of the other government for the purpose: First, of acquiring, each in his own country, such data as may be found necessary to supplement the existing engineering data and surveys and second, of preparing complete outline plans for the estimates of the cost of the proposed improvement, including the value of all property, easements, damages and rights connected therewith. These plans and estimates are to be submitted to the commission as soon as practicable, but not later than one year from the date of appointment, and the commission is requested to forward to the two governments its final report with recommendation not later than three months thereafter.

Lt. Col. Wm. P. Wooten, Corps of Engineers, U. S. A., has been appointed as the engineer representative of the United States Government.

The first public hearing of the international commission was held at Buffalo, N. Y., March 1 and 2. The Canadian section included C. A. McGrath, H. A. Powell, P. Urgnault, Wm. Hearst and L. J. Burpee. The American commissioners are O. Gardner, R. B. Glenn, C. D. Clark and W. Klutts.

Two Brigadier Generals in Corps of Engineers.—Senator Ransdell on Feb. 21 proposed an amendment to the Senate Army bill providing for two brigadier generals for the Corps of Engineers. Secretary Baker, in discussing this matter, stated that there should be a brigadier general, assistant to the Chief of Engineers, in charge of the civil functions of the corps and one in charge of its military activities.

Army Reorganization Bill in House of Representatives.—The Army reorganization bill introduced in the House on Feb. 25th resembles the Senate bill noted in our last issue so far as concerns the size of the Army and the provisions for promotion and elemination of officers. The House bill is modeled more closely on the National Defense Act of 1916, of which it is in fact an amendment, and it omits all provision for universal training. This means that universal training will be considered separately and that meantime Congress does not wish to delay the necessary reorganization of the Army. A special committee of Congress will study the question and prepare a measure for consideration at the next session. Meantime it is probable that universal training will be an important issue in the coming Presidential campaign.

On March 10 the House by a decisive vote of more than 3 to 1 overruled the efforts of certain members to reduce the strength of the regular army to the pre-war figure of 185,000. This action, while not final, indicates a strong sentiment in Congress in favor of an army of 17,820 officers and 289,000 men.

Ratio of Officers to Enlisted Men, U. S. Army.—In 1850 the ratio was 10 officers per 100 enlisted men. During the late war the rato was 5 per 100 (200,000 officers, 4,000,000 men). At present the rato is about 4.25 per 100.

Distance Record for Wireless Telephone.—The Air Service established at Ft. Sam Houston a new distance record of 12 miles for transmission by wireless telephone.—*A. & N. Journal.*

Bombing Aeroplanes Break Ice Gorge.—The great ice gorge in the Susquehanna River near Port Deposit has been broken by 500-pound T. N. T. air torpedoes dropped from De Havilland bombing planes. Smaller bombs having proved ineffective, large projectiles equipped with "delayed action" fuses were successfully employed by the army authorities.

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How to Give and Carry Out Military Orders.—There were some of our reserve officers in the World War who had very sound fundamental ideas as to how to give and to execute military orders, as the following anecdote of good military procedure illustrates:

In the fall of 1917 the A. E. F. organizations were being formed and work was starting. The means to accomplish work were exceedingly scarce. Personnel of all kinds was lacking and machinery was almost unobtainable. A call came from one field job for a steam shovel. The job was urgent, and there was not time to wait for anything from the United States. The Engineer Supply Office in Paris had no machinery and very little personnel. How a steam shovel was to be obtained was hard to see. The colonel in charge was equal to the emergency. He solved the difficult problem in a most simple and direct fashion. He called in one Lieut. Reidy and said "Get a steam shovel and deliver it to Col. ——— at ———, and don't appear in this office until said shovel is delivered."

The lieutenant also was equal to the emergency. He looked a bit startled, but he did not argue or ask any questions. Indeed there was nothing more to be said. The lieutenant could not speak a word of French and had no idea where a shovel could be obtained. He saluted and disappeared. After about two weeks he reappeared and reported that the steam shovel had been delivered at the place designated. The results were so astounding that the lieutenant was questioned as to how he had succeeded in carrying out his instructions.

It developed that this officer wandering along had found a French steam shovel lying idle alongside of a narrow-gauge railroad track, had loaded it on cars and carried it to the end of this track, which was about a mile from a standard-gauge railroad. Then he had unloaded it, "jackassed" it a mile to the standard-gauge road, reloaded it on cars and conveyed it to destination. All this had been done without money and without help. In some way the labor, etc., had been obtained on credit. The shovel had been taken apart and assembled twice. Considering the scarcity of French labor, both skilled and unskilled, the lieutenant must have had many difficulties. What language his negotiations were conducted in is not recorded.

It is believed that such men as this, although they worked unsung in the S. O. S., could be shown little in the way of getting results by those who were fortunate enough to serve within the smoke of battle, where any performances, however small, received prompt recognition and wide publicity.

A Wooden Railroad.—The United States has a railroad 15 miles long laid with wooden rails. It is in Alaska, and extends from the head of navigation on the Tolovana River up to some gold mines. A single locomotive, Dodge automobile, has done very profitable work throughout the last seasons. The automobile has flanged wheels and hauls three cars at a time, aggregating 6 tons under favorable conditions. The principal traffic consists of logs from the river to the sawmill, about the half-way point, and lumber from the sawmill to the mines. The freight rate is $3 per hundred pounds. The past season the automobile traveled 6,000 miles, sometimes making eight trips a day.—*Railway Age.*

Light Railways in New Countries.—Light railways of 30 cm. gauge can be constructed with greater rapidity and more economically than standard-gauge lines or roads to carry motor traffic, and cost much less to maintain. On the western front of the British army in France, where the existence of a network of motor roads favors that form of transportation, it was proved that motor transport on the whole could not compete with light railways, either in cost per ton hauled or in reliability. —*Geographical Journal.*

Opening of Railroad from Persian Gulf to Bagdad.—An item of considerable political and military significance is contained in recent press dispatches to the effect that the first through train from Basra northwest to Bagdad, containing British military and civil officers and Arab Sheiks, left Basra at midnight on Jan. 13th and arrived at Bagdad on the afternoon of Jan. 15th, where Lady MacMunn, in the presence of a large gathering, fixed the last fish-bolt and declard the line open.

Basra is a river port 60 miles from the Persian Gulf. From Basra to Bagdad is 352 miles. It is expected that a daily through passenger train each way will be put on to make the run in 28 hours.—*Railway Age.*

Status of Alaskan Railroad Construction.—The project of building some 470 miles of railroad in Alaska, begun a few years ago by the United States Government, has been progressing very satisfactorily, according to the annual report of the Secretary of the Interior, under whose direction the work is being done. The road is now more than two-thirds built and Congress, after making an exhaustve investigation into the project, has authorized additional appropriation sufficient for its completion. Secretary Lane states that the best estimate that can be made to-day as to the newly constructed line is that it has cost between $70,000 and $80,000 per main-line mile, or between $60,000 and $70,000 per mile of track. This cost per mile includes the building of the most difficult and expensive stretch of line along the entire route from Seward to Fairbanks—that running along Turnagain Arm, which is sheer rock rising precipitously from the sea for nearly 30 miles. There are miles of this road which have cost $200,000 per mile. Even to blast a mule trail in one portion of this route cost $25,000 a mile.—*Eng. and Cont.*

Susitna River Bridge, Alaska.—Bids were opened Jan. 26th for the Susitna River bridge at Gold Creek on the Alaska government railroad. The structure is to be a steel truss, weighing 1,650 tons and having a span of 504 feet. Bids ranged from $7.97 to $9.57 per 100 pounds. The main span is to be completed by Nov. 15, 1920. The American Bridge Co. was the low bidder.—*Eng. World.*

Proper Width of Paved Highways for Motor Traffic.—A writer in *Mun. and County Eng.* presents some logical arguments as to the proper width of a road for motor transport. However unimportant a road may appear, it usually becomes a well-traveled highway if provided with a good pavement. Therefore it is important that this pavement be given ample width to safely and efficiently carry the traffic that will develop. Motor cars travel at a speed of from 20 to 30 miles per hour on an open road. At such speeds it is not safe to run off the paved portion of the road onto the earth shoulders. A vehicle cannot travel safely at 30 miles per hour with a clearance of less than 2 feet between the wheels and the curb or edge of pavement. Passing vehicles should have a clearance of at least 4 feet. Assuming that a motor vehicle measures 6 feet wide over all, the width of the pavement should be 2 feet clearance on each side, two vehicles each 6 feet wide, and 4 feet clearance between vehicles, total, 2 plus 2 plus 12 plus 4 equal 20 feet. Such a width has the further advantage that when not passing other vehicles motor cars distribute their travel more evenly over the surface instead of moving always in the same place as on a narrower road, whereby the formation of ruts is avoided.

A writer in *Engineering and Contracting*, discussing the proper minimum width of paved roadway for motor-truck transportation, arrives by a similar course of reasoning at the same figures—20 feet. He assumes a speed of 10 to 15 miles per hour for trucks, allows 1 foot clearance between the truck body and the edge of the road, 8 feet for the overall width of each of two passing trucks, and 2 feet clearance between them.

Further evidence of the proper economic width of roadway is found in the figures adopted for the new interstate tunnel under the Hudson River, which is 20 feet, as recommended by the two writers mentioned. The traffic in each tube of the tunnel is to be in one direction only, but it is assumed that there will be two lines of traffic—slow and fast—so that continual passage of vehicles traveling in the same direction at different speeds will occur.

Rental Value of Construction Plant.—Arguing for a more intelligent and systematic procedure in charging plant rental against construction jobs, Mr. T. J. Herliby, in *Engineering News-Record*, gives an interesting table as indicating the manner in which such charges should be estimated. It shows that many elements enter into the question and that the crude method of charging the first cost of the plant against the job and crediting it with the value of the plant at its conclusion does not solve the problem. The figures given in the table are merely fair averages to illustrate the method of scientifically figuring the real cost. In any particular case the actual figures should be substituted. Thus, if the plant were purchased second-hand a lower original cost, but a higher depreciation and repair charge would be appropriate. The number of earning days per year is a matter of vital importance in the calculation, whose effects have too often been merely nervously guessed at.

The table includes items from steam shovels to water pipe, and the various entries for each are as follows:

1. Original capital cost.
2. Equivalent annual interest rate on original cost.
3. Annual rate of depreciation on original cost.
4. Annual insurance and storage rate.
5. Total annual rate of accrued charges, per cent.
6. Total annual charge, dollars.
7. Average earning days per year.
8. Daily charge for interest, depreciation and storage, dollars.
9. General shop repairs, daily, dollars.
10. Daily rental.
11. Field repairs, daily, dollars.
12. Total daily rental including field repairs.

Geographical Work on the Western Front.—When the war started in 1914 the British army consisted almost entirely of fighting men, and scientists did not figure greatly in the original expeditionary forces. Gradually, however, the need for men who had expert knowledge on different scientific subjects became apparent. The majority of the scientific departments were organized in the early months of 1915.

Geological work included advice on questions relating to water supply in the occupied area and ahead of the lines, listening and test boring for mines and dugouts, inundations, especially in the Yser district, behavior of ground under shell fire, sources for road metal

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and flint gravel for concrete, foundations for bridges and the many related and subsidiary problems.

In many cases the geological solution did not meet the military requirements, therefore, *the geologist must know the military* as well as the scientific aspect of his work.—*Geographical Journal.*

The Aeroplane in African Exploration.—In spite of the lack of suitable machines and efficient photographic equipment, experience during the East African campaign demonstrated the possibility and also the difficulty of exploration by aeroplane. It was proved that for making a first reconnaissance of a district not previously mapped the aeroplane, carrying a *well-trained observer*, gave better results within an hour than a ground party in a week.

On photographing an entirely unmapped district, a modification of a range-finding method was employed, requiring the assistance of a ground party to determine the range and azimuth of smoke bombs or Very lights dropped over the objects photographed. In this way a satisfactory map of the German positions in the flat, swampy valley of the Mgeta River was made.

Along the coast the aeroplane and camera were profitably employed in locating sunken coral reefs; also the constantly shifting mud and sand banks in the numerous estuaries.—*Geographical Journal.*

Emergency Shelter for Troops.—All army officers should be familiar with some of the devices that have been used for sheltering troops. This is especially true of some of those used on the Punitive Expedition into Mexico. On this expedition, neither canvas nor lumber was obtainable when it was needed, principally due to lack of transportation.

The troops that went into Mexico in 1916 lived at first in shelter tents. Later, all kinds of facilities were improvised out of "dobe." The soldiers learned to use this by seeing what the Mexicans had done and were doing. The soil in Texas and in Mexico can be made into a very serviceable brick by simply mixing it with water, and moulding it for the sun to dry. The dirt found almost everywhere is mixed with sufficient water to make it plastic, a little straw is added to help bind the brick together; the bricks, about 4 by 10 by 20 inches, are moulded on a smooth piece of ground and left for the sun to bake. Moulds can be improvised from scraps of lumber from commissary boxes. The bricks may dry sufficiently to handle in three or four days, although they are better if left a week or more in the sun.

On the Punitive Expedition our troops made houses for themselves out of these bricks. The principal difficulty was the roof. Poles were very scarce, and were extremely crooked. However, roofs were improvised with these by covering the poles with brush, and plastering adobe on top. If carefully done, such a roof is waterproof. The broad walls made of brick 10 inches thick would support such a roof up to about 20-foot span. Generally, it would also have to be supported by one or two posts inside.

In addition to huts of adobe, our soldiers made bake ovens, incinerators, water heaters, etc., out of the same materials. Sheets of iron, and gasoline cans split open and hammered out flat were used for moulds. The bake ovens were all that could be desired. Water heaters for baths were made by placing coils of pipe in adobe ovens. The pipe would be connected at both ends with a barrel of water, set up on posts. The water would, of course, circulate through the coils in the oven until the barrel was full of hot water. A soldier could stand under the barrel, and pull out a plug in the bottom and thus get a nice hot bath. Of course, the pipe, barrels, etc., were hard to get, but everybody managed to "rustle" them in one way or another. We never know what we can do until we have to.

The American soldier soon became awfully tired of making dobe brick, so the ingenuity of company commanders was brought into play. One company commander had a scale of company punishments, each prescribing so many brick. Finally, when his soldiers grew still more tired of this and asked for court martial and capital punishment in lieu of company "discipline" he thought he had reached the end of his rope and would have to go out of the brick business. However, he held a profitable interview with the Summary Court officer, and when the sentence was promulgated, it prescribed just twice the number of brick that company "discipline" had provided for. No further courts were necessary.

German Chemical Patents taken over by Americans.—The alien property custodian has sold some 4,500 German chemical patents, which have been bought by a corporation organized for the purpose—a Chemical Foundation. These patents will be licensed to American manufacturers. The corporation will also protect the manufacturers in the use of these patents.

The underlying purpose of this plan is to destroy the German monopoly in dye, and certain other chemical manufacturers, which existed before the war.

During the war the chief sources of supply of poison gas, high explosives and other chemicals were the dye and pharmaceutical plants. This was especially true in Germany, and constituted one of the strong elements in her scheme of preparedness for war. The stimulations of the dye and chemical industry in the U. S. is accordingly an important item in our own program of preparedness.

Water Power Bill.—The Senate on January 15 passed the bill providing a Federal Water Power Commission having broad powers in the issue of licenses for water power development. Considerable opposition developed to the bill on the ground that it was too liberal in giving away the government's water resources. An amendment to the bill provides that the secretary of the commission shall be an officer of the Corps of Engineers, U. S. Army. This amendment, designed to safeguard the interests of the public, as against those of a "predatory" nature, appears to have caused a feeling of great nervousness in certain quarters.

Who Furnished the Generals?—General officers in World War:

Inf.	137	A. G.	2
Cav.	72	J. A. G.	4
F. A.	51	Gen. Officers	38
C. A. C.	39	Retired	21
Engrs.	29	Natl. Guard	48
O. U.	10	Marines	6
Ord.	8	Civilians	10
Sig.	4		
Med.	10		489

Average age of regular general officers, 51.3; average years of service of regular officers, 27.4.

Resignation of Officers of Regular Army.—Since the date of the armistice 2,302 *regular* army officers have resigned from the service, or more than in the previous 70 years. This figure exceeds 22 per cent of all regular officers in the service on November 11, 1918.

Enlistments in the Regular Army.—On February 13, with 36 per cent of the time allowed for a recruiting "drive" for the army only 7.7 per cent of the quota needed had been obtained. In the past year 175,000 men have been enlisted; of these, 61,518 are infantry and 3,727 engineers.

Officers in Service, Feb. 17, 1920.—Regular officers, 8,540; emergency officers on duty, 8,283; emergency officers under treatment, 1,307.

Major JOHN A. GRIFFIN, who was with the 316th Engineers in France, has been elected city engineer by the Board of Public Works of Los Angeles, Cal., to succeed the late A. C. Hansen.

Col. F. M. GUNBY, formerly associated with Charles T. Main, of Boston, during the war head of the Engineering Branch of the Construction Division of the Army, has renewed his connection with the above-named firm as engineering manager.

Col. CHAS. L. POTTER, Corps of Engrs., has been appointed President of the Mississippi River Commission, succeeding Col. C. McD. Townsend, who has retired from active service.

Capt. P. C. POINTER, Engrs., recently discharged, has joined the staff of the Eastern Paving Brick Mfrs. Assn. While with the A. E. F., Capt. Pointer was engaged in road work.

Major H. H. WADSWORTH, Engrs., (recently discharged) Principal Asst. Engr. of the California Debris Commission, has resigned from the U. S. Service to enter private practice as a consulting engineer specializing in hydraulic engineering.

Col. ERNEST GRAVES, Engrs., has been relieved from duty in the Office of the Chief of Engineers and assigned to the Command of the 2d Engineers, Camp Travis, Tex.

Maj. Gen. W. L. SIBERT, has been relieved from duty as Chief of the Chemical Warfare Service and assigned to the Command of the 5th Division, Camp Gordon, Ga.

Col. G. E. EDGERTON, Engrs., has been assigned to duty in the Office of the Chief of Engineers.

H. T. CORY of the U. S. Reclamation Service has gone to Egypt to serve on the international commission which will pass on plans for irrigation in the Nile Valley.

R. F. RAGLAND, recently discharged from the Army as captain of Engineers, has opened an office in Livingston, Park Co., Mont., where he will engage in a general engineering and contracting business.

Lieut. H. J. LALONDE, recently discharged from the 71st Field Artillery, has accepted a position with the St. Louis office of the Portland Central Association.

Col. G. R. SOLOMON, recently discharged from the Construction Division of the Army, has resumed his engineering practice as vice-president of the Fuller Industrial Engineering Corp., New York City. Before entering the military service Colonel Solomon was a member of the Solomon-Norcross Co., consulting engineers, of Atlanta, Ga.

Maj. C. W. OTWELL, C. E., has been assigned to the charge of the Wheeling, W. Va. District, succeeding Lt. Col. G. P. Howell, During the war Maj. Otwell commanded the 319th Engrs., with the rank of Colonel.

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Constitution of the Society of American Military Engineers

PREAMBLE.

The Military Engineers of the United States, having associated themselves for the advancement of military engineering knowledge, do hereby adopt the following constitution and by-laws:

CONSTITUTION

ARTICLE I.

NAME AND HEADQUARTERS.

1. The name of this organization shall be "The Society of American Military Engineers."

2. The headquarters shall be in the City of Washington, D. C.

ARTICLE II.

OBJECTS.

1. The objects of the Society shall be in the interests of the national defence to promote the efficiency of the military engineer service of the United States; to maintain its best standards and traditions; to disseminate professional knowledge concerning developments in engineering with special reference to their application to military purposes; to develop between the military engineers and other arms of the service a spirit of co-operation and a mutual understanding of their respective duties, powers and limitations, and to foster relations of helpful interest between the engineering profession in civil life and that in the military service.

2. Among the means to be employed for this purpose shall be meetings for the presentation and discussion of appropriate papers, and for social and professional intercourse, and the publication of such periodicals and other papers as may be deemed expedient.

ARTICLE III.

MEMBERSHIP.

1. *Classification.* The membership of the Society shall be classified as Active, Associate, and Honorary.

2. *Active Members.* The following persons shall be eligible to active membership, viz, all persons holding commissions as officers in the engineer service of the military forces of the United States, or who, having held such commissions, have been honorably separated from said engineer service; all persons qualified as technical engineers, serving in any capacity in any arm, department or service of the military forces of the United States, or who, having so served, have been honorably separated from the military service: *Provided*, That any technical engineer serving in a civilian capacity exclusively shall not be eligible to active membership until he shall have completed six months' continuous employment in any one arm, department or service of the regular army of the United States.

3. *Associate Members.* The following persons shall be eligible to Associate Membership, viz, all persons not included in the provisions of preceding paragraph, holding commissions as officers in the military forces of the United States or in the United States Navy, including the Marine Corps, or in the Coast Guard, or who, having held such commissions, have been honorably separated from the service of the United States; all persons duly enrolled as members of technical engineering units of the Reserve Officers' Training Corps; civilians of suitable technical qualifications, interested in military engineering affairs, and all persons serving in any military capacity in technical engineering units of the military forces of the United States or who, having so served, have been honorably separated from the military service: *Provided*, That no person eligible to Active Membership shall be classified as an Associate Member.

4. *Honorary Members.* Persons who have rendered distinguished service to the Society, or who have otherwise attained distinction deserving of recognition by the Society may be elected to honorary membership for life: *Provided*, That the total number of honorary members shall not exceed fifteen at any one time.

5. Active members only shall be empowered to vote and to hold office.

ARTICLE IV.

GOVERNMENT.

1. The government of the Society shall be vested in a Board of Directors consisting of a President, a First and a Second Vice President, and eighteen active members. The President and the two Vice Presidents, all of whom shall be directors, shall be elected to serve for one year and until their successors shall have been duly elected: *Provided*, That no one of the three officers herein first named shall be eligible to immediately succeed himself in office.

The eighteen directors, other than the three officers above named, shall be elected to serve for three years: *Provided*, That six of their number shall be chosen from the regular army, six from the other military forces of the United States subject to active service, and six from the active members at large, exclusive of the foregoing two sub-classes of members: *Provided further*, That the term of office of two directors of each such group of six shall expire each year.

2. The Board of Directors shall elect from its own number a Treasurer to serve for one year and shall elect from the active members, though not necessarily from its own number, a Secretary whose term of office shall be one year.

ARTICLE V.

ANNUAL MEETING.

The Society shall hold an annual meeting of the members for the election of officers and directors and for the transaction of other business pertaining to the Society.

ARTICLE VI.

AMENDMENTS.

This constitution may be amended at any annual meeting by an affirmative vote of two-thirds of all ballots cast by the members of the Society voting in person, by written proxy, or by letter-ballot: *Provided*, That notice of proposed amendments shall have previously been submitted to all members of the Society not less than sixty days prior to the date of the meeting.

BY-LAWS.

ARTICLE I.

MEMBERSHIP.

Admissions and Separations.

1. The election to membership of all classes shall be intrusted to the Executive Committee of the Board of Directors, hereinafter provided for, and the decision of that committee as to eligibility shall be final.

2. Any person desiring to become an active or associate member shall make written application to the Secretary. Such application shall be in such form and contain such data as to military and technical experience as may be prescribed by the Board of Directors. The applicant shall give the names and addresses of at least three persons competent to serve as references.

3. Honorary members shall be proposed by at least ten active members and a unanimous vote of the Executive Committee shall be necessary to election.

4. Any member may withdraw from the Society at any time by tendering his resignation in writing, but such resignation shall not become effective until said member shall have paid all sums due the Society at the time of such resignation.

5. Any member may be dropped for cause by a three-fourths vote of the entire executive committee: *Provided*, That he shall have been given full opportunity for a hearing in his own defense; *Provided further*, That any member so dropped may be reinstated by a three-fourths vote of the entire executive committee: *Provided further*, That prior to such reinstatement he shall liquidate all indebtedness which may be due the Society.

6. Members whose dues remain unpaid on February 1 shall be notified of that fact and no publications of the Society shall be sent them pending adjustment of dues. Members five months in arrears may, after a further formal notice of one month, be dropped from the rolls of the Society: *Provided*, That the executive committee is further empowered to act in the best interests of all concerned in any case which may arise relating to dues or fees.

7. For the determination of eligibility qualifications and for other purposes of this Society the following definitions shall obtain, to wit:

The term "the military forces of the United States" shall include the Regular Army, the Reserve Corps, the organized militia of the several states, territories and the District of Columbia (otherwise designated as the National Guard), the National Army and any other forces which may heretofore have been or may hereafter be authorized by Congress and formally inducted into the service of the United States.

The term "technical engineer" shall apply to any person who possesses such qualifications as would entitle him to an unrestricted voting membership in one of the four leading national engineering societies, namely—civil, electrical, mechanical or mining, or in any other technical society of national scope affiliat-

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ed with the engineering profession and requiring for an unrestricted voting membership therein a degree of technical education and experience equivalent to that required for similar membership in the said national engineering societies.

ARTICLE II.

BOARD OF DIRECTORS AND OFFICERS OF THE SOCIETY.

1. The Board of Directors shall be the judge of the qualifications of its members and, subject to limitations herein prescribed, shall have power to fill vacancies arising in its own number: *Provided*, That any member so elected shall serve until the next annual election only at which time the vacancy shall be filled in the manner herein prescribed for other vacancies occurring in the regular course: *Provided further*, That a vacancy in the office of President shall be filled by the First Vice President, and *Provided further*, That the Second Vice President and the Senior Director in point of service as such shall succeed to the offices thus vacated by the First and Second Vice Presidents, respectively.

2. The Board shall have charge of the business, financial, military, technical and social interests and activities of the Society and, in the discharge of its duties, shall have power within the limitations of the constitution and by-laws to initiate and execute any measures whatsoever which in its judgment seem necessary or expedient to further the interests of the Society and to achieve its objects.

3. The Board of Directors shall meet at least once in every six months for the transaction of business and five members thereof shall constitute a quorum. Special meetings of the Board of Directors may be called by the President on his own motion or on the recommendation of the Executive Committee.

4. The Board shall submit at the Annual Meeting of the Society a report on the affairs of the latter and such suggestions as it may deem appropriate.

5. At its first meeting after the annual election, the Board of Directors shall elect from its own number a Treasurer to serve for the appointed term: *Provided*, That a majority of votes cast shall be necessary for election.

At this meeting the Board shall also appoint a Secretary to serve for the appointed term: *Provided*, That he shall be an officer of the Corps of Engineers on the active or retired list of the United States Army.

The terms of office of the Treasurer and the Secretary shall begin on such date subsequent to their election as the Board of Directors may appoint.

6. Duties of Officers. The President shall have general supervision of the affairs of the Society. He shall preside at the meetings of the Society and of the Board of Directors and of the Executive Committee herinafter provided. He shall be ex-officio a member of all committees and of all sub-committees thereof. In his absence his duties shall devolve upon the Vice Presidents in succession and in their absence upon the senior director.

7. The President, or in his absence the Vice President or other senior director, and the Secretary shall sign all written contracts and obligations of the Society. They shall jointly sign securities belonging to the Society and indorse financial papers necessary for the use of the Society.

8. The Treasurer shall have charge of the funds of the Society; under the direction of the Board of Directors he shall make collections and disbursements and render an annual report and such special reports as may be called for by said Board; his accounts shall be audited annually by an auditing committee of three members to be appointed by the President at least thirty days prior to the annual meeting in each year and the committee shall report the result of its audit at such annual meeting. In anticipation of the absence of the Treasurer and on his recommendation, or in the event of his disability, the executive committee shall designate a director or other officer of the Society to serve as Acting Treasurer and to discharge for the necessary period the duties devolving upon the Treasurer.

9. The Secretary shall give timely notice of all meetings of the Society, of the Board of Directors and of the Executive Committee; he shall record their respective proceedings and shall submit an annual report to the Board for presentation to the Society at its annual meeting. He shall furnish the Treasurer and the Editor with the names of all persons elected to membership, shall keep the roll thereof and shall be the keeper of the seal of the Society and shall conduct and have custody of such correspondence as does not relate directly to the duties of the Treasurer, or the duties of the Editor. He shall be responsible that suitable arrangements are made for the annual and other meetings of the Society, of the Board of Directors, and of the Executive Committee.

ARTICLE III.

COMMITTEES.

1. The standing committees of the Society shall be as follows, to-wit: An Executive Committee, a Committee on Membership, and a Committee on Service Relations and Military Policy.

2. *Executive Committee.* The Executive Committee shall consist of the President, the two Vice Presidents, the Treasurer, the Secretary and three others to be elected by the Board of Directors from its own number at its first meeting after the annual election.

3. The Executive Committee shall, during the intervals between the meetings of the Board of Directors, possess and exercise all the powers and functions of said Board except for consideration of matters which may have been specifically prohibited by said Board: *Provided*, That full report of its proceedings shall be made to the Board at its next succeeding regular or special meeting.

4. The committee shall have final jurisdiction on all questions concerning the eligibility of applicants for membership and shall be charged with the election of members of all classes.

5. The Executive Committee shall have supervisory charge of all publications of the Society and, for the discharge of its duties in connection therewith, may appoint sub-committees, boards of review and other assistants as hereinafter provided for. This committee shall also make arrangements for lectures under the auspices of this Society.

6. *Committee on Membership.* The Committee on Membership shall consist of not less than three active members appointed by the Executive Committee and it shall be the duty of said committee to inquire as to the character and qualifications of all candidates for membership and to report thereon to the Executive Committee for its final action.

7. *Committee on Service Relations and Military Policy.* The Committee on Service Relations and Military Policy shall consist of not less than five members so appointed as to equitably represent the entire membership of the Society. It shall be charged with the consideration of all matters which may be properly brought before the Society or may originate within the committee itself involving the relations between the military engineers and other arms of the military service and between the military engineers and the engineering profession in civil life, including all questions relating to the tentative military organization of the latter and other measures of military preparedness affecting such engineers. *Provided*, That the proceedings of this committee shall be confidential, and that its recommendations shall be advisory only and subject to review and final action by the Board of Directors. Said committee may appoint such assistants or sub-committees from amongst the members of the Society as it may deem necessary, subject to the prior approval of the Executive Committee.

8. In addition to the foregoing standing committees, the Board of Directors may appoint other standing and special committees with such duties as the Board may assign. Such committees shall report to the Board and take only such responsibilities as the Board may specifically authorize.

ARTICLE IV.

SUBSIDIARY OR LOCAL SECTIONS.

Subsidiary or local sections may be formed of members within any given geographical jurisdiction, or composing any military unit or organization heretofore existing or hereafter organized. Each such subsidiary or local section shall have power to select its own designation and draft its own constitution and by-laws: *Provided*, That the same shall be in harmony with the constitution of this Society and in furtherance of its objects, and *Provided further*, That prior to their final adoption the constitution and by-laws so drafted and all subsequent amendments thereto shall have been submitted to and formally approved by the Board of Directors of the Society of American Military Engineers.

ARTICLE V.

FINANCES.

1. The fiscal year of the Society shall begin on the 1st day of January.

2. The annual dues of members, which shall entitle them to all regular periodical publications and to all privileges of the Society, except as otherwise specifically provided herein, shall be fixed each year by a majority vote of the Board of Directors at not to exceed $5.00 per annum, payable at the beginning of each year of membership: *Provided*, That under exceptional circumstances said dues may be fixed by a three-fourths vote of the entire Board at not to exceed $10.00 per annum: *Provided further*, That applicants elected to membership after July 1 in any year shall pay not to exceed fifty per cent of the fees and dues for that year.

3. Any active or associate member not in arrears may, on the payment of $85.00, become a Life Active or Life Associate Member and shall not be liable thereafter to the payment of annual dues: *Provided*, That if the annual dues be increased, the Board of Directors shall be empowered to increase the cost of life membership in proportion: *Provided further*, That all moneys received from life memberships shall be invested and the income thereof only shall be used for current expenses of the Society.

4. *Budget.* The Treasurer shall prepare annually about December 1, a statement showing the probable income and the probable ex-

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penditures for the ensuing calendar year on account of publications, and a similar separate estimate covering expenditures for other activities of the Society. The Board of Directors shall then determine the amount of available funds to be applied to each of the various activities, naming in each case the maximum amount that may be expended. It shall be the duty of the Treasurer to report to the Board whenever there appears to be a probability that the income will not be sufficient to meet the several allotments.

ARTICLE VI.

PUBLICATIONS.

1 The Society shall issue a periodical entitled "The Military Engineer" and such other publications as the Board of Directors may prescribe.

2. The Executive Committee shall appoint an Editor from the active membership of the Society who shall serve for a term of two years and who shall be eligible for reappointment: *Provided*, That the Editor shall be an officer of the Corps of Engineers on the active or retired list of the United States Army.

3. Under the direction of the Executive Committee, the Editor shall have charge of the publication of the periodical and other literature issued by the Society. He shall receive moneys accruing from subscribers, advertisers and other sources pertaining to the periodical and other publications and shall be responsible for all details relating to the editorial and business management connected therewith. The Executive Committee may authorize him to engage clerks, proof readers and such other assistants as it may deem necessary and said committee may appoint such Associate or Corresponding Editors, Boards of Review, or other business and editorial assistants as in its judgment shall serve the best interests of the Society: *Provided*, That no such appointments shall be for a term of more than two years.

4. With the advice and consent of the Executive Committee, the Editor shall pass on the fitness of all articles and communications submitted for publication. The Executive Committee may appoint from amongst the members of the Society a Committee on Papers and Publications which shall act in an advisory capacity and assist the Editor in all matters connected with publications of the Society.

5. To help defray the costs of publishing "The Military Engineer" funds of the Society may be allotted in accordance with an annual budget to be prepared by the Editor and submitted to the Treasurer on or before December 1st of each year: *Provided*, That the business of publishing said periodical shall be conducted under accounts separate and distinct from all other business activities of the Society.

ARTICLE VII.

SEAL AND INSIGNIA.

The Board of Directors shall have authority to design and adopt a seal and insignia for the Society.

ARTICLE VIII.

MEETINGS AND ELECTIONS.

1. The annual meeting for the election of officers and for the transaction of other business of the Society shall be held in the City of Washington, D. C., on the Friday preceding the third Wednesday in January.

2. Special meetings for the transaction of business or for other purposes of the Society may be held at such time and place as the Board of Directors may appoint: *Provided*, That a notice of not less than twenty (20) days stating the object of the meeting shall be sent to all members.

3. The President, the two Vice Presidents and two directors in each group of six representing the three sub-classes of the active membership, to wit: the Regular Army, the other military forces of the United States and the membership at large exclusive of the fore going two sub-classes, shall be elected by a written ballot at each annual meeting of the Society to serve for the appointed term of office or until their successors shall be elected: *Provided*, That a plurality of all votes cast shall be necessary for election, and *Provided further*, That at the first meeting of the Board of Directors after the first election held under the provisions of this constitution, two directors of each group shall be selected by lot to serve for one year only, two others of each group to serve for two years only and the remaining six to serve for the full term of three years.

4. *Nominating Committee.* On or before the first day of October of each year the Executive Committee shall appoint a Nominating Committee of five members so distributed as to equitably represent the three groups of active members: *Provided*, That not more than two members of said committee shall be members of the Board of Directors. It shall be the duty of said committee to make nominations for President, for First and Second Vice Presidents and for places vacant or due to become vacant in the Board of Directors. The list of nominations shall be transmitted to the Secretary of the Society not later than the twenty-fifth day of October. A list of nominations so made shall be printed in "The Military Engineer" for November or in the discretion of the Executive Committee shall be otherwise published to the members not less than sixty days before the date of the annual meeting.

5. In addition to the nomination so made by the committee, nominations may be made by a "nominating letter" signed by not less than ten active members: *Provided*, That such nominating letter shall be received by the Secretary not later than the first day of December. The Executive Committee shall verify the eligibility of all nominees and their acceptance of nominations, and all nominees found eligible for election shall be included in the printed election ballot which shall be mailed to all active members between the first and fifteenth days of December. The names of candidates for each vacancy shall be arranged in alphabetical order with such data as to place of residence, civil and military record of each candidate, as the Board may deem pertinent or desirable: *Provided*, That no person shall at any one election be a candidate for more than one office or position.

6. The ballot shall also contain statements of any proposals which require determination by vote of the members and the voter's decision shall be indicated in each case in accordance with instructions furnished with the ballot as to the manner of voting. The ballot unsigned shall be transmitted to the Secretary in a sealed envelope on which the voter shall legibly write his name. The polls shall close at the hour fixed for the first session of the annual meeting, at which meeting all ballots shall be canvassed by three election tellers appointed by the President.

7. Prior to such canvass the Secretary shall mark all envelopes from persons not entitled to vote and shall furnish the tellers with a correct check list of all members entitled to vote.

8. The envelopes containing the ballots shall be delivered unopened to the tellers who shall carefully scrutinize the ballots, count the same and prepare a written report thereon. All votes shall be counted for those candidates for whom the voter has plainly indicated his choice and those candidates receiving a plurality of votes cast shall be declared elected to their respective offices or positions: *Provided*, That all votes not definitely identified by the names of voters on the mailing envelopes shall be rejected. In case of a tie vote between two or more candidates for the same office the members present at the annual meeting shall decide by ballot between the candidates thus tied.

9. The terms of all officers and directors shall begin upon the ajournment of the annual meeting at which such officer or director is elected.

ARTICLE IX.

GENERAL POLICY AND PROCEDURE.

1. The Society as a body shall take no action and make no recommendation which shall be or shall appear to be detrimental to any class or group of its membership or not in accordance with the purposes and aims of the Society as expressed in its constitution and by-laws.

2. In the event that any action is proterests of any such class or group or which is not clearly in harmony with the objects of the Society, the proposal shall be submitted to the Executive Committee in writing signed by not less than twenty active members. The Executive Committee shall canvass the entire Board of Directors and shall inform the original proposers of the opinion of the Board in reference to the proposal, whereupon the proposers may withdraw the same, may accept changes suggested by the Board or may adhere to the original form: *Provided*, That the declaration of such adherence shall be signed by thirty active members, of whom not less than fifteen shall have signed the original proposal.

3. The proposal, whether approved or disapproved by the Board of Directors, shall be brought before the Society for determination at its next annual meeting: *Provided*, That the proposal with full and fair statements for and against the action proposed shall have been published to all members not less than sixty days before the annual meeting. The original form, if adhered to, and the form preferred by the Board shall be mailed to all members with the annual election ballots in the shape of a ballot which shall permit the voter to accept one or the other form or to reject both: *Provided*, That any vote not clearly indicating a choice in favor of one or the other form shall be counted as a rejection of the proposal in both forms.

ARTICLE X.

QUORUM.

Twenty-five voting members present in person or represented by proxies shall constitute a quorum for the transaction of business at the annual or any special meeting of the Society. Five members of the Board of Directors shall constitute a quorum for the transaction of business except as otherwise specifically directed herein. Four members of the Executive Committee shall constitute a quorum for the transaction of business except as otherwise specifically directed herein: *Provided*, That in all cases a number smaller than that

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fixed for a quorum may adjourn to a future date to be determined by such number.

ARTICLE XI.

ORDER OF BUSINESS.

At the annual meeting the order of business shall be as follows:

(1) Reading of minutes of preceding meeting.
(2) Report of Board of Directors.
(3) Reports of officers.
(4) Election of officers and directors.
(5) Reports of standing committees.
(6) Reports of special committees.
(7) Miscellaneous business.
(8) Reports of election tellers.
(9) Announcement of election of new officers and directors.
(10) Literary and Social Program.
(11) Adjournment.

This order of business may be changed at any meeting by a majority vote of the members present.

Robert's Rules of Order shall be the parliamentary guide and shall govern the proceedings at all meetings of the Society.

ARTICLE XII.

AMENDMENTS.

1. Proposed amendments to the constitution shall be reduced to writing and shall be signed by not less than twelve directors or by not less than thirty active members. The procedure for the submission of such amendments to the Society for final determination shall be similar to that prescribed in Article IX of these by-laws in respect of proposals affecting the interests of any class or group of the members: *Provided*, That the declaration of adherence to the original form of the amendment shall be signed by not less than forty-five active members, of whom not less than twenty-four shall have signed said original form.

2. Amendments to the By-laws may be made at any regular or special meeting of the Board of Directors by an affirmative vote of two-thirds of the total number of ballots cast by the members of the Board voting in person, by written proxy or by letter-ballot: *Provided*, That the following procedure shall have been observed, to-wit: The proposed amendment shall have been presented to the Secretary in writing signed by not less than four directors or by not less than ten active members; copies thereof shall have been submitted to all directors at least sixty days prior to the meeting of the Board at which the amendment is to be voted upon and shall have been published in THE MILITARY ENGINEER or otherwise communicated to the members of the Society in ample time to permit them to express their opinions to the Board.

In its discretion the Board may refer a proposed amendment to the by-laws to the Society for determination in the manner hereinbefore prescribed for amendments to the Constitution.

ARTICLE XIII.

ADOPTION.

1. The constitution and by-laws shall be considered as adopted and shall be in full effect when they shall have been accepted by not less than seventy-five persons having the qualifications herein prescribed for active members, and these persons shall then and thereafter be known as charter members of this Society: *Provided*, That all subscribers to THE MILITARY ENGINEER (formerly PROFESSIONAL MEMOIRS, Corps of Engineers and Engineer Department at Large), whose subscriptions are paid in full to December 31, 1920, and who are otherwise eligible to membership in any class under the provisions of this constitution may on their own application become charter members of appropriate class without payment of further dues for the current year. Non-members may enter or renew subscriptions to the journal at their option.

2. As soon as practicable after such adoption of the constitution and by-laws the charter members shall proceed to the election of permanent officers and directors in accordance with methods hereinbefore prescribed: *Provided*, That for officers and directors so elected the first year of office shall terminate with the adjournment of the next annual meeting of the Society in January, 1921: *Provided, further*, That pending such election and induction into office of the officers-elect and the Directors-Elect, the temporary Board of Directors shall discharge the duties herein prescribed for the permanent Board.

Washington, D. C.
March 1, 1920.



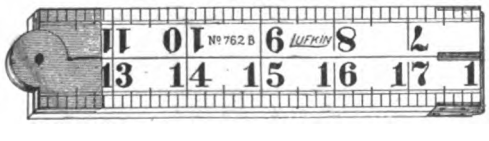
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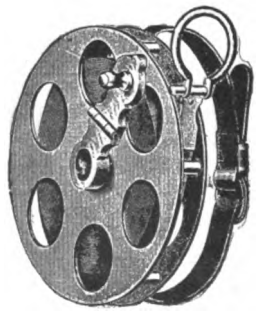
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Address—

The Secretary
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Harnessing the tide in the Bay of Fundy. The essential requirements for a tidal power development, according to a Canadian engineer are:

1. Sufficient tidal range to produce a good head.
2. *Two* reservoirs to insure continuous power.
3. Power plant centrally located in district to be served.

These essential conditions are found at the confluence of the Petitcodiac and Memoramcook Rivers when they empty into Shepody Bay, an arm of the Bay of Fundy, and lead to the hope that the first great tidal power development in the world will be installed at the village of Hopewell, New Brunswick.

It is well known that the Bay of Fundy exhibits the greatest tidal range of any locality in the world. At Hopewell the ranges of spring and neap tides are 45 and 38 feet, respectively. Two great reservoirs, almost completed by nature, exist in the lower reaches of the two rivers, and the development would serve a population of 250,000.

Shepody Bay and the two rivers form a large letter Y of which the stem is Shepody Bay, designated as S, and the branches are the two rivers, designated L and R (left and right). These three are to be separated by dams, according to the project, the dams forming an inverted T at the confluence of the two rivers.

Water is to be admitted and discharged by sluice-gates in the dams, and the cycle of flow will be from S to L, from L to R, from L to S and finally from R to S. Thus L is evidently a high level reservoir and R a low level.

The high level basin L is filled at high tide. At the next low tide water passes through turbines from L to S and also from R to S. As the tide rises R is cut off from S, and water flows through turbines from L to R. When the tide reaches the level of L the power flow from L and S, of course, ceases, and the tide replenishes the storage in L, the power developed by flow from L to R continuing meantime until the tide has half ebbed, when a power flow from both L and R to S is again possible. This cycle is continually repeated.

The mean area of the high level basin (L) is 330,000,000 sq. ft., but that of the low level (R) is only 60,000,000. Thus while L is lowered 6 inches R is raised 33 inches. This condition limits the available power, but by enlarging the low level basin by dredging an output of 200,000 H. P. may be obtained, which is the untmost possible under existing natural conditions.

The average head on the turbines would be 22¼ ft. The estimated cost of the first 100,000 H. P. is $11,000,000; the next 100,000 would cost much less. The average charge to consumers per horse-power year would be $45, which would cover all costs and returns on the investment and at the same time furnish electric power at about half the present cost.

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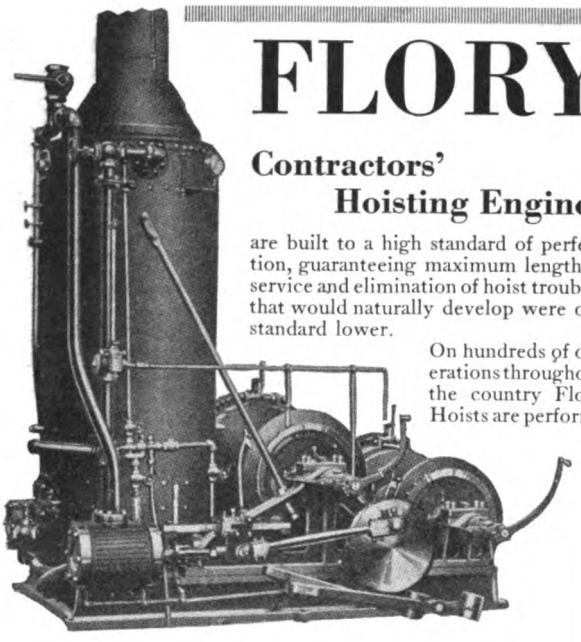
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The Society of American Military Engineers

What It Is

The Society of American Military Engineers is an organization composed primarily of engineers—civil, electrical, mechanical, mining and others—who have served at any time as officers, soldiers or civilians in any arm or department of the military forces of the United States, including the National Guard, the volunteers, the Reserve Corps and other contingents. Its ranks are open also to persons other than engineers who may be interested in the national defense. The society was organized by officers of the Corps of Engineers and by prominent engineers now in civil life who served as officers during the World War. The formation of the society has been approved by the Chief of Engineers and the Chief of Staff, U. S. Army.

Purpose

The constitution of the Society provides that, "The objects of the Society shall be in the interests of the national defense to promote the efficiency of the military engineer service of the United States; to maintain its best standards and traditions; to disseminate professional knowledge concerning developments in engineering with special reference to their application to military purposes; to develop between the military engineers and other arms of the service a spirit of cooperation and a mutual understanding of their respective duties, powers and limitations, and to foster relations of helpful interest and friendship between the engineering profession in civil life and that in the military service."

Membership

The following persons are eligible to active membership, with power to vote and to hold office, viz,

(*a*) All persons who at any time have been commissioned as officers in the engineer service of the United States, in the Regular Army, the National Guard, the Reserve Corps, the volunteers or in the selective service forces.

(*b*) All technical engineers, or others of equivalent technical education and experience who have served or are serving in any capacity whatsoever, whether as officers, soldiers, or civilians in any arm or staff department of the military forces of the United States above mentioned, but civilians must have rendered at least six months' continuous service.

Associate membership is open to all officers of the military forces of the nation, other than engineers; the Navy, including the Marine Corps, the Coast Guard, the members of technical units of the R. O. T. C., and to all soldiers serving in technical engineering units of the military forces, including Engineers, Ordnance, Signal Corps, Chemical Warfare Service and other technical arms or branches.

Government

The Society is governed by a Board of Directors consisting of a President, two Vice Presidents and eighteen other active members. These are all elected by vote of the active members. The three officers first named serve for one year and the 18 directors serve for three years each. Six directors are chosen from the Regular Army, six from the National Guard, the Reserve Corps and other contingents subject to active military duty, and the remaining six are from the membership at large not including the foregoing two groups; that is to say, from former officers, soldiers and others who are not now subject to active military duty.

Local Sections

Local sections may be formed of members within any given geographical jurisdiction or composing any military unit or organizaton heretofore existing or hereafter organized. This permits regimental associations to be formed as branches of the main Society and also permits sections to be formed in any city or state.

Journal of the Society

The Society publishes a bi-monthly journal called THE MILITARY ENGINEER which contains articles bearing on engineering in both war and peace, as well as articles of a general military nature. It contains news of the work done by the Corps of Engineers and other technical services of the Army, items of interest concerning the engineer regiments of the Regular Army and the National Guard, news of the local sections of the Society and the individual members, and of the activities of the Reserve Corps and R. O. T. C.

This journal is the medium through which you may keep in touch with engineering developments bearing on the national defense, and with other engineers both in the service and in civil life, who are interested in this important matter.

The journal is sent without additional cost to all members of the Society. For non-members the price of subscription is $4.50 per annum.

Dues

No entrance fee is charged and the annual dues are fixed each year by majority vote of the Board of Directors and normally will not exceed $5.00 per year. Under exceptional circumstances, however, the dues may be fixed by three-fourths vote of the entire Board at not to exceed $10.00 per year. For the year 1920 the dues are $4.50, and this includes subscription to THE MILITARY ENGINEER.

Further Information and Applications

For further information and for application blanks for membership address The Secretary, The Society of American Military Engineers, Washington Barracks, D. C. If you desire to receive THE MILITARY ENGINEER beginning with the first number, send $4.50 at once, with address. You will promptly receive the journal and your name will be entered for membership subject to examination as to eligibility.

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The Officer's Library

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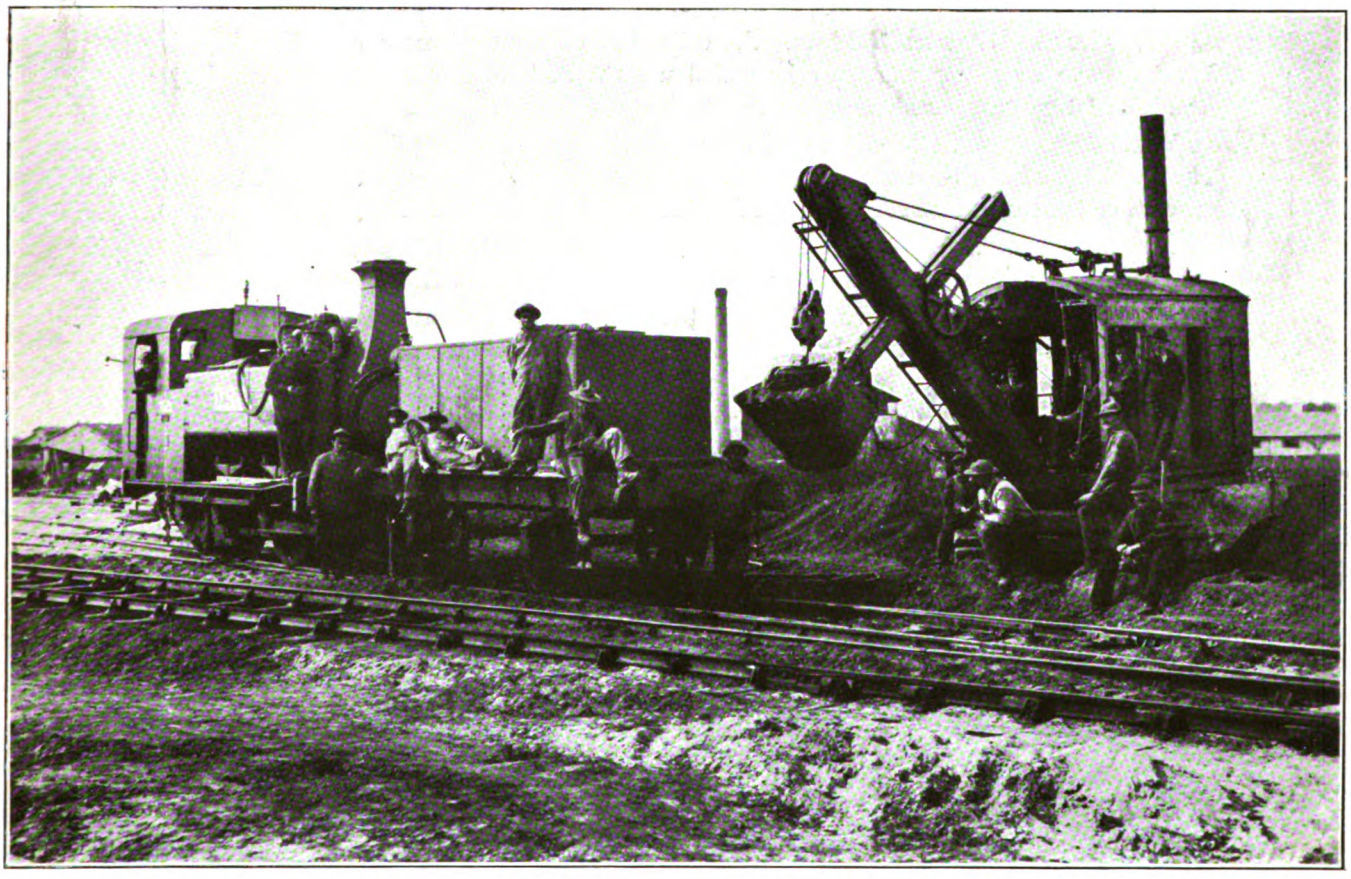
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VOL. XII, 3 MAY-JUNE, 1920 NO. 63

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The Military Engineer



"ALLIES!"
An American steam shovel and a Belgian locomotive working together to beat Germany

JOURNAL OF
THE SOCIETY OF AMERICAN MILITARY ENGINEERS

Some Practical Points on the Training of Troops
Pipe-Line Dredging in the Open Gulf of Mexico
Co-operation of Airplanes and Searchlights in Anti-Aircraft Defense

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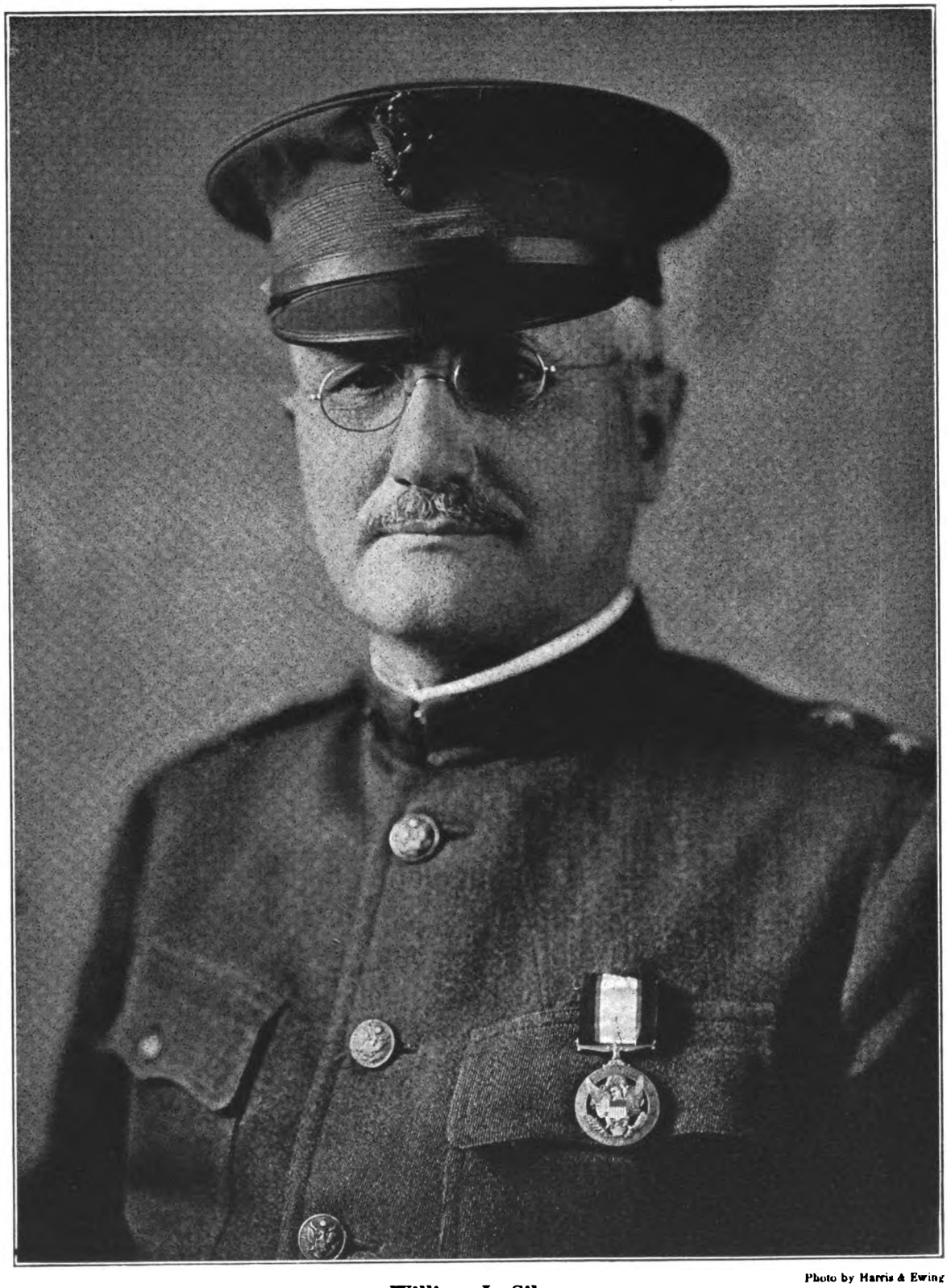


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William L. Sibert

Major General, U. S. Army

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Some Practical Points on the Training of Troops

By

H. A. Finch

Colonel, Engineers; formerly Commanding the 6th Engineers and Division Engineer, 3rd Division, A. E. F.

ALL engineer regiments in the regular service are now at a very low strength. In some cases the entire enrollment of the regiment totals only about 100 men.

This means that should these organizations be finally recruited to full strength, the situation as regards training the large draft of new men will closely approximate the condition which existed throughout the summer and autumn of 1917, when 90 per cent of the men were recruits and the burden of the training was borne by a small nucleus of the personnel that had seen service.

The difference is that, while in 1917 the prospects for immediate war service acted as a wonderful inspiration, the training nowadays lacks that great stimulus and consequently the burden thrown upon the instructor will in many respects be heavier.

In view of this situation, a few notes on the practical training of Engineer troops should not be amiss.

The writer's excuse for putting down these notes is not that he believes that he knows more about the subject than anyone else but because through the fortunes of war he was associated with eight different regiments during the period March, 1917–March, 1919, and having worked with six of these regiments during their training for overseas service, it is hoped that the points emphasized by this rather varied experience may be of interest or assistance to other officers of the service.

So far as the actual theoretical training itself is concerned, there is an ample supply of literature available to act as a guide. Part VIII of the Engineer Training Manual, 1917, dealing with "Intensive Training and Mobilization for War" contains some excellent advice and some thoroughly practicable schedules of instruction. It is evident that a great deal of work was devoted to the preparation of this Manual. Morrison's "Training Infantry" is full of meat for those who have to teach infantry tactics; an excellent guide for Engineer instruction is the "Training Circular No. 1," and its appendices issued by the office of the Chief of Engineers beginning in October, 1918. It is regrettable that this last Manual (particularly Appendix No. 2 dealing with recruit training) could not have been published earlier, for it would have been very timely and would have met a real need.

The three manuals mentioned above and some of the A. E. F. notes were found to be most helpful as guides to the hours for instruction and the subjects to be taught, but certain useful and practical methods are developed by all trainers of troops and these are not always fully treated in published manuals.

The following pointers are submitted for what they are worth. They at least have the merit of having been used with success in actual practice.

Recruit Training

(*a*) Follow some such schedule as that set forth in Appendix 1, Training Circular No. 1, which makes the drills short, snappy and progressive.

(*b*) As soon as possible separate the men into two groups according to progress shown, so as to avoid having the bright men held back by the "slow" ones.

(*c*) Select the non-com. instructors very carefully and have them on duty as *specialists*. Recharge their batteries every day. Give them special privileges as a recognition of fact that their duty is extremely important.

(*d*) On no account allow profanity to be used, also encourage the instructors to strive to avoid impatience, and to establish a friendly spirit in dealing with their men.

(*e*) Encourage the officers concerned (including yourself) to give the recruits a friendly word from time to time. Some men get very homesick and the habit of "passing the time of day" does no harm.

(*f*) *Tell the recruits why they are required to do things and invite question.* (Very important.)

(*g*) When the time comes for the recruits to take up special Engineer training, make them talk about the lines open to them for instruction and let them choose what they would like to take up first. It will be found that every line will have sufficient volunteers to provide a class, but some little shifting may be necessary. The great point is that the majority of the men have the opportunity of choosing a congenial line of work.

(*h*) Be sure to insist on having credit given for good work whenever done. This helps a great deal, for all of us appreciate commendation.

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Recruits are human beings, sometimes a little too human, but they are responsive and are eager to find out what the Army has to offer. It has been found to be an excellent practice to give them frequent talks during the afternoons or, better still, in the evenings when they have idle time to "kill." These talks can be made on a large variety of subjects including the news of the day and the part that our Army might be called upon to play in the world's events.

Target Practice

The value of efficient shooting in keeping up the morale of an organization is admitted on all sides.

During the eight months' period following the armistice when the writer's regiment "roosted on the Rhine," about the only courses of instruction that aroused great interest were those in gas engine operation and in rifle and machine-gun practice. All men like the idea of being able to shoot; the marksmanship badges are popular and the extra pay helps. It is thoroughly practicable to have 80 per cent of the regiment qualified as Marksmen or better. The Fifth and Sixth Marines in the spring of 1919 averaged 75 per cent qualified. The Engineer Regiment above referred to qualified slightly less than 50 per cent and should have done better.

The McNab system of instruction is excellent. This demands nothing more than thorough and progressive individual training to be given by patient, interested and painstaking instructors. The pamphlet on this system is obtainable from the War Department.

During the last two target seasons, the writer followed this method for preliminary training, and on the range he used the system of coaching which has been employed by Colonel V. L. Peterson, C. E., and others with marked success. Non-coms are carefully selected for duty as coaches. Each coach is assigned to a definite target, which assignment is permanent for all firing points throughout the season. The men are likewise assigned to definite targets and shoot at the same target throughout the season. In this manner each coach deals with a definite group of men and soon becomes acquainted with the weak points that he must work on in each individual.

As a time and labor saver, the Belgian Aiming Device will prove of great assistance.

Trade Schools

Great stress is now being laid upon the advantages given the young man entering the Army in the way of vocational training. This the writer firmly believes in. One of the strongest appeals that the Engineer branch has always made is that the man enlisting for our service is taught a trade that otherwise in all probability he could not hope to learn.

Except for good food and decent treatment nothing promotes contentment and pride in an organization more than an opportunity given men to follow their trade or to learn one.

As set forth in Training Circular No. 1, it is believed that general pioneer training should be given to the entire personnel, leaving the special training to be given to selected men from each platoon who do not take any other course until they have completed the special one to which they are assigned.

Another point which is brought out in the Circular No. 1, but which should be emphasized is that the instructor should also be specialized, *i. e.*, be assigned to a definite subject and teach that subject day after day.

This has been objected to on the ground that, with special instructors handling his men, the captain of a company will lose touch with them. However the captain loses touch with his men to a great extent anyway when the company is divided into working platoons, and the field of engineering instruction is so wide at present that it is almost impossible for a captain to do justice to all subjects.

The method of assigning special instructors to supervise courses of training was followed with great success by Colonel E. I. Brown, C. E., during the spring of 1918 and by the writer with two different regiments in the United States and in France. Doubtless many others have followed this system; the writer was told by an inspecting officer that at Camp Taylor, the engineers operated what was in effect a vocational college.

It has been found practicable to qualify men in one or more courses following the completion of the first course assigned them and this plan has even been followed in bayonet training, each platoon being assigned a daily period for instruction under commissioned and noncommissioned experts.

It has also been demonstrated that certificates of proficiency, signed, and countersigned by the instructor and the regimental commander, are eagerly sought after. These serve to stimulate interest in all subjects, particularly the less popular ones, such as trench and dugout construction.

Guard House Administration

Some ten years observation of the manner in which guard houses are administered in our Army has convinced the writer that not only do most of our guard house sentences fall far short of the purpose for which they are intended but many of these sentences are total failures.

The chief difficulty appears to lie in the fact that, due to the daily shifting of the officers and non-coms of the guard, there is no one man charged with the definite and continuous duty of seeing that the prisoners are properly looked after and are worked or drilled for reasonable periods each day. In some

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regiments there is a provost sergeant whose duty it is to supervise the work of the prisoners but this method at best is unsatisfactory unless by some great good fortune the sergeant is very wise in the handling of men and is interested and impartial in the discharge of his duty.

Another difficulty in securing better results from guard house sentences is the fact that all of the regimental officers are usually too much occupied with their work to give the prisoners any attention except perhaps for a brief time during their tour of duty as officer of the day. The company and battalion commanders, the adjutant and supply officers are all so fully occupied in their respective spheres that ordinarily these officers are willing enough to leave the handling of the prisoners to anyone designated by the colonel.

The number of prisoners in the guard house is a good barometer to consult on the state of discipline in the command. These men are a sore spot in the organization. Dealing with them is too important a matter to be left to the discretion of anyone but a carefully selected officer, who should be detailed by the regimental commander and provided with one or two assistants.

It should be the duty of this officer and his assistants to see that the work required of the prisoners is neither degrading nor too easy. The prisoners should turn out for drill with their companies. Ordinarily this is not done and as a consequence a guard house sentence is often a restful and agreeable change from the routine of company drills.

If the prisoners are drilled daily and in addition if they are required to work during certain periods that are devoted by the other men to recreation, the effect of the guard house sentence will not be lost but if the work be made degrading or useless or if the provost officer fails to take advantage of every opportunity to help the individual much good that might be done will be missed.

Many of us make the mistake of assuming that a man is incorrigible because he is frequently in trouble. The writer has made his errors along this line but he has learned that there are extremely few incorrigibles among the men who appear for trial before our Summary Courts. By far the greater part of them will respond to individual treatment accorded them by a wise commanding officer.

The great thing to work for in any organization is an empty guard house. This point is an excellent one for captains to bring out at their company gatherings and for the colonel to present at the periodic meetings of his officers and the non-coms.

Much may be accomplished by extending special privileges to the companies which run for a month or more without having a man in the guard house. While this may prove somewhat of a temptation to the non-coms to conceal breaches of discipline the result on the whole has been found to be very beneficial since it has the effect of causing, to a certain extent, the men in the ranks to discipline one another.

In the writer's experience by far the best method that he has seen tried of encouraging good behavior and keeping an empty guard house consists in organizing a disciplinary squad or platoon from the guard house habitués. This organization not only receives the direct personal attention of the provost officer but of the colonel, the chaplain, the medical and dental officers and in fact every officer of the regiment except perhaps the veterinary whose services unfortunately can hardly be utilized along such sociological lines!

This expedient never fails to work. The last time the writer tried it the disciplinary platoon consisted of some 18 "hard boiled" drinkers and "bad actors" who apparently couldn't stay out of the guard house. All sentences were suspended, the prisoners were removed from the guard house and were quartered in a single large room to themselves. They had no guards posted over them and were not allowed to do any work around the stables or latrines that might be called in any way degrading.

A group of selected officers and sergeants was detailed to supervise the schedule for "J" Company (as the platoon soon became known) and one or more of these drillmasters was present with them at all times from reveille until well after taps. The daily schedule consisted of drills of every kind that fall to the lot of a soldier. These were short, snappy and followed each other at five and ten minute intervals throughout the entire day with the different drill masters relieving one another at certain intervals. The point was made to the men that due to their shiftlessness and indifference they had become poor soldiers and that consequently (since they had shown that the guard house did them no good) a special drill schedule had been prepared for the purpose of placing them on a par with the other men of the regiment. The men were advised that they were not prisoners, that there were no guards over them and that nothing degrading would be required of them. Furthermore, they were told that all sentences were suspended and would be remitted upon a satisfactory showing during the course of training prepared for them but that any indifference on their part, any failure to meet the snappy standard set for them, would result in their having an extended period of the intensive training.

A system of daily demerits was started and the men were urged to work up to their limit in order to avoid demerits and thereby secure a prompt return in good standing to their company. The point was made that none of the men detailed for duty over

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them welcomed the hardships which such duty imposed but that everyone was actuated by a sense of duty that the schedule would be maintained until every former prisoner showed by his actions that he met the standard required.

In carrying this plan into actual practice the men were handled with the utmost fairness and patience, no profanity nor rough methods were permitted but the greatest precision and snap were insisted upon. When a man did not know, he was taught and was thereafter required to remember what he had been shown.

Whenever the platoon was dismissed from drill the men were not allowed to break ranks but were marched in a body first to the lavatory and then to their quarters to prepare for the next drill or for a meal. They were marched to their meals by an officer or sergeant and they were served together in one mess hall after the main organization had eaten.

During the few brief periods throughout the day and throughout the evening when the men were resting in their quarters they were allowed to smoke or read but no loud talking and no games were permitted. An officer was always present in the room, seated at a table and engaged on any work that demanded his attention. If a man desired to leave the room he was required to state his business and, if allowed to leave, the officer checked him out and he departed and returned on the run. About every second evening night exercises were given; on other evenings the officer in charge gave a talk to such as could keep awake.

The schedule was exceedingly strenuous and made heavy demands upon the nervous and physical force of the instructors, but the results were more than worth the energy expended.

The point that appeared to make the deepest impression on the men was the fact that they were not left to themselves for a moment during the 16 hours or more covered by the daily schedule. They could stand the work, they didn't mind the drill more than soldiers usually do but they hated the idea of not being able to relax and "rough house" or "shoot craps."

Three days of such a régime is believed to be equivalent to a sentence of several weeks in the average guard house. The best men can safely be released within three days; the worst will hardly require more than a week or ten days before they "see the light." It has also been found after several experiments that the repeaters for this form of disciplining are extraordinarily rare.

As stated, all agencies throughout the regiment were brought to bear on the men in the disciplinary platoon in the endeavor to bring these men back to a normally good standard of behavior. It was noted first that nearly all of them were untidy in their appearance and wore disreputable looking uniforms. The supply officer was thereupon required to outfit them completely with the best clothing and equipment available. Once equipped the men were required to take care of the property entrusted to them and with this end in view there was held a daily inspection of arms and uniforms.

Acting on the well established theory that a man's poor physical condition is often the cause of misconduct, the medical officer was urged to find out what was wrong with the physical mechanism of the individuals in "J" Company. This also applied in the case of dental treatment—the dental officer being given to understand that if pulling teeth would make a good soldier, there were several candidates in the "J" Company group who could afford to lose their entire dental equipment!

Laying all levity aside, the writer submits that the question of the proper handling of delinquents is one of the most important that can be presented to an officer in command of troops. The system of treatment described herein has been proven in actual practice but its administration requires patience and tact and makes heavy demands upon the physical strength and nervous energy of all men charged with this duty.

Many soldiers find the montony of the normal drill schedule very irksome and as a consequence they are discontented or indifferent. A tour in "J" Company serves to show such men how much harder their lot might be made on strictly military lines.

This plan is a great remedy for an epidemic of summary court cases and for an overtaxed guard house.

Discussion

Lytle Brown
Lieutenant Colonel, Corps of Engineers
formerly Brigadier General, Chief of War Plans Division

The author has indicated that the training of troops in the immediate future will not have the stimulus of war conditions as was the case in 1917. All who direct or are responsible for training should realize the difference and act accordingly. The work will not be done with as much spirit, and the identical measures used in 1917 will not serve now. The men cannot be held to the work as closely as was the case during the war. There must be more recreation and amusement, less severity; better judgment on the part of instructors, and more tact on the part of all concerned.

Superiors must concentrate attention on the unit schools for the preparation of competent instructors—commissioned and non-commissioned—to prepare them for their duties, as proper vehicle for carrying the instruction to the men.

In order to foster and promote organization spirit and emulation, and place responsibility where it belongs, as well as to secure initiative, as much instruction as possible in strictly military duties should be conducted within the company. In the recent experience the tendency was otherwise for obvious and good reasons, which now do not

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or should not long exist. Trust the company commander to train his men; if that can not be done there is something the matter with one authority or the other. The inspection for results may be as detailed and as vigorous as desired. Before drawing men out of their companies for instruction by special instructors be sure that there are the strongest reasons for so doing. It is as a practice not conducive to the best general results in the long run.

The guard house, nor any special arrangement, is not good for discipline of minor offenses; that should be a company affair—but the company should handle it thoroughly, *more as a matter of instruction* than for punishment. I concur in general with the author, but do not favor a special company nor a large number of offenders gathered together either in the guard house or elsewhere. The treatment is good, but I prefer it in the company and administered by the captain and his subordinates who are always present and who are best informed and most interested.

Often before the war I have seen the responsibility of subordinates usurped by those in higher authority; have been guilty of it myself to my own discomfiture, but believe that it was often done in training, with reason, during the war. The temptation to do so should be strongly resisted; but the determination to fix that responsibility and hold it fast where it belongs as well as to constantly verify the results can not be too strongly held.

I am led to these remarks by the author's reference to special instructors, and by what I know of my own tendency to make use of them. Present conviction is that the special instruction method is very easily abused, and tends toward unsound practice, based on the supposition of incompetency somewhere down the line.

M. J. McDonough
Colonel, Engineers
formerly Commanding the 114th Engineers, and Division Engineer, 39th Division

I heartily concur in keeping the guard house empty. This institution is the lowest in corrective value, its use properly is either punitive or preventive, but it often tends to harden young soldiers in evil ways. My experience for many years is that captains generally speaking are too prone to send a man to the guard house, lieutenants are even worse than captains. The average soldier is not vicious, the great majority of his sins are minor and even unintentional. Rather than put him in the guard house the captain should be encouraged and even compelled to exercise ingenuity in his corrective discipline. If space permitted I should like to write a brief memorandum on punishments other than guard house confinement. [Colonel, we would like to have this.—Ed.]

For instance, for mistakes in connection with guard duty let the offender be required to write out five pages of the guard manual each day, in all fifty pages. The writing should be handed in daily without fail to the commander. For drinking offenses it may be practicable to compel the culprit to send to his mother ten or fifteen dollars next pay day. [Some other method of giving money to mother must be provided for these dry times.—Ed.] For repeated lates the wood pile is excellent. For uncleanliness in the toilets or latrines let the culprit clean the same for a given period. Confinement to the tent or barrack only irritates all parties concerned; I find it a poor punishment, because it is too slow and negative. Where the culprit is truly penitent it is often wise to suspend all punishment for a month with the promise that if he sins again he will answer both charges and if he does not sin again within the month all will be forgiven. This is a common practice in civil life. Ridicule is a powerful corrective weapon, but should be used carefully. Except for desertion, theft, and grave cases of moral turpitude, the general court martial should be almost unknown. Punishment should be summary and as nearly practicable appropriate to the offense, having in view that "object all sublime to make the punishment fit the crime." For a vast number of minor offenses a severe "tongue-lashing" by the captain is better than anything, this implies that the culprit is truly sorry.

The use of "J" Company is very interesting and is new to me, I should think it would work very well; it requires good officers who are devoted to their duties.

Commanders are advised to obtain as much first hand information of their men as practicable; this can be done in an infinite variety of ways. It implies that the colonel or captain shall talk to the men a great deal—at inspection, on the drill field, in the office, on the march and so forth. Sometimes when the talent is low the captain may complain to the colonel that he hasn't one man who can be the company clerk or who can fill this or that job. The colonel may have noticed a 1st class private in the company who kept and owned a general store in his home town. The colonel then tells the captain to look over his talent more carefully, giving the captain only a hint as to the man. When the captain realizes that the colonel excels in certain detailed knowledge of his own company he usually wakes up. I have never countenanced the practice of requiring a soldier to obtain the 1st sergeant's permission in order to interview the captain. Each soldier should have free access to the captain without going through intermediaries. The captain gains in intimate knowledge and control of his men by close personal contact. Likewise, the adjutant should not act as insulation to the colonel. I allowed and invited an officer or soldier to see me at any time on any business without the use of the adjutant; thus the colonel gains greatly in detailed knowledge of what is going on under him. The confidence of the men is also gained.

Knowledge by the commander is gained in no way better than by frequent inspections of everything. The colonel should spend more for shoes than for trouser reinforcement.

To increase accuracy among officers, it is well that the colonel send officers to make inspections of all kinds and then frequently follow up himself. His immediate knowledge will then check the accuracy of his subordinates' reports as well as their powers of observation. He also freshens his own knowledge of what the regiment is doing.

In these days there is a tendency to enlist boys. These boys are incapable of performing full duty or of understanding discipline, they are wholly useless and if enlisted they ought to be discharged. It is impracticable to allow them to break discipline and yet it is sinful to punish these immature youths.

Night schools for all ranks are a powerful means of promoting efficiency. Lessons should usually be assigned in advance and the class held responsible. The recitation usually was followed by a brief written test of five or ten questions. The advantage of the questions is that it makes every individual express his opinion or his knowledge in writing, he cannot escape or bungle it. The papers can be marked by a detail of instructors; another quick way to mark is for each man to exchange his paper with his neighbor, each question is then marked according as the instructor announces the answer.

Proper execution of guard duty is the criterion for all other discipline, it should receive immediate and vigorous attention. If the guard detail be a platoon with its own lieutenant responsibility is well fixed and the regiment quickly reaches a high state of guard discipline. If the commander of the guard has his own men rather than a

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mixed detail from the regiment, he can be held to high responsibility because he instructs his own men in guard duty at all times in connection with drills; he is thus not limited to guard instruction when on actual guard duty. Guard duty should be executed literally according to the manual and with the utmost snap. The usual theatrical variations of this duty which new troops introduce should be anticipated by the officers and vigorously routed.

J. L. Schley
Colonel, Engineers
formerly Commanding the 307th Engineers, Division Engineer 82nd Division, and Corps Engineer, 5th Corps, A. E. F.

Colonel Finch's remarks are very interesting and contain useful suggestions. The following points on troop training seem worthy of special emphasis:

The Engineer Training Manuals, 1917, served a very useful purpose during the training period of the draft forces. These manuals should be revised in the light of the experience of the war.

Special instruction, theoretical and practical, should be given to officers and non-commissioned officers regularly throughout the training period.

Short talks should be given to the men by the unit commander. In this way his spirit and ideas are transmitted directly to the men.

The present strength and equipment of the engineer regiment make it necessary that it be given enough infantry training to give a good account of itself when acting as infantry on the offense and defense.

I agree with Colonel Finch in emphasizing the recommendation that general pioneer training should be given to the entire personnel of a regiment, and that special training should be given to selected men. I assume, however, that these selected men for the more technical training would first receive the preliminary infantry training which the entire organization must be given at the outset for purposes of discipline, set-up, and the other rudimentary developments of a soldier. After the selected men have received their special training, the special training can be extended to other men.

The technical instruction should be conducted at first under specialists by battalion or regiment. When a certain degree of proficiency has been reached, the men should be returned to the company to apply what they have learned to practical drills under the company commander.

In assigning the specially trained men to companies and platoons, it must be remembered that platoons often operate independently, and each platoon may be called on to perform many different kinds of special work.

Careful thought is necessary at regimental headquarters in order to prescribe what is wanted without destroying the initiative of the battalion and company commanders in training their units. The latitude given to the commanders of the lower units should be increased as the training progresses. I think it advisable, even during the early days of training, to set aside a portion of the time for the battalion commanders and company commanders to have their units for such drills and exercises as they wish to prescribe.

This brings to mind the existence of a tendency on the part of regimental commanders to look on the regiment as a unit composed of six companies instead of a unit of two battalions of three companies each. In active operations, the battalion is an important unit.

Colonel Finch properly lays stress on the question of the proper handling of "delinquents." Instilling a high degree of discipline and maintaining it in an organization is undoubtedly one of the most important and difficult problems which confront a unit commander. It is believed that no standard procedure can be prescribed and that the individuality of the units and of their commanders must be studied carefully as the unit develops, in order that the most effective means to the end may be applied.

I can give further testimony to the successful use of disciplinary units. I can conceive of conditions under which it would be advisable to have disciplinary units in the smaller organizations of the regiment instead of a single unit for the regiment.

Colonel Finch's remarks on the relation of the guardhouse to this problem are undoubtedly along sound lines.

In adopting methods for maintaining discipline and in prescribing drill schedules, it is necessary to take into consideration the character and the spirit of the organization. By "character" is meant that deep-rooted quality of a unit which depends on such features as the kind of commissioned and enlisted personnel of which it is composed, their length of service and perfection in training and in discipline, and their sense of loyalty and service. By "spirit" is meant that more changeable quality of a unit which depends on such features as living conditions, weather conditions, the current training schedule, disciplinary treatment, and the type of men who assume what may be called the unofficial leadership among the enlisted men. Units are not alike. They have individuality. I feel that it cannot be too strongly emphasized that the characteristics of a unit must be studied at all times and the results of these studies should influence the drill schedules and the methods of maintaining discipline.

E. J. Atkisson
Colonel, Engineers
formerly Commanding 30th and 1st Engineers, A. E. F.

The absence of prospects for immediate war service should not be allowed to alter or change the spirit of instruction. From the day a recruit reports until the day he is discharged, he should feel and later know and understand that every duty and drill is better fitting him to meet the real tests of war. This point must not be camouflaged, whether in doing the many odd jobs which fall to the engineers in a division (similar work has to be done in time of war) or in vocational training. Men skilled in the trades are essential in war, train them accordingly, and consider it fortunate but of secondary importance that this training is also useful after the men cease to be soldiers.

Seven years ago, few of us really believed we would ever be called upon to train and probably lead troops against the veteran forces of Germany. This experience should make the spirit, the very foundation of our training, that of fitness for actual war service. It should not be implied, it should be a real living thing, which inspires the instructor and is transmitted to his men. It makes discipline mean something and furnishes the reason for exact performance of even the most trivial duties. If men can be made to do the "little things" right, and to realize their importance, the "big things" are provided for, since they are made up of little ones.

In the preparation of schedules there should be one, underlying the detailed schedules of the month or season, which is progressive throughout a period corresponding to the enlistment. Certainly each man can learn something new which will make him a better soldier, every day of his enlistment, if the instruction is progressive. This is certainly sufficient to justify the additional work necessitated by progressive instruction. It also emphasizes the importance of keeping the same officers on duty with units for a considerable period of time.

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The use of enlisted specialists as instructors is desirable and undoubtedly must be resorted to in any case, due to shortage of officers. But it is considered of special importance that this work be closely supervised by officers, and that these officers be thoroughly competent to supervise. The troop commander's supervision and training of his officers will have much to do with the success of the training of the men. It is considered especially important that company and platoon commanders should have much experience in handling their men, both in routine and special work.

Engineers have much special work to do outside of routine instruction, such as road repairs and signs, bridge construction, athletic field construction, operation of utilities, and many other miscellaneous jobs. This is considered an advantage and should be solicited, provided it is handled as an important part of the training, and not turned over to some old reliable non-commissioned officer and a fatigue detail as a side issue which unfortunately must be attended to even though it interferes with regular instruction. When the request for a particular job comes to regimental headquarters, formulate the necessary work order, making the assignment to an officer or non-commissioned officer who will profit by the experience. Follow his work through his plan, estimates for men, material and transportation, handling of job, completed work and final report. Give the next job to a new man. In the operation of a utility requiring a continuous detail, rotate the men so that a particular man will remain in one position only long enough to thoroughly master its requirements. Use it as a training center.

In recruit instruction as well as in later instruction and work, I agree with Colonel Finch in giving the men definite reasons and clean-cut explanations of the methods to be used. Invite comment and questions. The training should develop a proper self-confidence and ability to assume responsibility.

In target practice, I have had an opportunity to observe a course of instruction given under the personal direction of Colonel A. J. ("Sandy") MacNab and to hear his comment on the subject generally. This course was given to the infantrymen from the last class graduating from the Military Academy. Every man qualified and the average of all scores was above the expert rifleman requirement. Several points with which I was not previously familiar are as follows:

(1) The sighting and aiming drill (triangle-exercise) was carried out at 200 yards, using an 8-inch disk. This gives the man a true conception of how the target will look when he goes on the range, does not require a readjustment, and having qualified in the triangle exercise, the indistinctness of the bull does not give him concern.

(2) Careful instruction was given in the manner of taking up the correct positions and the method of trigger squeeze. Further time is not spent on this work except during actual firing, when the coach makes the necessary corrections. Trigger-squeeze exercises are not used in preliminary instruction or on the range.

(3) Every shot in preliminary instruction is fired under the supervision of a coach and the men are required to coach each other. No men are allowed to idle around the firing point. With this class, pistol practice was carried on at the same time, and men not actually firing or coaching spent their time on the pistol range rigged up at the side of the particular firing point in use.

(4) Great use was made of dummy cartridges, in both slow and rapid fire. A special dummy made from service ammunition was used in rapid fire.

Colonel MacNab states, with reference to correcting trigger-squeeze and preventing flinching, that by this means alone men will average better scores at rapid fire than at slow fire. Firing in which the coach squeezes the trigger was also used.

One of Colonel MacNab's reasons for the differences between this system and previous systems is very pertinent and is as follows:

Any man who is physically able to walk to the firing point has all the strength necessary to make a score well over 40. If he is making very low scores it is because he is not aiming and squeezing the trigger properly. To give him push-and-pull exercises is no more beneficial than to have him take a trip in a balloon or ride in a sight-seeing automobile, or do any thing else except to learn to hold his aim while he squeezes the trigger in the right way. To take a man who is making a low score off the firing point and give him "push and pull" with a view to improving his score is about as sensible as to have him skip rope as a means of teaching him how to remove a tire from an automobile. Good physical condition is of course an asset to an excellent shot, and physical exercises may help him to raise his score from an average of 47 to an average of 47.5, but physical exercises will not help in the least degree a man who is averaging under 40. Each man undergoes all the necessary muscular training while he is being taught to aim, how to take the correct positions, how to squeeze the trigger, and in acquiring a habit of smooth and rapid bolt manipulation.

It is believed that group athletics, as developed by the War Department, should be included in all schedules of training. They can be made interesting and all the men are reached.

Special emphasis should be placed on the importance of the closest personal supervision and interest of all officers, in the mess, clothing and equipment, bathing, guard instruction and recreational features.

Colonel Finch's guard house administration is considered especially good where conditions, personnel and facilities exist to carry it out. I used the following system with considerable success. A special officer, the adjutant in this instance, made it his business to study each case, get at the bottom of the particular man's trouble, learn his weakness. He soon was ready to recommend that the man be put on probation in some particular job, or assigned to a company in which the company commander knew how to reach such men. One man who failed to respond to treatment I took as my personal orderly, had him properly outfitted and except for one slight relapse he continued to make good during the remainder of his service.

C. P. Gross
Captain, Engineers
formerly Colonel, Commanding the 318th Engineers, A. E. F.

I do not share Colonel Finch's hope that recruits will come to the regular army in such large numbers that the conditions of training will approximate those that obtained in 1917–1918. Under a system of universal military training, these conditions, however, would again prevail.

Colonel Finch's pointers are in the main concurred in. However, I am not inclined to be so kindly. I would not encourage my officers to "pass the time of day" to the men. Nor would I permit recruits to choose what they would do first where they have two or more things to do. It has been my experience that the familiarity of the recruit has to be curbed rather than encouraged. A recruit passed me one day coming from the post exchange, with cigarette in his mouth and hands in his pockets. I wheeled, calling, "You man, with the cigarette in your mouth." He

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turned, and with an engaging smile, drew a package of Fatimas from his pocket, offering it with "Here, have one." It is difficult to teach the average American obedience. I do not believe it wise to permit him to have a choice other than in voluntary subjects, not required of him as a duty. I would not define any of the duties of a soldier as "degrading work" and exempt prisoners from performing it on that ground.

Colonel Finch's "Guard-House Administration" I think is excellent. While the number of prisoners in the guard-house is significant, there has been a tendency to regard it as indicative of the discipline of a command, and to call a regimental commander to account because his guard-house has more prisoners than that in another regiment held up as an example. If that is the view taken, how easy it is to secure a rating of 100 per cent on the discipline of a unit. (In truth, the fact that there are prisoners in the guard-house is a sign that discipline is exercised.) As in times past discipline is based on the hope of reward and the fear of punishment, and of the two, despite the wave of sociological effort, the latter seems to be the more effective.

The pioneer regiment in war always works and sometimes fights. It should be trained for both. Its excellence, either working or fighting, depends on its discipline, its organization for the duty in hand and its morale. Morale is dependent in part on the other two, on the knowledge of excellence, and is here not considered further.

Under intelligent drafting or assignment of recruits, engineer regiments receive the specialists they require. They can not make them. The task is to discipline them and to organize them. Vocational training, as far as the organization is concerned, is a liability. It will not produce specialists for the regiments in numbers to justify it on that ground. Artisans are not made in a school year. It merely provides a means to the individual soldier of utilizing his spare time by learning a trade from one of his fellows who acquired his skill generally before entering the army. To that extent, of course, vocational training is excellent.

Discipline can best be obtained by intensive infantry training. That is well recognized and provided for in the training manuals.

During this early infantry period, the trade qualifications of the recruits should be indexed, both in the company and in regimental headquarters, preparatory to the engineer training. Headquarters should know from that time on that they can turn out 60 carpenters and who they are by name, 44 truck drivers, 35 miners, etc. The company commanders should then use this information in organizing their platoons and in selecting men for special engineer training.

It is not believed that in the past our engineer training has been carried to completion. It has not provided training in organization for real work. The tendency has been to establish a school system—a "vocational college," as Colonel Finch calls it. That is excellent if we provide for a graduation from the school and have the unit plan and perform real work.

The 318th Engineers, after an uninterrupted period of training, following a school system in the states, arrived in France two months in advance of its division. During that period it was assigned to the Division of Construction and Forestry and worked at Gievres, Mehun, and at Montierchaume, laying railroad tracks, building wood and steel warehouses, constructing water tanks, laying concrete, building roads, etc. It was ideal training because it brought to the officers and men definitely the knowledge that they *could* perform. Officers were developed in planning work and organizing their men for it. The work showed up the skilled and reliable men of the regiment as nothing else had previously done. That training proved invaluable. The confidence gained by the officers in themselves and in their units led them to engage in tasks at the front from the start with dispatch and skill. Such work for a short period hurts the military courtesy shown by a command. However, it improves its real discipline, for it teaches the men to form for organization around their leaders and to perform work as a unit.

Now, in the normal training of our pioneers, no such instruction is given. Work as extensive as that mentioned above, of course, can not often be provided. Work of this nature in the past has been possible only in exceptional cases and then not encouraged. Its encouragement, it is believed, should be definitely made a matter of policy. Military mapping, logging in woods, building roads, constructing bridges like the one at Fort Riley, fortification construction, give the training that rounds out the unit. Funds are frequently necessary and should be allowed liberally for that purpose. It is appreciated that work of this character, if too long engaged in, is harmful, injuring the organization as a fighting unit. However, with such instruction for two or three months each year to try it out and complete its training, it is believed the engineer unit would render better service when facing its real duties in war.

E. C. Kelton
Major, Engineers

This article has many points which it is believed should be emphasized even more strongly than the author has done. One of these is the importance of training engineer troops in conjunction with infantry.

Fortunately for the good of the army as a whole, we at last are to have divisional camps, where will be located under one command troops of the infantry, artillery, signal corps, engineers, medical corps, etc. This permits the formation of a fighting unit, the elements of which, provided they are properly trained together in time of peace, will know what is expected of them in campaign and what they in turn can expect of the others. In time of war nothing is more important than that the different branches of the service understand exactly this point. Combined with it there must also be a spirit of co-operation and mutual esteem which can only be accomplished by establishing friendly social relations between the officers of the various units.

This friendly relation is especially necessary between the engineers and the infantry. Some engineers believe that it is not their function to help the infantry in special work; that it is not their place to help improve the camp of a neighboring infantry regiment, or even to send an officer or qualified non-com to the other camp to give technical advice on some minor engineering point. Such should not be the case. If there is a target range to be built for the division or even for one particular infantry regiment in the division, the work should come under the province of the division engineer. An officer of the engineer regiment should be in charge of the work. Sufficient engineer soldiers should be employed to care for the tools and perform any special work that may be required, such as carpentry work, sign painting, laying out of drainage systems and supervising the infantry working parties. The engineer regiment is thoroughly equipped to do this sort of thing and will be called upon to do it in time of war. Why, then, should not this necessary work be used as a basis for the instruction of the officers and soldiers of the

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regiment? It is realized that there are some practical difficulties connected with the plan due to the shifting of personnel in order to give the whole regiment an equal amount of training in all subjects but it can be accomplished if the companies are rotated upon the tasks as they come up.

Considering the problem from the purely instructional side, much may be gained by having the engineers enter into all the maneuvers of the infantry. To do this it will be necessary for the regimental commander to know what is going on in the division and be ready with schemes by which the maneuver can be changed slightly as to time or location so as to include certain engineer problems. During several months at one of the large corps schools in France, I was fortunate enough to be able to put these principles into practise. Each month, several days were devoted to maneuvers which combined the functions of the infantry, the signal corps, air service, artillery and engineers. Arrangements were made by which the maneuver was made to take place over ground which required the bridging of a stream and the construction of a small piece of road. On the day before the maneuver, application was made to the aeronautical school for aerial photographs of the ground over which the advance was to be made. From these, sketches were prepared showing the exact location of the bridge. Engineer orders were issued, based on the general orders for the maneuver. At H hour the engineers started to put the bridges across the stream protected by the barrage of machine guns, 37 mm. guns, Stokes mortars and thermit bombs, the last being handled by the students of the gas school. As soon as the foot-bridges were across the stream, the infantry advanced to the attack. The foot-bridges were then replaced by heavy ponton bridges. There is no reason to believe that the same sort of instruction could not be carried on in the divisional regiments in this country, especially at the present time in the big camps where there is (or should be) engineer material ready for use.

Colonel Finch's remarks on the subject of recruit training are full and convincing. It is believed, however, that more stress should be laid on the importance of properly selecting the n.c.o. to train the new recruits. The first month of a recruit's life in the army is by far the most important. It is believed that he should be sent quickly to his regular organization and then receive instruction heretofore ordinarily given in the recruit depot. Having joined his own company and regiment the recruit is at once taught the traditions of that regiment, his thoughts are for the regiment and he works for the good of the regiment from the very first. *Esprit de corps* is thus instilled in him in the shortest possible time. This being the case it is seen how important is the task of the n.c.o. in charge of the recruits. The company officers can do their part, but it is really the non-commissioned officer who moulds the mind of the recruit at this impressionable period. He is with him on the drill field, at meals, when he is cleaning his equipment, his tent, or squad room, he is the one of whom the recruit asks questions concerning all the strange things that he is hourly learning or seeing. To him comes the recruit to ask the proper manner of approaching the captain, to ask what he is to do when an officer passes; what is the reason for the salute, etc. To answer all these questions tactfully, to gain the respect and at the same time the confidence of the recruit, to insure his absolute obedience and yet make him feel free to come and ask such questions is a difficult task. But that is what is required of the recruit instructor and he must be selected with these points in mind.

Too much cannot be said in favor of the plans suggested for reducing the guard house "population." The "J Company" plan referred to in the article was put into effect the day before I rejoined my regiment. Most of the officers never having seen the scheme in practise were most skeptical as to the results. However, in a very short time they were all enthusiastic in its support. On the other hand, it must not be forgotten that there are certain offenses which for the good of the regiment and discipline generally require the use of the court-martial and severe punishment.

R. G. Moses
Major, Engineers
formerly Commanding 601st Engineers, and Commandant, Engineer Candidates School, A. E. F.

This article, I am sure, will be welcomed by all officers and especially by those who have command of troops just at the present time. The suggestions herein will be thankfully received by those who are hard pressed for expedients to keep up the morale of the men in their organizations. Since, as Colonel Finch states, in the depleted organizations of to-day a large number of the personnel are recruits, and they will be brought up to full strength by recruits, pointers on recruit training are particularly valuable.

Short, snappy and progressive drills have clearly demonstrated their superiority. Ordinarily, drills of one hour or less enable the instructor to cover a complete section of the subject at hand. It should be left to the discretion of the instructor to dismiss his platoon ahead of time when the work for the period has been covered thoroughly and the men have done particularly well.

The two group system works well and the "slow ones" should be given extra work to bring them up to the standard. This system also appeals to the pride of the men.

Thorough preparation by the instructor for the next day's schedule is most important. Only by the careful selection of instructors and their assignment as specialists, as Colonel Finch says, can the best results be obtained. These instructors are able to develop the fine points of the work, are able to criticize more closely, and give more real help to the individual. It was clearly demonstrated at the Engineer Candidates School in France that the "specialist," or man who was particularly well qualified to teach a certain subject and who developed himself in it, accomplished far better results than the average or "general" instructor.

Every man wants to know why it is necessary for him to do certain things, and when he knows, he does them more efficiently and in a better spirit. This is a matter of the utmost importance. If the reasons for things are not explained the men too easily come to believe that everything is unnecessary and a waste of time. If they can be convinced during their period of training that they are never called upon to do anything that is not vitally necessary, they can then be depended upon to do their full duty at all times. In the stress of battle there may not always be an officer at hand to keep the men up to their work and they will not always understand the reasons for what they are told to do. But if they have been properly taught they will have faith that nothing unnecessary is ever demanded of them. They will say to themselves: "We cannot see the reason for doing this just now, but the captain told us to do it, and we know he never asks anything unnecessary." By establishing friendly relations with the men through "friendly words," better co-operation will be obtained; questions will be asked and answered, and interest aroused. Each man can easily be made to feel that the instructor has a personal interest in him, by the attitude of

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that instructor. Short talks or conferences are particularly valuable.

A system of marking proficiency by the men themselves was used successfully where the men were officer candidates. The same system is of value with recruits, although it is not practicable to use it to so great an extent. The recruit should be taken out of his squad or section and told to give each man a rating after watching them drill for some time. This causes the recruit to look for mistakes and to see the small things which are essential to good performance. Most men involuntarily apply the things they have seen to themselves, and correct many faults in their own work.

As stated by Colonel Finch, efficient shooting on the range is very valuable in keeping up the morale of an organization. Thorough preparation of schedules and instructors before the season begins is extremely important. I have seen a company of engineers make the eighty per cent qualification said to be "thoroughly practicable." The obtaining of this result was clearly assisted by having "specialists" see that no man took the next step in the schedule without being checked as proficient in the preceding one. Patience and thoroughness in instruction are necessary for the instructor. It is particularly valuable in this instruction to show the recruit why he is required to hold the rifle and take the positions in prescribed ways.

Lake Erie-Ohio River Barge Canal

Governor Cox, of Ohio, approved on Feb. 20th the Bellew-Pearson bill, providing for the creation of a canal zone to aid the Federal government in constructing a barge canal between Lake Erie and the Ohio River.

The bill provides in detail for financing the undertaking and for all administrative matters, and for enforcing its provisions.

The gist of the bill is contained in Sec. 2, as follows:

SEC. 2. That whenever the Congress of the United States shall authorize (the construction, maintenance and operation of) a canal or waterway along a substantially definite route situate either wholly within the State of Ohio, or partly within the State of Ohio and partly in some other State or States for the purpose of connecting the Great Lakes with the Ohio River or its tributaries so as to provide a route for the passage of steamships, barges or other vessels from the Great Lakes to said Ohio River, and shall make an appropriation or appropriations for the construction, maintenance and operation of the same on condition that the State of Ohio or any part thereof shall contribute a certain part of such cost of construction, then the lands within the zone described in Sec. 3 hereof, all of which said lands will be specially benefited by the construction of said canal, and by the operation thereof, may be organized into a canal district in the manner hereinafter described, with all the rights, powers, liabilities, organization and administration as in this act set forth.

Northampton County Federal Road Project

This project is located in Northampton County, Pennsylvania, and is the generally recognized standard 18-foot, two-way traffic roadway, 5.45 miles in length. In general the location follows an old right of way but the original alignment has been improved, sharp curves eliminated, and reasonably long tangents introduced. In one of the relocations advantage was taken of a high railroad crossing over a small creek to eliminate a grade crossing. Savings in distance on relocation was also based on the comparison of the surfacing cost of $6 per linear foot and the excavation and right of way cost.

The salient features of the design are short uniform gradients, frequent breaks in grade, and long vertical curves. The adjustments of the grade line was also influenced by the fact that, generally speaking, hard surface pavements have given more trouble on deep fills and deep cuts than where the original ground surface has been slightly disturbed. Consideration was also given to the impression that the less cutting therein done the better both from the standpoint of the safety of the pavement and of the traffic passing over it. The ditchless cross section, advocated by those who consider a heavy ditch dangerous to fast moving traffic, was adopted: extensive tile drainage and careful maintenance provision control the effectiveness of this section. The surface is concrete with 8-inch center and is of 1-2-3 mix.

The contract was let for approximately $320,000. The maximum use is made of machinery and particular attention is paid to the accurate cutting of the road bed, rolling the fill in layers, and protection of the concrete until it is cured. Since the concreting began the mixing plant has worked 30 out of 31 working days and has averaged 240 feet of 1-2-3 concrete pavement 18 feet wide and an average of 7.33 inches thick per day with a force of 8 men on the mixer, 6 men on the material piles, and 4 men on the trains.

The above is taken from *Public Roads,* issued by the U. S. Department of Agriculture, Aug.-Sept., 1919.

De Havilland "Fours" Equipped with Eight Machine Guns

The Engineering Division of the Air Service at Dayton, Ohio, has remodeled four DeHavilland Four airplanes to carry a total of eight machine guns each. The DeHavilland 4's now carry two fixed synchronized guns, two fixed Marlin guns projecting through the floor of the pilot's cockpit, firing at an angle of about 45 degrees, two flexible guns on the upper gun mount, and two Lewis guns in the floor at the rear of the observer's cockpit. In several of these airplanes these lower rear Lewis guns are fixed while in others they are mounted on a sort of a floor turret which allows them to be directed by the observer.

In all of these airplanes the arrangements of the guns are such that the pilot can direct his airplane in such a way as to fire his synchronized guns directly at the object to be attacked. As he gets closer to the object and can no longer fly directly toward it he raises his nose slightly and flies horizontally, firing the lower forward guns at the target. After he passes over the target he brings his lower guns to bear and as he then begins to climb away from the ground the observer can fire his flexibly mounted Lewis guns at the target; thus the pilot and observer have four sets of guns shooting at the target at different times as the airplane passes over.

Suitable sights are provided so that by maneuvering the airplane the pilot is able to aim accurately all of the fixed guns while the observer is able to direct the fire of the flexible guns. The completed airplanes now at McCook Field are to be sent to the Border for service tests.—*War Dept. News Bureau.*

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Pipe-line Dredging in the Open Gulf of Mexico

Atchafalaya Bay Ship Channel

By

T. E. L. Lipsey

U. S. Assistant Engineer

THE following is a description of the work done by the U. S. Dredge *H. S. Taber,* on the Atchafalaya Bay Ship Channel, under the direction of the U. S. Engineer Office, New Orleans, La., from December 2, 1918, to April 5, 1919.

The *Taber* is a 24-inch hydraulic dredge of the self-propelling, stern-wheel type, designed for work in the Arkansas River. The hull is of steel, 206 feet 9 inches long, 44 feet 4 inches wide, and 7 feet deep, with 3 feet 7 inches draft. It has one 24-inch centrifugal dredging pump, driven by a triple-expansion engine. The suction-pipe has what is known as a dust-pan head, with a system of water jets for agitating and disintegrating the material to be dredged. This dust-pan head is 20 feet wide, and can be lowered to a depth of 14 feet below the surface.

The dredge cannot be swung while in operation, but is pulled straight ahead, making a comparatively narrow cut. The discharge can be arranged so as to leave the dredge from either side a little forward of midship. The discharge line is a very heavy pipe, in 50-foot sections, each on a turntable on the center of a steel ponton. The connections between the pontons were rigid when the dredge arrived in this district, but were afterwards modified as herein described, to meet local conditions of exposure.

The dredge was transferred to this district from the Kansas City District, leaving there on August 20, 1918. The plant stopped at the mouth of White River en route to do some dredging, and arrived at Plaquemine, La., on September 28, 1919. As the dredge was to work on the Atchafalaya Bay Ship Channel in the open waters of the Gulf of Mexico, it was decided to modify the ponton pipe-line by removing the large rigid flange connections and providing rubber sleeves in lieu thereof. The result was a pipe-line 500 feet long in sections of about 50 feet, supported on small single steel pontons 12 feet wide, 47 feet long and 2 feet 10 inches deep, all connected in the usual manner. In operation, this line proved to be one of the best ever seen, and was capable of standing the most severe weather and seas.

The work to be done was the dredging of a channel 14 feet deep at mean low Gulf, and 200 feet wide on bottom, for a distance of 15¾ miles in the Gulf, the inner end being 4 miles from the mouth of the Atchafalaya River in Atchafalaya Bay. This is a very exposed locality and the work had to be done during the winter months, in order to prepare the channel for ships being constructed at Morgan City, La., by the Emergency Fleet Corporation. Fig. 1 shows the location of this channel. The winter of 1918-1919, proved to be one of the worst in years, and in consequence of bad weather, and other unfavorable conditions, about 27 per cent of the available time was lost, as will be seen from the records herewith.

This dredge is without spuds, and could not swing as is the usual case with a hydraulic dredge, hence a new scheme of anchoring and moving the dredge had to be devised. This was successfully done by a system of anchors arranged as shown in Fig. 2. A double drum hoisting engine was installed near the rear of the dredge, to operate the rear anchor lines. The forward anchor lines were operated from the main spool of the dredge winding engines. When the dredge was in place for work, the anchors were placed as shown, the dredge was slowly but continuously hauled forward about 1,000 feet, making a cut as wide as the suction head, namely, 20 feet. The dredge was then pulled back to the point of beginning, shifted sidewise the width of the first cut, and the operation repeated until the entire cut 200 feet wide had been made. To make this cut usually took five operations, as the material was very soft and flowed freely from the sides to the suction head. The material was also drawn upwards from the bottom of the cut, making the average cut 2 feet deeper than the 14-foot depth of the bottom of the suction head. In some places the overdepth was as much as 3 to 5 feet, depending upon the depth of the material dredged, being greater for the shallower cuts.

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The pile sinker, which was a part of the dredging plant when received, was anchored in a similar manner to the dredge, and was used to hold the pipe-line straight out from the side of the dredge, the whole line being connected to the dredge by a wire cable which passed along the tops of the pontons. This enabled the ponton line to be held securely when heavy cross seas were running. During very calm weather the baffle-plate, which was placed on the extreme end ponton, was sufficient to hold the line straight. The method of holding and operating the ponton line is shown in Fig. 2. When the seas were so rough that dredging operations were suspended, the wire line holding pontons to dredge was turned loose, and the ponton line was allowed to swing around in lee of the pile sinker, so that it would ride the seas in safety. Due to the shoal water and the extreme depth of the soft mud, it was exceedingly difficult to handle the heavy anchors that were necessary to hold such a large plant in position against the prevailing high winds and rough seas. On several occasions these anchors sank 60 feet into the mud.

To handle the anchors readily, it was necessary to use a large shallow-draft snagboat (the *Denison*) and a 50-horse-power gasoline launch (the *Beaumont*). The powerful rigging for snagging on the *Denison* was very satisfactory for pulling these anchors out of the mud, although the large house combined with the shallow draft made the boat rather unhandy in the wind and sea. However, on the whole, it proved fairly satisfactory. An additional 40-horsepower launch was provided to carry the personnel, mails, and supplies to the dredge. The site of the work was from 30 to 45 miles from the base at Morgan City. All men, coal, and supplies had to be brought from this locality. The remainder of the equipment consisted of two coal barges and two water barges. It should be stated that this work was done during the period of the worst emergency of labor conditions, due to war and draft, and when it was almost impossible to secure men of experience or those who were even worth their hire. Ofttimes they would go to the plant, get something to eat, and return by the next trip of tender to Morgan City. Some trouble was also experienced with steam engineers who demanded the rates of pay adopted by the Steam Engineers' Association. This was overcome, however, by getting the chief engineer to stick, and by having all others rated as dredge engineers, as this designation did not require a license. In addition to this, the epidemic of influenza was at its height during this work, and the dredge at times was almost a hospital.

The plant usually was operated with three crews working eight hours each, but due to shortage of men, the average was not over two crews for continuous service.

The number of men and rates of pay on each plant are shown in the accompanying tables. The ordinary ration allowance was 60 cents per day per man.

The material handled was a very soft mud, mixed with shell in certain portions of the channel. A mechanical agitator was not found necessary, as the jets sufficiently disintegrated the material, and rendered it fluid enough to pass readily to the suction.

The tables herewith show the time lost from different causes, and also the time actually working and pumping.

The total cost of the work, from the date of arrival of the plant at the site, December 2, 1918, to the date of completion, April 5, 1919, including all lost time from all causes, was $59,815.64. The total yardage removed, figured on the theoretical cross-section of 14 feet deep at mean low Gulf and 200 feet wide on bottom, with side slopes 1 on 1 and 1 foot overcut, was 2,480,724, costing 2.4 cents per cubic yard. The actual number of cubic yards removed was 3,202,217, costing 1.9 cents per cubic yard. The above yardage was figured on actual cross-sections taken before and after dredging.

The total cost of bringing plant from the Kansas City District and altering it for work on the channel was $13,808.27. The total gross cost of the work, including all expenses to this district, was $73,623.91, or 3 cents per cubic yard on the theoretical cross-section and 2.3 cents on the actual section.

The largest day's work was on March 22, 1919, when the dredge excavated a channel of the above dimensions 2,000 feet long, removing 82,900 cubic yards at a field cost of $375.00, or 0.452 cents per cubic yard. During this 24-hour period, the dredge lost 3 hours and 40 minutes shifting anchors, and 4 hours "dropping back" to take up new cut and shift over." The pump was actually running 16 hours and 20 minutes. "Field cost" includes payroll, subsistence, fuel, engine room and miscellaneous supplies.

Distribution of time. December 2, 1918, to April 5, 1919.

Time at work.—	Hours	Minutes	Per cent
(*a*) Pumping	556	55	.185
(*b*) Handling pipe-line	10	22	.008
(*c*) Handling anchors	377	14	.126
(*d*) Placing dredge	112	26	.038
Total	1,056	57	.352
Time lost from work.—			
(*a*) Changing location of plant	6	50	.002
(*b*) Bad weather	811	00	.270
(*c*) Out of commission, at nights	296	00	.099
(*d*) Washing boilers	112	45	.038
(*e*) Ordinary repairs	55	11	.018
(*f*) Miscellaneous—taking on supplies, etc.	159	17	.053
(*g*) Sundays and holidays	504	00	.168
Total	1,945	03	.648
Grand total	3,002	00	1.000

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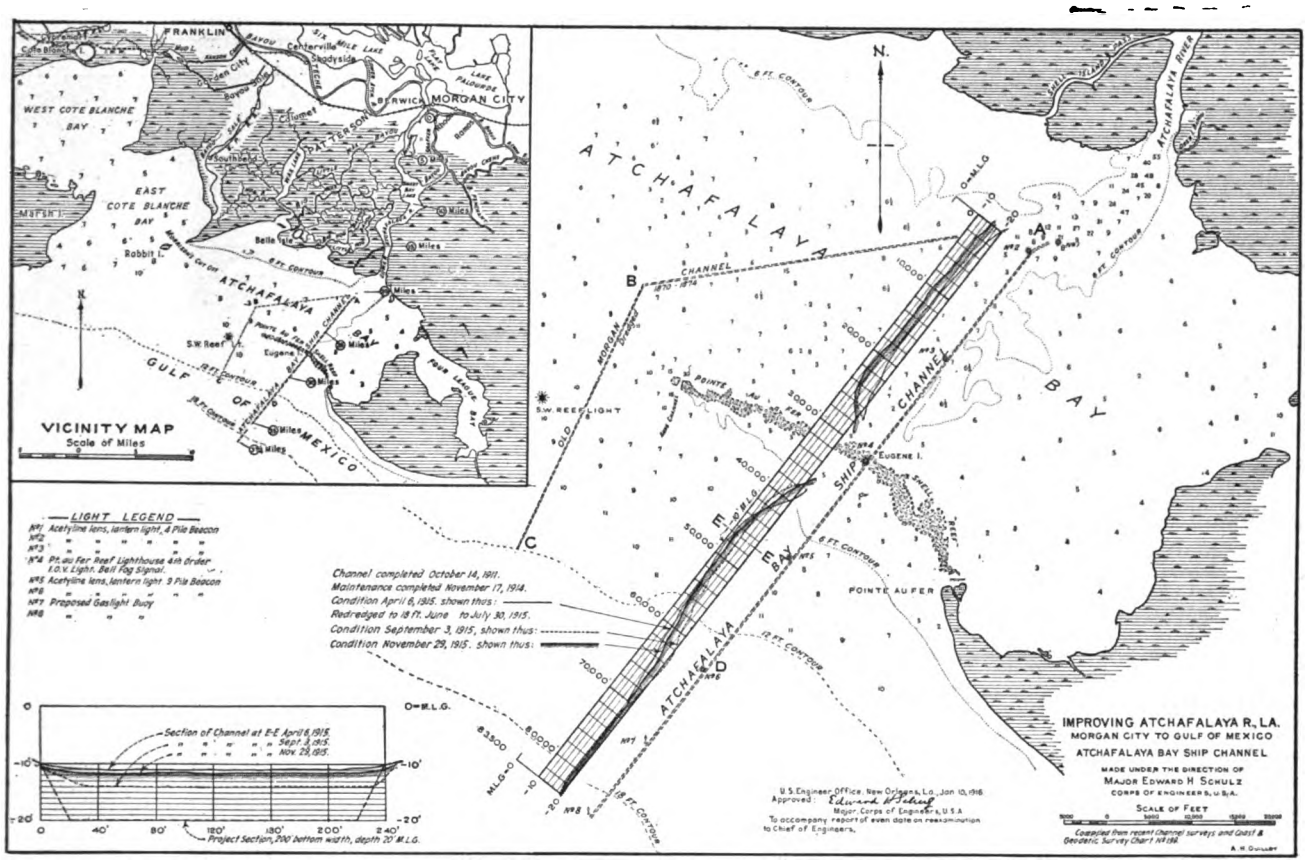


Fig. 1. Index and locality map, Atchafalaya Bay Ship Channel

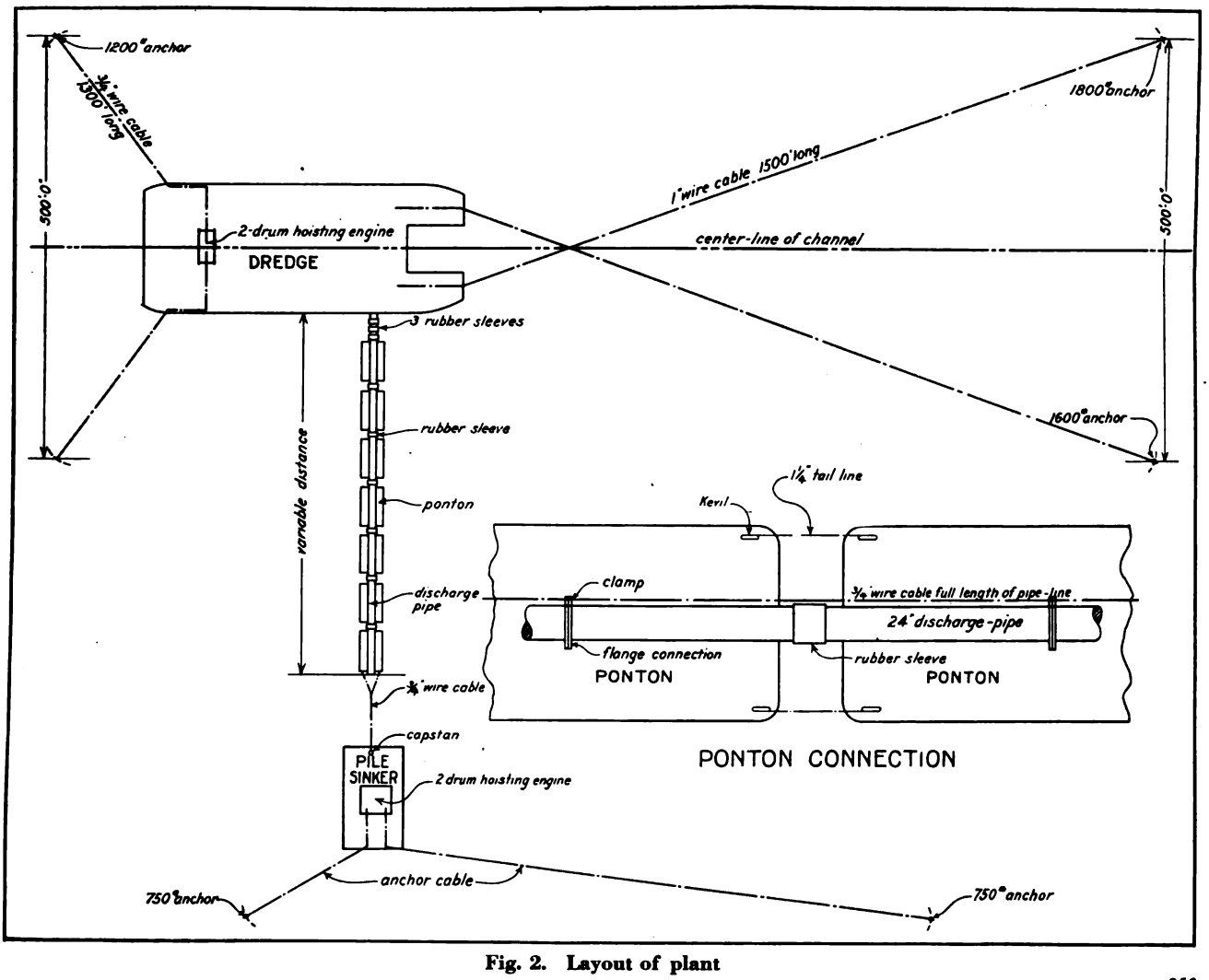
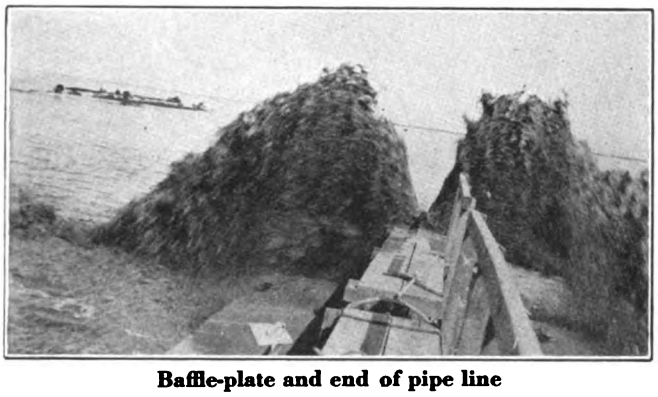
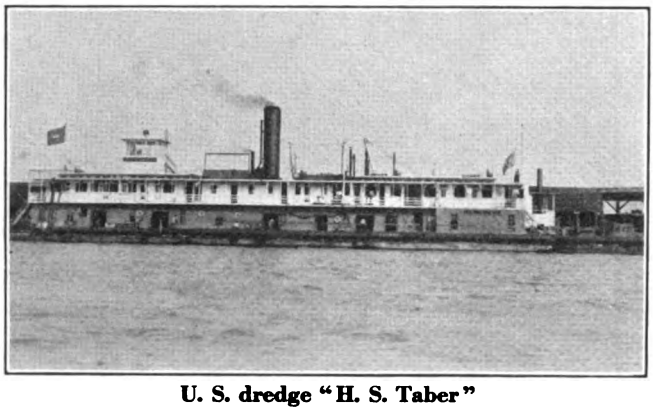


Fig. 2. Layout of plant

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Baffle-plate and end of pipe line



U. S. dredge "H. S. Taber"

Authorized number and pay of employees on U. S. Dredge "H. S. Taber" (3 crews).

No.	Position.	Total Pay (mo.)
1	Master	$165
1	Mate, first	125
1	Mate, second	110
1	Mate, third	99
1	Steam engineer, chief	150
1	Steam engineer, 1st asst.	125
1	Steam engineer, 2nd asst.	105
1	Steam engineer, 3rd asst.	95–99
1	Engineman (operator) first	100
1	Engineman (operator) second	100
1	Engineman (operator) third	100
3	Firemen (pile sinkers)	55–65
1	Steward	95
1	Blacksmith	95–99
1	Cook, first	77–87
1	Cook, second	55–65
9	Firemen (marine)	55–65
3	Stokers (watertenders)	50–60
3	Stokers (coal passers)	50–60
3	Oilers (marine)	55–65
1	Waiter, first	45
1	Waiter, second	40
1	Waiter, third	35
3	Deckhands (boatswain)	55–65
14	Deckhands (ordinary)	45–55
1	Gasoline engineer (Nezpique)	80–90
1	Deckhand (boatswain) (Nezpique)	75
1	Gasoline engineer (Beaumont)	95
1	Deckhand (boatswain) (Beaumont)	95
1	Machinist	95–99
1	Carpenter	85–95
62		

Authorized number and pay of employees on U. S. Steamer "Denison" (1 crew).

No.	Position.	Total Pay (mo.)
1	Master	$150
1	Mate	105
1	Steam engineer	125
2	Stokers	70
4	Deckhands	70
1	Cook	75

Note: Subsistence also furnished all hands.

In 1915 the hydraulic dredge *Gulfport* (20-inch pump) worked in this same channel, removing nearly 2,000,000 cubic yards at a field cost of 1.04 cents per cubic yard. The following is a comparison of the work of the two dredges. All figures are cubic yards.

	Taber	*Gulfport*
Average dredged per hour, pumping	5,750	2,620
Average dredged per hour, effective working time	3,030	1,875
Average dredged per working day	41,054	40,920
Maximum dredged in one month	892,312	1,062,030*

*July 1-29 only.

Record Dredging on the Mississippi River

[The following data concerning the performances of the dredges *Fort Gage* and *Fort Chartres*, furnished by the District Officer at St. Louis, will be of interest in comparison with that of the dredge *Taber* in Atchafalaya Bay.—Ed.]

These are self-propelling steel-hull suction-dredges, each 97 by 45 by 7½ feet, 4-foot draft, 815 tons, built in 1908 at a cost of about $177,000 each.

Complement (double crew, two 8-hour shifts) 9 officers, 39 men.

Boilers, six Mississippi River type, horizontal, externally fired, each 30 feet by 44 inches diameter, with three 10-inch and two 11-inch flues; 3,900 square feet, total heating, and 130 square feet, total grate surface; 160 pounds steam.

Propelling engines, two Mississippi River, 24 inches by 8 feet; 800 I. H. P.

Paddle wheel, stern, 26 inches by 21¾ feet diameter; 16 buckets, 35 inches wide, revolutions per minute 16; speed of boat, 7 miles per hour.

Pumping engines, 2 tandem compound condensing, 16½ inches and 30 inches by 24 inches; 140 to 150 R. P. M., 1,000 I. H. P.

Dredging pump, centrifugal, balanced type, volute lined, diameter of runner 84 inches; discharge overhead, either side of dredge.

Suction pipe, "dustpan" head 30 feet wide, 2 suctions, 24 inches diameter; average vacuum, 22 inches.

Discharge pipe, 32 inches diameter, 400 feet; maximum pressure, 5 pounds.

For a number of years these dredges have handled 500,000 to 2,000,000 cubic yards of river sand and silt per low water season, August to December.

The record monthly output thus far of these dredges is by the *Fort Chartres*, in August, 1919, when 344,000 cubic yards were dredged in 20 working days. The actual dredging time was 203 hours, with 111 hours consumed in handling pipeline and dredge, cleaning suctions, etc.; the effective hourly rate thus being 1,100 cubic yards.

The record day's work, however, is by the *Fort Gage*, August 6, 1919, when 32,439 cubic yards were dredged in 12¼ hours actual dredging time, with 3¾ hours for placing dredge and pipeline; giving a maximum hourly rate of 2,650 cubic yards, and an effective hourly rate of 2,000 cubic yards.

Unit costs, cents per cubic yard.

	Field	*Gross.*
For season 1919—		
Fort Gage (679,000 cubic yards)	7.9	11.9
Fort Chartres (654,000 cubic yard)	9.3	13.5
Average	8.6	12.7
For 10 years ending December 31, 1919.—		
Fort Gage (4,678,000 cubic yards)	6.6	12.1
Fort Chartres (5,864,000 cubic yards)	5.6	10.1
Average	6.0	11.0

Dredging in the Gulf of Mexico

In the month of January, 1914, the dredge *Texas*, belonging to the Atlantic, Gulf and Pacific Co., removed 1,246,000 cubic yards of material from the Houston (Texas) Ship Channel. Data furnished by U. S. Engr. Office, Galveston.)

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Duties of Engineers

A Map Problem on the "Applicatory System"

By

L. M. Adams

Colonel, Engineers

Note: The "applicatory system" of tactical instruction was in vogue in most armies prior to the World War. Its highest development was found at the Service Schools of the U. S. Army, at Fort Leavenworth, Kansas. The usual means of instruction is the "map problem." The student is given an assumed military situation and a map. He is then required to make an "estimate" or appraisal of the "situation," to determine his "mission," and decide upon a plan of action for carrying it out. These constitute the "solution" of the problem, which the student is required to write out. Having completed his own solution (and not before) the student is permitted to read an "approved solution" by his instructor, and to note the things he has overlooked or the mistakes he has made. This system has been found to be the best substitute possible in time of peace for the actual experiences of war. It places upon the student the *responsibility* of making his own estimate and decision and formulating his own plans of action.

The following problem is an application of the "applicatory system" to the duties of the engineer in war, and illustrates the methods of instruction at the Engineer School, Camp Humphreys, Va.

This problem demands of the student fast original thinking along practical engineering and military lines. It will have, of course, little value for instruction purposes unless it be honestly and conscientiously solved before the "approved solution," which accompanies the problem, is read.

Officers of the regular service or of the Reserve Corps who desire to learn how the military art is best taught in time of peace are urged to essay the solution of this problem, and especially *not to read the approved solution until they have completed their own.*

For guidance in the solution of the problem the following suggestions are offered:

The "Estimate of the situation" should include the following considerations so far as they may influence Major A's actions:

(*a*) Major A's "mission"—what he aims to accomplish.
(*b*) The forces of both combatants.
(*c*) The existing conditions, both favorable and unfavorable.
(*d*) The terrain.
(*e*) The enemy's intentions—what he may be expected to do.

Having reviewed the "situation" Major A next considers the various courses open to him, from which he arrives at a "decision" as to the course which gives the greatest promise of fulfilling his mission. And finally he prepares in detail his adopted plan of action.—ED.

General Situation.—The U. S. and Mexico are at war. The U. S. is taking the offensive and has already launched four Divisional invading forces from LAREDO, EAGLE PASS, EL PASO and COLUMBUS. U. S. forces of all arms are also known to be concentrating opposite OJINAGA. MEXICO'S armed forces are scattered from DURANGO to TAMPICO and number some 75,000 poorly disciplined and poorly equipped troops of all arms. Those in the vicinity of CHIHUAHUA are known to be very capably led.

Special Situation (United States or BLUE):

You are Major A, the senior engineer officer on duty with a re-inforced brigade which has been concentrated under Brig. Gen. B near SHAFTER. The command consists of:

1st Inf. Brig. (1st and 2nd Infs.).
1st Reg. F. A. (75 mm. Rifles).
1st Sq. 1st Cav.
9th Engineers (Mounted).
1st Field Signal Battalion.
Trains: 1st Division Trains practically complete.

On January 19, war was declared and the four Divisions mentioned above each crossed the Border. On January 20 the 1st Sq. 1st Cav. forded the RIO GRANDE at OJINAGA and moved to SAN JUAN to cover the advance of the rest of Gen. B's Command. By 8 a.m. Jan. 21st the whole of Gen. B's Command was at or s. w. of SHAFTER. You are with the General and his staff at SHAFTER and at the first meeting of the C. G. and Staff the General reads the following:

HDQRS. SOUTH. DEPT.,
SAN ANTONIO, Jan. 21, 7 a.m.

To Gen. B., SHAFTER (by Wire)

MEX. NAT. R.R. from JUAREZ to CHIHUAHUA completely destroyed, and will take weeks to open up. I count on your command moving on CHIHUAHUA at once from your present position via RANCHOVIEJO and the K. C. Y. M. & O. R. R. It is intended to increase your force to two divisions just as soon as it becomes clear that you have established a line of communications for such a command to CHIHUAHUA. Unlimited funds and supplies are at your disposal. Your base will be SHAFTER, you are responsible for everything from SHAFTER (Exclusive) to your objective. Chief QM. this Department opens L. of C. MARFA to SHAFTER by tomorrow night. This will be followed by a branch R.R. very soon. Lose no time.

DICKMAN.

The General then turns to you and says:

"Major A, you are to be my Chief Engineer, a member of my staff, as well as commander of the engineer troops. We shall cross the RIO GRANDE immediately after dark tonight. Our cavalry have just reached ALAMO after considerable skirmishing, and report the road to that point unmetalled, but in very fair condition, with all bridges and culverts intact. There are no towns worthy of the name this side of CHIHUAHUA. I count on marching via SAN JUAN—ALAMO—FORTIN—COYAME—PUEBLITO—RANCHOVIEJO and then via the RR to CHIHUAHUA. Supply will be by motor transport (the divisional trains) until we reach RANCHOVIEJO. Submit to me not later than noon today, a full plan of the contemplated engineer operations to cover our march to RANCHOVIEJO. There is only one crossing of the RIO GRANDE between here and SAN JUAN suitable for military vehicles and that is the ford at OJINAGA, 700 feet wide. With RANCHOVIEJO once in our possession I expect to make it an advance section (line of communications) for the two division expedition. Our progress from thence onward will depend largely on the success of our cavalry and upon the capture of rolling stock. We are going to take CHIHUAHUA, but we must fight our way through the mountain passes to do it. Here is a copy of the best map available (handing Major A a copy of the map herewith). You will be furnished copies of the March Order for tonight, about 5 p.m. We now have both wire and wireless communication to MARFA and we expect to have this continue by wireless at least, no matter what happens. We will be joined by an air squadron tomorrow. I may be able to answer a few questions if you are not clear on the situation as we find it."

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(The situation seems clear, and Maj. A asks no unnecessary questions.)

Note: Area concerned is on the "Tableland of Mexico" or "cold country" as Mexicans would call it in English. January and February are dry season months where we find only the larger streams, such as the RIO SAN PEDRO, flowing. The country is open rocky "mesa" with very limited wooded areas except on the steep mountain slopes and along the streams. The country is now practically barren of resources. The railroads are all standard gauge and are, or were, very well built with American and British capital. Chihuahua is a fine city with all modern improvements but the stores and factories are stripped.

Solutions will be turned in not later than 12 M.

All work will be in ink.

Where orders, messages, etc., are sent as part of the Solution, they will be written out in full, just as in the actual case they would be.

Fifteen minutes will be allowed after the issue of the Problem to the Class in which Student Officers may ask questions; thereafter no questions bearing on the Problem will be answered. A General Map of Mexico is posted on the front board, for anyone to consult if he so desires.

There will be a full discussion of this problem at a later conference period.

Required.—

1. Major A's estimate of the situation.
2. His actions and orders until noon January 21st.

An Approved Solution

REQUIREMENT NO. 1.

Mission.—Major A is to act as Chief Engineer of a small expedition as well as to command the mounted engineer battalion of the expedition. He is to rapidly prepare "a full plan of the contemplated engineer operations" to cover the first part of the march—that is 100 miles by dirt road to the beginning of the standard gauge railroad at RANCHOVIEJO.

Forces on both sides.—The U. S. forces are given in the problem and may be tabulated as follows:

	Officers and men	Animals	Horse-drawn vehicles	Motor vehicles
1st Infantry Brig.	8,417	854	370	11
1st Field Artillery	1,543	1,330	169	6
1st Squadron 1st Cav.	400	470	10	
9th Engineers (Mtd. Bn.)	387	465	12	
1st Field Signal Bn.	488	34	10	38
Aero Squadron	173			56
1st Div. Trns. Hdq. & MP	269	107	5	20
Ammunition Train	1,333	634	93	213
Supply Train (motor)	501			211
Engineer Train	84	110	26	15
Sanitary Train	951	205	35	123
	14,546	4,209	730	693

It thus appears that Brigadier General B has well over half of the equivalent of an infantry division at his disposal. They are well equipped, well disciplined and presumably seasoned regulars. The command is concentrated at its Base, SHAFTER, a small Texas town about 40 miles from the RAILHEAD at MARFA on the main line of the Southern Pacific. Four other widely scattered U. S. divisions are already across the BORDER but at points so distant that Gen. B probably expects no direct assistance from any of them. They are most probably already acting as magnets, however, to attract much of the original MEXICAN armed strength to them. However it is known that the enemy is already resisting our independent cavalry in its movement towards CHIHUAHUA, and with an alert commander at CHIHUAHUA, Gen. B probably expects a very well conducted resistance to develop soon. The Command is to move across the RIO GRANDE in a few hours, and thence force its way rapidly along the main road, some 100 miles to its first objective—the railroad at RANCHOVIEJO. Major A wishes that he had at least an Engineer Platoon with the Independent Cavalry now half way to RANCHOVIEJO. He plans to remedy this at once by despatching one of his mounted companies to catch up with this Cavalry Squadron. This will insure prompt and thorough Engineer Reconnaissance. The enemy's forces are inferior troops, poorly equipped but ably commanded by a Mexican Officer who operates in his own territory.

Conditions—favorable and unfavorable.—The most unfavorable conditions from the Americans' point of view are:

Territory almost unknown and unmapped.

Poor roads probably for motor transport.

No rail line of communications.

No grazing for over 4,000 animals.

A very long line of communications to be opened and held open by a force that must be rapidly depleted by L. of C. Detachments as the advance progresses.

An advance section is to be established at RANCHOVIEJO, with depots, repair shops, corrals, stables, hospitals, etc., all to be built sooner or later. This means that hundreds and hundreds of tons of lumber, nails, roofing, ironwork, machinery and general supplies and equipment must be assembled and erected at RANCHOVIEJO, and this all done weeks and perhaps months before any branch standard gauge railroad could be put in service via either EL PASO or EAGLE PASS and CHIHUAHUA.

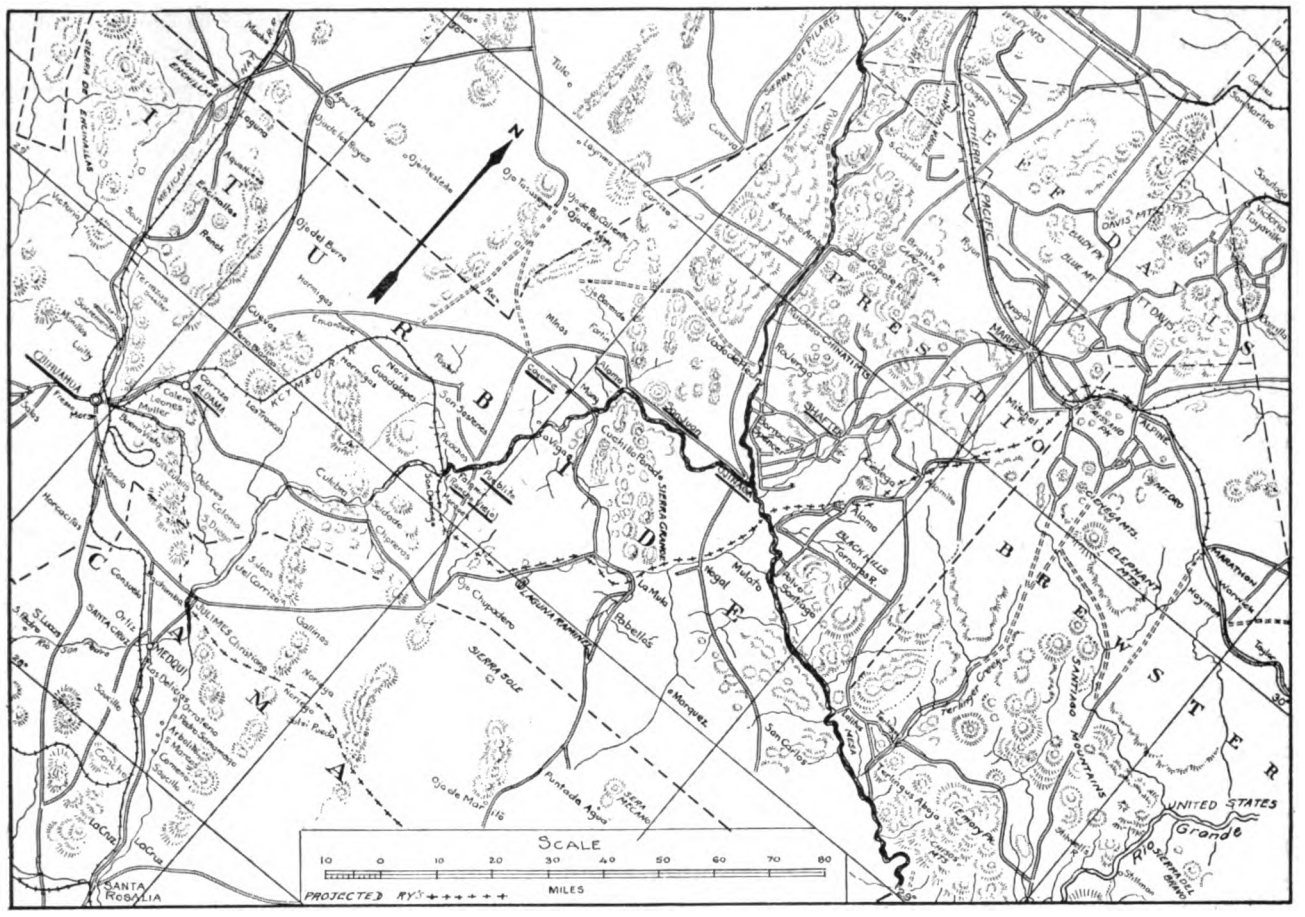
Assuming prompt success in reaching and taking CHIHUAHUA, it will become necessary almost at once to prepare for the arrival of another division and a half. The resulting Army Corps is expected apparently to be based on SHAFTER, which will soon be connected by rail (standard gauge) with the S. P. R. R. at MARFA. However, Major A is most concerned now with the plan of engineer operations to include the occupation of RANCHOVIEJO.

Most favorable conditions affecting the U. S. forces appear to be:

Well equipped and well disciplined troops.

The water situation (usually critical in Mexico) practically solved without effort by the proximity of the RIO SAN PEDRO. With the opening of the

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SCALE
10 0 10 20 30 40 50 60 70 80
MILES
PROJECTED RYS
SANTA ROSALIA
UNITED STATES
Grande
SHAFTER
CHIHUAHUA
OJINAGA
SIERRA SOLE
SIERRA GRANDE
SIERRA DE PILARES
SIERRA DEL ESCARPADO
SIERRA DE LA ESPUELA
SIERRA DE LA ENCINILLAS
SIERRA DE LA CANDELARIA
SIERRA DE LA CRUZ
SIERRA DE LA CUCHILLA
SIERRA DE LA CUCHILLA
SIERRA DE LA CUCHILLA

will be a very weak link in the proposed line of communications.

Courses open to Major A.—Major A is primarily concerned with those engineer plans having to do with insuring a proper line of communications, first, for Gen. B's small force via motor transport to RANCHOVIEJO and thence via the repaired K. C. Y. M. & O. R. R. to CHIHUAHUA, and later for a largely augmented force of an Army Corps to be based on CHIHUAHUA—RANCHOVIEJO—OJINAGA—SHAFTER.

Major A must make a rough calculation of what the motor transport (Supply Train and possibly part of the Amm. Train, 1st Division), will be capable of in the way of supplying the column by dirt road.

He bases his general supply figures on:

14,000 men requiring 5 lbs. a day	70,000 lbs.
4,000 animals requiring 26 lbs. a day	104,000 lbs.
Minimum daily requirements	174,000 lbs.

Now there are 163 2-ton trucks available in the Divisional Supply Train, but it will not be safe to count on better than 1½ tons net capacity on dirt roads, or 3,000 pounds per truck.

It will also not be safe to count on the truck convoys making more than 5 miles per hour, for 10 hours per day. This means that 4 days will be required for the motor truck trains to make the round trip from SHAFTER to RANCHOVIEJO. Say there will be 160 supply train cargo trucks available — then we may count on an average daily delivery at RANCHOVIEJO of 40 by 3,000 or 120,000 pounds. This is 54,000 pounds less than the estimated daily minimum requirements. This difference will have to be made up by using a part of the 100 trucks of the ammunition train. This capacity of 110 ammunition trucks is based on the 3 regiment brigade, so its depletion to even one-third full strength would not be unreasonable, particularly as a large expenditure of ammunition will probably not be be required to brush aside the small hostile bodies that will be encountered. We do however wish to "get a bluff" on the enemy from the start, by making his first contact with American troops in force one to remember with fear thereafter. Major A will therefore assume that as many as 75 of the 2T. ammunition trucks will be available for regular supply cargo carrying when RANCHOVIEJO is reached. This will keep the expedition supplied with food and forage, while water and firewood will have to be obtained locally.

Major A carefully considers the possibility of running a narrow gauge railway, or even a standard gauge from SHAFTER, to reduce the truck haul. However he gives up this idea for the present when he considers that the branch line from MARFA is yet to be built, and at the rate of 1 mile per day will require over 40 days to build as far as the base at SHAFTER.

Major A decides at once on a temporary heavy ponton bridge crossing at OJINAGA, this to be replaced by a trestle structure at an early date.

Good maps of the country in general are very desirable, but mapping on a large scale is as slow as railroad building, so that Major A will be careful not to encourage Gen. B to think that fine maps will soon be made available for all. Active reconnaissance by the cavalry, mounted engineers and aeroplanes must furnish the necessary data for Gen. A to make his tactical decisions, instead of the almost perfect maps the U. S. forces became somewhat spoiled by in FRANCE.

Even with the hiring of large numbers of Mexicans for road work, Major A believes he will have his hands full to keep open a suitable road for heavy motor trucks for 100 miles. He also expects to have several destroyed stream crossings to replace, with skilled enlisted labor, and he does not forget that before many days he will have a project for an advance section at RANCHOVIEJO to begin work on; the searching out and seizure of every available article for such project in or anywhere near RANCHOVIEJO will warrant Major A in sending forward a large mounted engineer party at once to join the independent cavalry.

To accumulate the necessary quantities of lumber, iron, roofing, nails, machinery, etc., at RANCHOVIEJO an additional system of supply columns of the line of communication must be organized at the BASE for the heavy extra hauling by truck involved.

Major A's plans will be laid with the object of insuring the successful advance of Gen. B to RANCHOVIEJO, and he will carefully avoid trying to do the impossible with the small force at present at his disposal. A series of small, safe, successfully executed engineer projects, will secure Gen. A in the rapid accomplishment of his very important mission, whereas to plan for and attempt the impossible will result in hopeless delay and eventual failure.

Decision.—Major A therefore decides to send forward at once to join the independent cavalry, one company of engineers (less the combat wagon and the platoon that operates with such wagon). The captain of this company is to be principally concerned with engineer reconnaissance and the advising of the cavalry commander of those points on the projected line of communications whose early seizure is vital. He will ask the General for orders to cover this at once.

He further decides: To leave one company (less its pack train and the platoon that operates with such pack train) at SHAFTER. This company to have orders to take charge of the vital matter of promptly erecting a heavy ponton bridge and then a pile

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trestle bridge at OJINAGA, then to take charge of all road building and maintenance from SHAFTER (exclusive) to SAN JUAN (inclusive).

To accompany the advance guard of the Command with the rest of his battalion—that is, bn. headquarters plus 1 mounted company plus 1 extra combat wagon plus 1 extra pack train plus two extra platoons. Major A expects to assign a definite section of the road (depending on condition in which it is found) to the company commander with most of his company available to oversee the work on such section.

To use the rest of his command, that is 2 platoons and the 1st Engineer Train, on the last section of the road to include starting work on an Advance Section at RANCHOVIEJO. It is evident that more line of communication troops must be detailed before Major A can plan the engineer operations beyond RANCHOVIEJO.

Major A will urgently demand the assignment of 3 Southern Dept. National Guard Infantry regiments to act as L. of C. troops in the near future on the road from SHAFTER (excl.) to RANCHOVIEJO (excl.) These troops should be available in a very few days, and will soon be competent to guard and maintain the road and stream crossings to RANCHOVIEJO. They will thus release most of Major A's command for duty again with the advanced elements of Ge force. The expedition is doomed to failure unless some such assignment of additional L. of C. units is made, and made promptly.

REQUIREMENT NO. 2.

Major A returns to his own headquarters and orders all officers, master engineers and 1st sergts. of his battalion and the engineer train, to assemble. On arrival the situation is explained from the map as given in the problem. He then tells Capt. D of B Company, "Get your company ready to leave at once. Your orders to join the independent cavalry under Major E, will be asked for immediately." Major A then asks if there are any questions. Answers such as he can and dismisses those assembled so as to get to work on his "plan of engineer operations." This takes about the same form as the "decision" given above. It will be presented by Major A in person at noon, and will be resolutely backed up by more detailed explanation as exemplified in the estimate of the situation above.

Message from Major A to the Dept. Engineer, Southern Dept., San Antonio, Tex., a copy being sent to Gen. A at once:

"I am Chief Engineer of Gen. B's column here. We move tonight by the road OJINAGA—ALAMO—FORTIN—COYAME to RANCHOVIEJO, to carry out GEN. DICKMAN'S orders of this date. Only engineers are my mounted battalion. Will leave part of my command to build heavy ponton bridge over RIO GRANDE at OJINAGA, this to be replaced soon by a pile trestle good for military highway traffic. Rush 4 heavy divisions ponton equipage to MARFA. Follow this with 2 portable pile drivers and all lumber, spikes, etc., necessary for pile trestle bridge 800 feet long and 20 feet above river bed at center, further details later. Also send MARFA all road machinery necessary to maintain 100 miles dirt road dry season, use figures based on COLUMBUS—COLONIA DUBLAN road. Mail me rough plans and estimates of all necessary for the advance section, RANCHOVIEJO. I am going to demand 3 SOUTHERN DEPT. NATIONAL GUARD INFTY. REGIMENTS to relieve me of L. of C. maintenance as soon as we get the line opened to RANCHOVIEJO. Send me all available data of RAILROAD, RANCHO to CHIHUAHUA. Hire an American engineer familiar with that road and send to me. Send also $10,000 gold and $10,000 MEX. silver for requisitioning materials and labor for cash. I leave Capt. C with A Company at SHAFTER to build bridges OJINAGA and look out for things as far as SAN JUAN. I send one company ahead to join our cavalry now at ALAMO, while I march with GEN. B with the remainder."

Draft of an order for Gen. B to sign:—

Company B 9th Engineers (Capt. D) is assigned to the independent cavalry (Major E). It will join at once. Captain D will acquaint Major E with the new developments in the situation, and keep him informed as to all points along the proposed line of communications which engineer reconnaissance indicates it vitally necessary to seize and hold.

Topographic Survey of the City of Flint, Mich.

A topographic survey of the City of Flint, Mich., now in progress, was undertaken for city planning purposes. The survey covers the 30 square miles to which the city limits are soon to be extended, the adjacent areas expected to fall in the city limits by 1960, and certain small additional tracts included to secure complete drainage data. The total area to be covered is approximately 60 square miles. The scale is 1 inch, equals 200 feet, with a contour interval of 1 foot. Horizontal control is established by primary traverses in which direction is measured to 30 seconds and distance to hundredths of a foot. The average error of closure in a representative traverse is 1 in 24,150. About 3 miles per day is the average progress of each traversing party. Vertical control is established from existing precise level bench marks by level lines with an error of closure less than $.05\sqrt{M}$, M being the distance between bench marks (presumably in miles.—ED.).

All mapping is done in the field by plane table. Secondary control is obtained by the plane table traverse with stadia and magnetic needle. The area involved embraces a small river and varying topographical forms, including drift plains, irregular glacial forms, and the rugged river valley. The average day's work of a single mapping party is about 28 acres. The accuracy of the map is established by test profiles run with the plane table and compared with profiles scaled from the map. The average error of 130 test points in a profile 6,423 feet in length, amounted to 0.26 foot and only 0.03 per cent of the test points on the profile disagreed with the contours by more than 1 foot.

In the finished map topography is shown in blue, culture and lettering in black, and hydrography in blue.—*Eng. News-Rec.*

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Army Essay Winners

The three prize winners in the Army National School Essay Contest on the subject "What are the Benefits of an Enlistment in the United States Army," are:

1st—Donald L. Campbell (age 15),
Junior Class, Clinton High School,
Clinton, Iowa.

2nd—Marjorie Sheetz (age 14),
Chillicothe High School,
Chillicothe, Missouri.

3rd—Bettie Bowen Eason (age 16),
De Soto County High School,
Olive Branch, Mississippi.

This decision was announced April 17 by the Board of National Judges consisting of the Secretary of War, General John J. Pershing, and General Peyton C. March, Chief of Staff, U. S. Army. The judges themselves did not know the identity of the winners, nor the states from which they came until after their decision had been made, as no markings whatever were permitted on the copies of the essays submitted to the Board.

The three winners of this National Essay Contest in which about ten million school children took part received a gold, silver and bronze medal according to their standing in first, second or third place. They also were given a free trip accompanied by their parents or guardians to Washington where Secretary Baker presented the medals and also a large silver loving cup to each of the schools they represent. The competitors who receive an honorable mention are the recipients of engraved certificates signed by Secretary Baker, General March and General Pershing, also each of the fifty-six District competitors will receive an autograph letter from the Secretary of War.

A total of more than one million dollars in local prizes was offered throughout the country to the winners in the various cities of the Recruiting Districts. This essay contest has aroused unusual interest among the school children throughout the nation. It has been suggested that this School Essay Contest be made an annual event in the Army.

The essay of Donald L. Campbell, Clinton, Iowa, deemed the most expressive, original and sincere by the judges, and which was awarded first prize, is as follows:

As Horace Greeley once said, "Young man, go west!" we now say, "Young man, join the Army!" Why? It is the big opportunity of the age.

Are you physically weak?

"Health is the first wealth," and the Army is a health-builder. It provides wholesome food, clean, comfortable surroundings, proper clothing, and medical attention when necessary. Physical exercise is compulsory and every encouragement is given athletics. These, with out-door life, make men straight, strong, and healthy.

Do you seek an education?

You can attend school at any Army Post and study grammar and high-school subjects.

Would you learn a trade?

The government has recently appropriated two million dollars for the establishment and maintenance of vocational schools where you can learn to be a mechanic, auto repairman, electrician, telegraph operator, chemist or almost anything else you wish. These courses prepare you for a return to civil life or continued service in the Army.

Do you long for travel and adventure?

Join the Army. You can be an engineer at the Panama Canal, a wireless operator in the Philippines, a lineman in Alaska, or an aviator flying in the clouds. Whenever possible, the government gives you a choice of station.

In the Army you can travel, learn and earn at the same time.

You may think Army pay low. In addition to the $30.00 a month, Uncle Sam pays for your food, clothing, rent, light and fuel. With the present High Cost of Living, why not leave all the worries to Uncle Sam? After thirty years service, you can retire on three-fourths pay plus $15.75 a month. The Army is not all work and drilling. There are movies, libraries, games, music and dances; furloughs whenever conditions permit.

Do you admire courage, honesty, square-dealing, resolution, and tenacity of purpose? You will find these qualities in men like Washington, Grant, Sherman, Roosevelt and Pershing—men developed in our Army.

This training of body, mind, and soul, and these opportunities for education, travel and adventure are more than sufficient reasons for joining the Army; but there is another and greater motive for donning the "olive drab." Do you *love* your country and would you be worthy of her? You must be willing to serve her both in War and Peace.

Have you, like Nathan Hale, "one life to give for your country? If so, join the Army!"

It would seem that the school girls are better writers on military subjects than their brothers. Of the 56 District essays, 33 were written by girls and 23 by boys. Of the three prizes two were won by girls and one by a boy. Of the ten who received honorable mention, 7 were girls and 3 were boys.

The contest was conducted under the auspices of the War Department, but the prizes were purchased by the "Come-Back," the official newspaper organ published for the benefit of wounded soldiers at Walter Reed General Hospital, Washington, D. C. The essays were written in the school class-rooms on February 20th last, and the principal of each school selected one essay as the best product of his institution. The District Recruiting Officer then appointed a Board of three judges to pass on the essays submitted by the schools of his District, and those selected were sent to the National Board of Judges in Washington, whose decision was announced to-day.—*War Dept. News Bureau.*

Reinforced concrete freight car.—A concrete gondola is an innovation in railway equipment. The frame is of steel and the walls and floor of light-weight concrete with burned clay aggregate. The capacity is 100,000 pounds, and the weight 53,600. The car has now been in service 9 months.—*Concrete and Const. Eng.*

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Governmental Investigation of River and Harbor Improvements

By

A. H. Ritter

Chief Clerk, Board of Engineers for Rivers and Harbors

Introductory Remarks

From time to time in recent years articles have appeared in periodicals of the country purposing to expose a wanton waste of public funds in connection with the improvement of our rivers and harbors. Quite frequently these articles are by professional magazine writers whose lack of knowledge concerning the conduct of this important work is exceeded only by their desire to create a sensation and their reckless indifference to the truth.

Those who really know the subject and who have undertaken to present it in the proper light have experienced difficulty in finding a medium through which to reach the public. The publications that lend themselves to "muckraking" attacks are in general unavailable for the presentation of the sober and non-sensational truth. It is with a sense of propriety, therefore, that THE MILITARY ENGINEER furnishes space for an article concerning one phase of the duties of the Board of Engineers for Rivers and Harbors, written by its chief clerk, Mr. A. H. Ritter, who having been with the Board practically from the date of its organization in 1902, may be credited with a knowledge of the subject whereof he speaks. His paper was inspired by certain articles in a well-known weekly periodical, containing references of a derogatory nature in regard to the work of the Board, and to these Mr. Ritter's account may be accepted as an adequate reply. The article is followed by a discussion by Col. Charles Keller, Corps of Engineers, who, since his return from France, has been resident member of the Board, of which he was also a member prior to his assignment to duty abroad.

The Board is constituted under authority of Section 3 of the Rivers and Harbors Act of June 13, 1902. Authorship of this piece of legislation is generally accredited, and it is believed rightfully, to the Hon. Theodore E. Burton, late chairman of the Committee on Rivers and Harbors of the House of Representatives, at that time accepted as a real friend, and one of the most influential, while also cautious and economical, advocates of waterway improvement.

Prior to 1902, preliminary examination and survey reports were prepared by the district engineers, except in the comparatively limited number of cases where special boards were appointed. The recommendations submitted varied not only with the importance of the project involved, but also with the individual judgment of the reporting officers, for, strange as it may seem, engineer officers under the same system of education and training, in common with people of all classes, do, did, and will differ in their views. Similar arrays of facts with respect to physical conditions, cost, traffic, and commercial prospects, may naturally be expected to appeal to the young and the optimistic while appearing doubtful to the mature and the conservative, and absolutely without merit to the superannuated, pessimistic or dyspeptic. It was with a view to eliminating these temperamental inequalities and standardizing the conditions precedent to a favorable recommendation for improvement, that the idea of the creation of this Board of Review was conceived.

As originally constituted the Board was composed of Col. A. Mackenzie, Maj. Harry F. Hodges, Maj. Edward Burr, Capt. C. H. McKinstry, and Capt. W. V. Judson. The list of officers later detailed for duty with it includes such names as Rossell, Kingman, Black, Beach, Abbot, Newcomer, Winslow, Flagler, and Harding. The present membership is—Col. W. C. Langfitt, Col. J. C. Sanford, Col. Harry Taylor, Col. Charles Keller, Lieut. Col. Jas. P. Jervey, Lieut. Col. John C. Oakes, and Maj. Max C. Tyler. It seems almost incredible that anyone with knowledge of the professional qualifications, character and reputation of such men as these and their associates, would intentionally call in question their motives as members of this Board.

At this time, when there is a strong agitation throughout the country in favor of economy in governmental construction, it should be of interest to the nation, and especially to the engineering profession, to learn that governmental expenditures on rivers and harbors are not made with reckless disregard of the taxpayers' rights, as certain ill-informed persons would have us believe.

This article indicates that there is a tendency on the part of Congress to gradually enlarge the advisory powers of the Corps of Engineers, and to repose greater and greater confidence in its judgment and advice. This is a confidence which the Corps has earned in over a hundred years of faithful service, strict observance of the law and the expressed wishes of Congress.

The Corps of Engineers is well qualified by its long and varied experience to study and formulate comprehensive plans for waterway improvement and development. While, as stated by Col. Keller, the final determination of our waterway policy is a function of statesmanship, the Corps of Engineers is prepared to conduct the necessary studies and investigations and to make intelligent recommendations on the whole policy or any phase of it, to the extent the Congress may decree. There would appear to be every reason why its powers to do so should be enlarged, it being borne in mind that these powers are advisory only. Congress is not bound to accept any recommendation of any corps or department unless the evidence presented is indisputable and convincing, and the recommendations based upon the evidence and sound and practicable in themselves.—ED.

Erroneous accounts in current periodicals

IN the recent past, certain writers for the daily press and current periodicals have attempted to explain the procedure of the investigations made to determine the advisability of proposed river and harbor improvements. It is a commentary on the knowledge or the candor of these writers to note that they seldom, if ever, correctly state the facts. To those familiar with the subject, it is not difficult to trace the source of much of the misinformation given in articles appearing in the popular magazines, and while it is not claimed that the writers intentionally deceive, yet they certainly make no effort to verify information furnished by opponents of river and harbor improvements, and it is not right to make statements one does not know to be true. The public appetite for sensation, even for scandal, is keen, and muck-raking is more interesting than prosaic truth. So far as is known, complete and accurate accounts of the procedure in determining the advisability of river and harbor improvements have never been published, and it seems opportune to present some information on this subject for the benefit of those who prefer facts to fiction.

Procedure in river and harbor legislation

Legislation pertaining to river and harbor improvements is under the jurisdiction of the Committee on Rivers and Harbors of the House of Representatives, and the Committee on Commerce of the Senate. In common with other appropriation acts, the river and harbor bill originates in the House of Representatives.

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The first section of the bill is always devoted to appropriations for improvements, and a separate section contains a list of localities to be examined with a view to determining the advisability of improvement. This list of localities is made up by the Committee from the many requests received by it from members of Congress and others interested. The investigations are called "Preliminary examinations," and it is expressly provided by law "That no preliminary examination, survey, project, or estimate for new works other than those designated in this or some prior Act or joint resolution shall be made." The procedure also requires that, "In all cases where preliminary examinations and surveys are authorized, a preliminary examination of the river, harbor, or other proposed improvement mentioned shall first be made and a report as to the advisability of its improvement shall be submitted, unless a survey or estimate is expressly directed. If, upon such preliminary examination the proposed improvement is not deemed advisable, no further action shall be taken thereon without the further direction of Congress; but in case the report shall be favorable to such proposed improvement, or recommends that a survey and estimate should be made to determine the advisability of improvement, the Secretary of War is authorized, in his discretion, to cause surveys to be made, and the cost and advisability of the project to be reported to Congress."

After the bill is passed by the House, it goes to the Senate and is referred to the Committee on Commerce, which usually includes additional preliminary examinations.

As is well known, the work of improving our rivers and harbors is under the jurisdiction of the Chief of Engineers, United States Army. It is carried on through some fifty district offices located chiefly in the larger cities, each district being normally in charge of an officer of the Corps of Engineers, who is known as the District Engineer. In addition to duties connected with the actual construction work involved, this officer is charged with making investigations specifically called for by Congress with a view to determining the advisability of undertaking new improvements, or of extending or modifying those already in progress.

For many years, the District Engineer sent his reports on examinations and surveys directly to the Chief of Engineers, who, in accordance with the law as it then stood, frequently forwarded them to Congress without recommendation. This condition is now changed and reports on examinations and surveys are now required to include specific recommendations as to worthiness or advisability which, in turn, are based upon commercial benefits or economies likely to result from the proposed work.

There are now, however, a number of Division Engineers, through whom all these reports in each corresponding geographical division must be forwarded. These Division Engineers are generally officers of high rank and are selected because of their particular qualifications for the supervision of the District Engineers.

The present policy of having "preliminary examinations" precede surveys was inaugurated by Congress in the river and harbor act of 1890, but prior to that date the making of examinations, surveys, or both, at localities designated by the different acts was, as a rule, left to the discretion of the Secretary of War, and where an examination made prior to 1890 sufficed for the preparation of a project and estimate the survey was omitted as unnecessary.

Creation of the Board of Engineers for Rivers and Harbors

Section 3 of the river and harbor act of June 13, 1902, provides for the organization in the office of the Chief of Engineers, by detail from time to time from the Corps of Engineers, of a board of five engineer officers (later increased to seven) whose duties shall be fixed by the Chief of Engineers, and to whom shall be referred for consideration and recommendation, in addition to any other duties assigned, so far as in the opinion of the Chief of Engineers may be necessary, all reports upon examinations and surveys provided for by Congress, and all projects or changes in projects for works of river and harbor improvements theretofore or thereafter provided for. And in the consideration of such works and projects the board shall have in view the amount and character of commerce existing or reasonably prospective which will be benefited by the improvement, and the relation of the ultimate cost of such work, both as to cost of construction and maintenance, to the public commercial interests involved, and the public necessity for the work and propriety of its construction, continuance, or maintenance at the expense of the United States. It is further the duty of the board, upon request to the Chief of Engineers by the Committee on Commerce of the Senate or the Committee on Rivers and Harbors of the House of Representatives, in the same manner to examine and report through the Chief of Engineers upon any projects heretofore adopted by the Government or upon which appropriations have been made as to the desirability of continuing the same or upon any modifications thereof which may be deemed desirable. This provision of the law was extended by act of March 3, 1905, to require the board upon request of the committees of Congress specified above to examine and review surveys as well as projects provided for by acts or resolutions prior to the river and harbor act of June 13, 1902, and it was further modified by the act of March 2, 1907, to include consideration of any examination or sur-

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vey made pursuant to any act or resolution of Congress.

Increase in scope of duties

Section 13 of the act of March 3, 1909, increased the scope of preliminary examinations and surveys by providing that every report therein ordered shall contain such data as it may be practicable to secure regarding (first) the establishment of terminal and transfer facilities, (second) the development and utilization of water power for industrial and commercial purposes, and (third) such other subjects as may be properly connected with such projects. It further provided that the investigation and study of these questions may, upon review by the board, "when called for as now provided by law, be extended to any work of improvement now under way and to any locality the examination and survey of which has heretofore been, or may hereafter be, authorized by Congress." Section 6 of the same act requires the board to pass upon all modifications in plan and location involved in the reconstruction of any lock, canal, canalized river, or other work for the use and benefit of navigation, for which expenditures are authorized by that section.

The provisions relating to terminal and transfer facilities, water power, etc., were renewed in the act of June 25, 1910, and extended to apply to all examination and survey reports hereafter provided for. The required investigation of these questions was considerably amplified by the act of July 25, 1912.

Outline of procedure. Publicity

From the above, it will be seen that Congress initiates each investigation by including in a river and harbor act direction for the making of a preliminary examination. The duty of making this examination is assigned to the proper District Engineer, who undertakes a study of the physical and commercial situation. He obtains as much definite information as possible regarding the character, scope, and alleged advantages of the desired improvements as the commercials interests, at whose solicitation the examination has usually been ordered, are able to furnish, and he holds amply advertised public hearings to enable the views of all persons advocating or opposing the improvement to be ascertained. In accordance with law, no estimates of cost are included in the report on preliminary examination, but the field examination of the physical conditions is sufficiently thorough to enable him to judge whether the cost will be reasonable in comparison with the money value of the probable benefits of the improvement. If the conclusions of the District Engineer are favorable, he recommends that a survey or estimate be authorized, and similar recommendation is permissible if he considers that a survey is necessary in order to reach a decision. If his conclusions are unfavorable, he notifies by letter all persons known to be interested, giving briefly the reasons for his conclusions, and invites them to submit statements and arguments, or within four weeks, to apply for a hearing to the Board of Engineers for Rivers and Harbors. His report is then transmitted to the Chief of Engineers, through the Division Engineer, who also gives his views on the matter.

Upon receipt of a report on a preliminary examination by the Chief of Engineers, it is referred to the Board of Engineers for Rivers and Harbors. The Board then makes a detailed study of the engineering, commercial, and economic questions involved, and if the report of the District Engineer is unfavorable, before submitting its report, it awaits the expiration of the four weeks allowed for appeal by interested parties. In case the report of the District Engineer is favorable, but the Board is unable to concur in his findings, it causes notices to be sent to all interested parties, advising them of this fact, and giving them an opportunity to be heard. If the Board concurs in a favorable recommendation of the District Engineer, it recommends the authorization of a survey, or a plan and estimate of cost, if a survey is not required, as a basis for formulating a project. In case of an unfavorable report on the survey, the same procedure as to notification of interested parties is followed. It will thus be seen that at every step the interests concerned are given ample opportunity to establish the merits of the improvement desired.

At this point, it is appropriate to remark that the object of the public hearings given by the Board is to secure facts, and that mere expressions of interest or general commendations of proposed improvements unsupported by facts, have little weight. The questions involved are susceptible of solution only by consideration of definite evidence. The most valuable evidence is usually given by men directly connected with the use of the improvements. Thus, in the case of the channel at Pollock Rip, Massachusetts, the testimony which served to finally convince the Board of the desirability of undertaking certain work at this locality, was furnished by a vessel captain who knew very little about politics, but a great deal about navigation. In contrast with this case, there are others in which strong delegations of influential citizens backed by their Senators and Members of Congress, have failed to produce the evidence necessary to secure a favorable decision. As many persons who have been before the Board can testify, there is no judicial body more conscientious in its decisions, and more immune from political influence than is the Board of Engineers for Rivers and Harbors. Those of us who are familiar with the work of the Board can recall more than a few instances in which the Board has reversed the findings of one of its own members, who, as District or Division Engineer, had reported in favor of a proposed improvement.

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Decisions based on economics, not politics

It is obvious to all students of commercial and economic problems that there may be honest differences of opinion regarding the best solution in any given case, and it is not to be expected that in all instances the solution will meet universal approval. There is no objection to honest criticism as to the wisdom of a recommendation, and in fact such criticism is desirable, but there is clearly a rightful objection to expressions designed to impugn the integrity of those responsible for the execution of the processes laid down by law. It has been alleged, in effect, that the Board is unduly influenced by the desires of Congress. In contradiction of this charge, it may be stated that the Board gives no consideration whatever to the distribution of improvements according to their geographical location, nor does it takes any notice of the theory, occasionally heard, that governmental assistance should be apportioned in proportion to the local contributions to the national treasury (the "Pork Barrel" policy). Each proposition is considered on its merits and the verdict is favorable only when the evidence shows that the return to the public in general, and not merely to the locality, will be adequate.

Number of unfavorable reports

In a recent issue of a well-known weekly magaz ne, it was stated that "some five or six hundred projects for waterway improvements, each and all duly approved and recommended by the expert engineers, have been held up at the Capitol." Here is a plain statement easily susceptible of corroboration or refutation, so as to give some hint as to the dependence which can be placed upon other statements appearing in the same article.

From its organization in 1902 to January 1, 1920, the Board submitted a total of 1,986 reports on investigations ordered by Congress, of which 679 were favorable and 1,285 were unfavorable. In 22 cases, there were no recommendations as to worthiness. The details are as follows:

Authority for investigation. Acts of—	Investigations ordered.	Reported on to Jan. 1, 1920.	Favorable.	Unfavorable.	Per ct. of favorable reports.
June 13, 1902	170	170	52	118	30.6
Mar. 3, 1905	176	176	74	102	42.0
June 28, 1906	2	2	1	1	----
Mar. 2, 1907	200	200	108	92	54.0
May 28, 1908	1	1	1	------	----
Mar. 3, 1909	274	274	120	154	43.8
June 25, 1910	187	187	62	125	33.7
Feb. 27, 1911	90	90	28	62	31.1
July 25, 1912	226	226	70	156	31.0
Mar. 4, 1913	122	119	43	76	36.1
Mar. 4, 1915	219	210	42	168	20.0
July 27, 1916	128	112	15	97	13.4
Aug. 8, 1917	84	59	5	54	8.4
Mar. 2, 1919	53	6	----	6	----
Resolutions	*157	154	58	74	----
Total	2,089	1,986	679	1,285	34.2

*No recommendation as to worthiness in 22 cases.

Of the 679 cases favorably recommended, Congress has appropriated for 541, leaving 138 not adopted. From the latter figure must be deducted, however, those rendered obsolete by later recommendations. In explanation of this necessary deduction, several typical cases may be cited. In 1902, the Board recommended the improvement of Wrangell Narrows, Alaska. Subsequently, an examination of Dry Straits, Alaska, was authorized, and upon investigation it appeared that Dry Straits afforded a more desirable passage than Wrangell Narrows, and it was accordingly recommended *in lieu* of the latter. There are also many cases of investigations ordered by Congress at localities which the Board had previously reported as worthy of improvement, and the adoption of the second recommendation frequently rendered the first one obsolete. An example of this kind is the Hackensack River, for which the Board recommended an improvement to cost $60,000 but after a later investigation recommended a more extensive improvement costing $171,018. The latter project was adopted by Congress. In this case, the restriction of the law made it impracticable for the Board to report on a project of adequate scope on the first investigation.

There are also a number of cases where favorable recommendations were later superseded by unfavorable recommendations because of changed conditions since the first report was rendered. Examples of this kind are Wickford Harbor, R. I., Manchester Harbor, Mass., and Cohasset Harbor, Mass.

Of the 138 cases not adopted by Congress, 54 have been superseded by reports which have had the effect of revoking the first recommendations, leaving before Congress at present only 84 favorable reports which could be made the basis of action. The details are shown in the following table:

Authority for investigation.	Favorable reports.	Adopted by Congress.	Superseded and obsolete.	Not adopted by Congress.	Estimated costs of improvements recommended but not adopted.
June 13, 1902	52	30	17	5	$2,154,980.00
Mar. 3, 1905	74	67	5	2	136,750.80
June 28, 1906	1	1	--	0	----------
Mar. 2, 1907	108	96	6	6	479,048.00
May 28, 1908	1	1	--	--	----------
Mar. 3, 1909	120	102	16	2	34,300.00
June 25, 1910	62	55	--	7	5,837,700.00
Feb. 27, 1911	28	24	2	2	42,468.00
July 25, 1912	70	44	4	22	7,862,820.00
Mar. 4, 1913	43	23	2	18	5,780,720.00
Mar. 4, 1915	42	28	2	12	13,351,145.00
July 27, 1916	15	11	--	4	526,800.00
Aug. 8, 1917	5	3	--	2	150,000.00
Resolutions	58	56	--	2	111,800.00
	679	541	54	84	$36,468,531.80

Due to the great increase in cost of labor and materials during the last two years, the estimates contained in many reports submitted prior to 1916 are inapplicable, and there are now only a very few

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Co-operation of Aeroplane Searchlights in Anti-Aircraft Defense

By

W. F. Tompkins

Major, Engineers

NOTE:—The Engineers had charge of all searchlights operated by the American Expeditionary Forces, and of training, supply and development in the United States and in France. The searchlight organization consisted of the 56th Engineers, ten companies of 250 men each, under command of Lt. Col. J. C. Gotwals, Engineers, who directed all searchlight operations of the American Army in France. The entire 56th Engineers was in France at the time of the armistice. Three companies were with the American 1st Army, operating 42 searchlights, and two with the 2nd Army, operating 16 searchlights. In addition they manned the searchlight defenses around Is-sur-Tille and Colombey-les-Belles. The remainder of the regiment, not thus employed, was in training. Many of our searchlight troops had received previous training and had seen service with the French and British armies in the operation of searchlights.

The Engineers in the U. S. Army are charged with the development and supply of searchlights for all purposes and with the operation of mobile units. They accordingly operate all searchlights except those at permanent (sea-coast) fortifications, or semi-permanent land defenses of important cities, railroad or industrial centers. It is regarded as desirable that the same service should operate all the correlated equipment of a semi-fixed searchlight installation.—ED.

Bombing and bombing machines

THE importance of bombing in warfare is now well recognized by all of the leading nations. During the past war bombing machines were constantly increasing in size, and cruising ranges were continually extended. The size of the projectiles and the quantity of explosive carried were similarly increasing. It became more and more difficult to withdraw troops to billets where they could rest and recuperate in safety. Large dumps, rail heads, bridges and other items of military value were not only most seriously and constantly threatened, but actually destroyed in vast quantities. The greatest cities, such as Paris and London, were subjected to bombardment from the air, and thus the civilian population found itself in closer contact with the enemy and more or less open to demoralization, with its consequent tendency to weaken the resistance of the allied nations against the common enemy. Smaller cities, such as Amiens, Nancy, Peronne, Bapaume, Abbeville, Bar le Duc, were greatly damaged or nearly wiped out by aerial bombardment. The fact that the enemy received similar punishment was satisfying, but did not prevent the destruction visited on Allied territory.

As defenses against aerial bombardment became stronger, day bombing gradually decreased and more reliance was placed upon night operations. The advantage of the day bombing machine is that routes may be easily followed and objectives clearly seen. However, defending aircraft, having much greater power of maneuver and being very much faster, soon demonstrated their ability to prevent bombers from crossing the lines during daylight. The bombing machine, heavily loaded, must always fly at a comparatively low altitude and thus is constantly exposed to attack by pursuit planes, the fire of anti-aircraft artillery, and even machine gun and rifle fire. The greatest difficulty for bombing machines at night is the darkness, which is, in turn, also their greatest security. Routes of approach are hard to locate and follow and it is extremely difficult to see even a large objective. They have the great advantage of being hidden in darkness, so that the defending forces find it extremely difficult to locate and attack their targets. So far as airplanes are concerned, the most dangerous natural objection to night operations is in landing. Here the slow flying bombing machine finds another advantage over the fast pursuit planes which must combat it, since it lands without great difficulty. There is one other advantage of note in night bombing, and that is the far greater demoralizing effect upon troops and especially civilians.

Searchlights against aircraft

In order to locate the night bomber and successfully attack him, past experience has shown that he must be artificially illuminated. This not only renders him open to attack, but the searchlight beams dazzle and confuse the aviators, and, by contrast, hide objectives. The pilot and his companions are flying at night, necessarily at a comparatively low altitude, in a slow machine very difficult to maneuver. As soon as a bomber is illuminated, the realization that he forms a large target, especially unprotected in the rear, open to attack by fast pursuit planes, anti-aircraft artillery and machine guns, possesses him. The psychological effect on the aviator is very important.

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Seeing nothing himself and yet seen, he soon loses hope of a successful mission. If he flies higher, the risk of losing his way correspondingly increases, and he can never rise above a certain level which is always within easy range of illumination and attack. If an attempt is made to circle the lighted area, the distances to be traveled become very much greater, with correspondingly greater chances of becoming lost or meeting with some accident which necessitates a landing in hostile territory. It is thus seen that the use of searchlights with pursuit planes and anti aircraft artillery constitute a defense against night bombing operations.

Searchlight tactics

In order to avoid becoming lost, and to find objectives, night bombing machines must follow certain clearly defined natural features, such as large rivers and river valleys, edges of great forests, coast lines, railway tracks with trains moving over them, canals, clearly defined highways and railroads. Consequently, searchlights in defense should be placed in bands along the entire front, but especially defending, by more concentration and additional depth of the lighted area, the prominent routes leading to the important objectives in the rear. The closest liaison and coöperation with other branches is essential. When hostile planes have been illuminated, they must be attacked by pursuit planes or by well-placed bursts of anti-aircraft fire. Excellent telephonic communication between searchlights, pursuit squadrons and anti-aircraft batteries is necessary. Wherever possible, listening posts should be established along the front to report back by wireless or telephone whenever hostile planes cross the line, giving their direction and other important information.

The band of lights must be continuous along the entire front, in order to avoid the encircling of flanks by bombing squadrons. If a dark gap is left in the lighted area it will soon be found and passed through by hostile aviators. The searchlights are placed in lines, and the lights in each line are staggered with respect to those in adjacent lines. Wherever there is sufficient equipment, there should be a depth of at least four searchlights. It has been found best to locate the emplacements so that targets may always be held by three beams, and this is done by placing the searchlights in quincunx order. In addition, more material should be placed so as to protect especially vulnerable objectives in the rear, in case hostile planes should penetrate the primary defenses or circle around the flanks. All positions must be selected so as to have excellent coöperation between adjacent lights, while covering as great an area as possible. It is of interest to note that, as a rule, bombing planes strike a lighted area nearly perpendicular to its length and therefore, when turning to the right or left to avoid the nearest beam, must pass obliquely through a greater distance in which they are subject to illumination.

The individual locations should be on high ground to obtain a good field of view and to avoid ground mists. They should be near good roads, but preferably not main roads, since continuous traffic interferes with listening, which is essential for determining the general location of the plane before searching commences.

The map herewith shows the locations of searchlight defenses during the Meuse-Argonne offensive. This gives an example of searchlight defense, as outlined above. It is unfortunate that the contour lines are missing, as they would show why the final location was selected. The traces of hostile planes can be seen, which in general, show the effectiveness of the defenses. At the time of the armistice, searchlight equipment was becoming available in huge quantities, and searchlight troops were being rapidly trained, so that soon a closer concentration of lights would have been assured and the lighted area doubled in width. It is confidently believed that the defenses would have been nearly impregnable.

Night pursuit squadrons

During the early part of October, 1918, at a conference at First Army Headquarters, it was decided to utilize a squadron of pursuit planes in coöperation with searchlights and anti-aircraft batteries for defense against hostile night bombing machines, and by the middle of that month the general plans and details had been drawn up. It should be noted that the British, employing only one squadron, the 151st Squadron, Royal Air Force, had already met with marked success in night air defense, bringing down 25 bombing planes after illumination by searchlight beams during the month of August, with the loss of not a single plane or aviator. American searchlight units had coöperated with British searchlights during this remarkable period of successful defense against night raiders, at a time when strategical considerations and exceptional weather conditions called for great activity by the enemy's bombing squadrons.

The adoption of this policy had had great advantages in that the anti-aircraft defenses were made more effective, and were greatly increased. In order to clearly illustrate how these advantages resulted, the actual plan adopted will be detailed briefly.

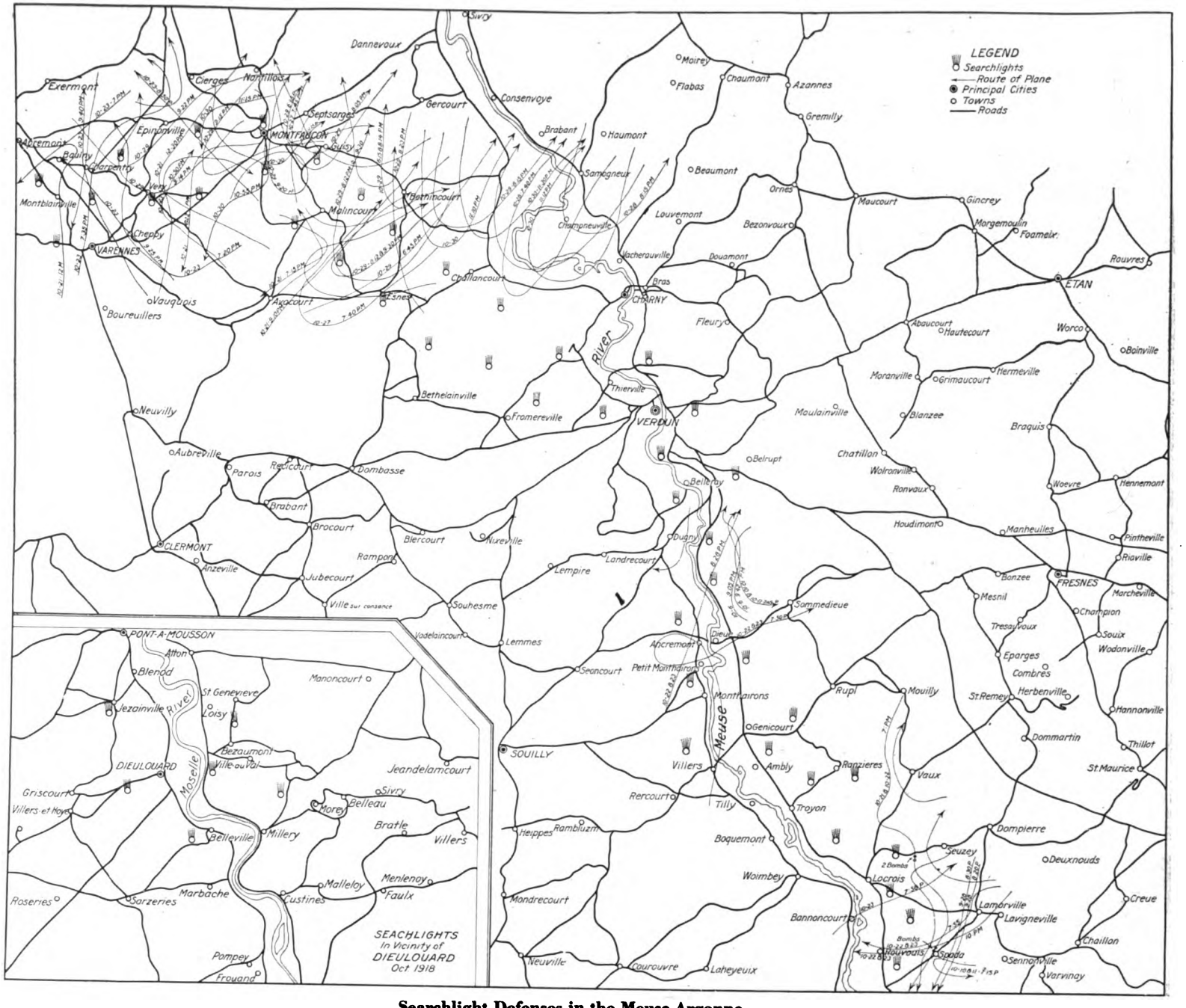
The pursuit planes defended the following areas:

(1) From La Croix-sur-Meuse to Verdun.
(2) From Verdun to Varennes.

The anti-aircraft batteries defended the following areas:

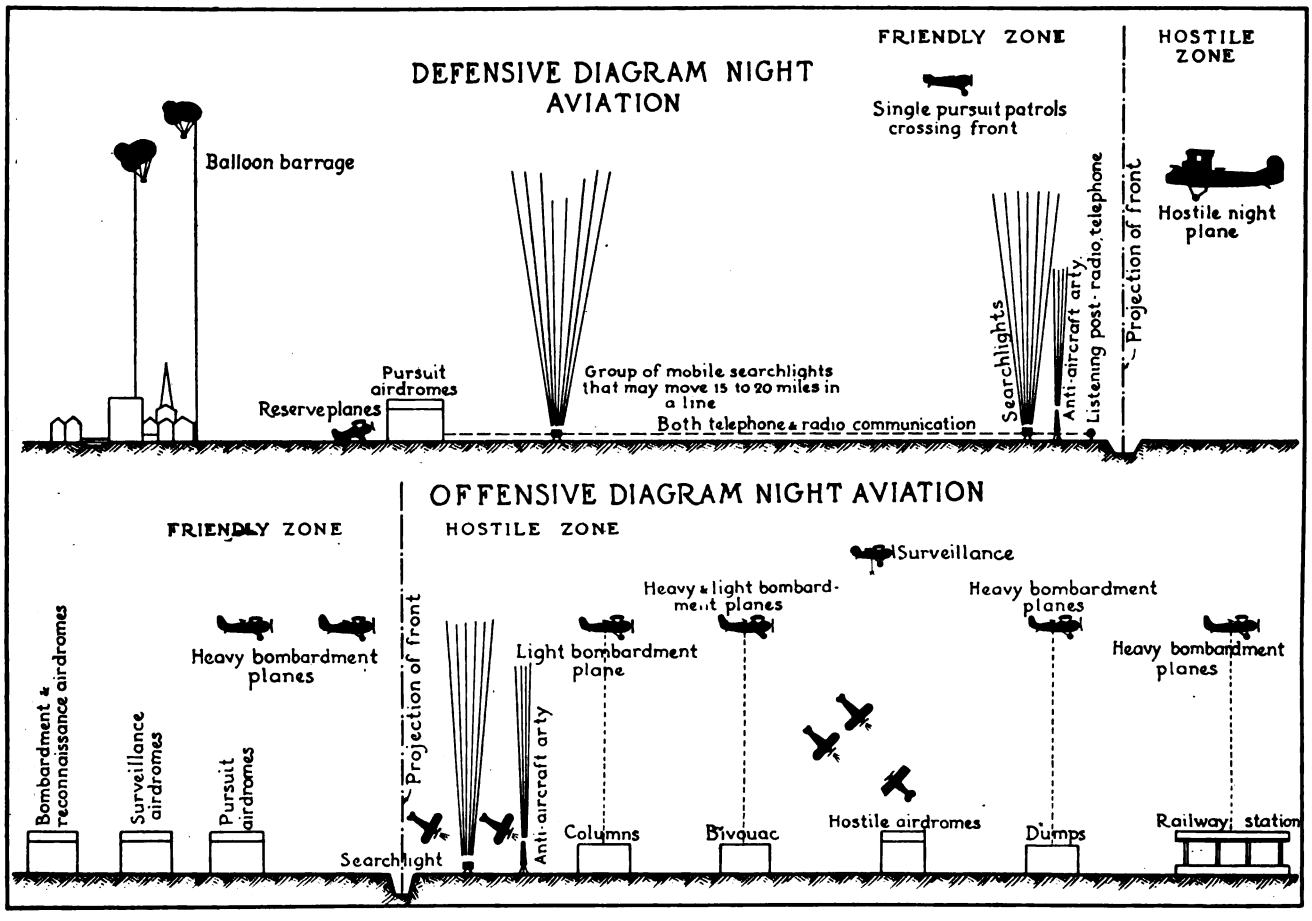
(1) The area south of a line running east and west through La Croix-sur-Meuse.
(2) The area northeast of Verdun, between the

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Searchlight Defenses in the Meuse-Argonne

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Meuse River and the Verdun-Metz Highway, including Verdun.

(3) The area west of the eastern edge of the forest of Argonne and south of the lighted area.

A brief outline of the principal details of this coöperation follows:

(1) Sopwith-Camel planes with Monosoupape motors were employed. These planes were very suitable, since they were comparatively easy to land at night, easy to maneuver, climbed quickly and had rotating motors which could be shut off for quite a length of time, thus enabling the searchlight personnel (and the aviators) to listen and detect the location of the hostile plane. It is worth noting that the fastest pursuit planes, which are most suitable for day work, are not as desirable for night operations, due to the increased difficulty in landing. The night pursuit plane need only be faster than the slow-flying bombing machine.

(2) On such nights as were suitable for attack, pursuit planes patrolled over the lighted areas which were defended by planes. They flew at a very high altitude and in rear of the searchlights. Rising to about 10,000 feet, the motors were shut off, and they slowly glided to about 5,000 feet, thus leaving sufficient time for the searchlight personnel to listen and direct their beams on the target. Sound locators aided the searchlights by giving a general direction in both azimuth and elevation, thus limiting the field of search. Additional planes stood by at the airdrome ready to start as soon as an alarm was received.

(3) A searchlight officer with sufficient personnel was stationed at the airdrome to insure thorough liaison, and to operate an additional searchlight placed near the airdrome. This searchlight, by directing its beam at certain prescribed angles in the air, acted as a guide for the patrolling pursuit planes, so that they would locate their landing field without difficulty. When a patrol was completed, the pilot easily recognized his guiding beam, and when he neared that beam, the ground lights could be seen and the landing signals observed.

(4) Practice was carried on by day and by night to familiarize the pursuit aviators, gunners and searchlight personnel with the details of operation, so as to avoid challenging or searching for friendly planes or firing in areas which were patrolled by pursuit planes, and similarly, to prevent pursuit planes from entering areas which were defended by anti-aircraft batteries. The night fliers became familiar with the areas to be patrolled, routes to and from the airdrome, the best positions for attack, etc.

(5) Wireless stations were installed, so that prompt signals of "alertes" (alarms) could be sent from the front line to the searchlight command post and to the airdrome. Excellent telephonic communication was also established between the searchlight command post and the airdrome; and the searchlight emplacements were connected to central switchboards at platoon, company, and searchlight headquarters.

(6) Experience has shown that a plane may land on a suitable field with the aid of the searchlight beam and no other illumination. The beam is directed across the ground and the aviator thus judges the ground line and makes his landing across the beam

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away from the mirror so as to avoid being blinded by the brilliant light. On a given emergency signal from a friendly plane, all searchlights near suitable fields illuminate those fields, thus aiding the pursuit plane in making a forced landing. By this method many widely scattered locations where friendly fliers could land, when forced to, were established, and the greatest danger in night flying was materially decreased. This use of searchlights was extended so that friendly bombing planes could also take advantage of the safer means of landing at night when necessity demanded it.

(7) The illuminated hostile planes were carried near the edge of the searchlight beams and then were attacked by pursuit planes close in, from underneath and behind. Due to its greater speed and maneuvering ability, the small pursuit plane can avoid attack, and, concealed by the darkness, it suddenly attacks an illuminated large target, from a dead angle where



Sopwith-Camel British pursuit plane

no defensive fire can be brought to bear on it. It is believed that it is not even necessary to illuminate a hostile plane, for if three searchlight beams are searching for a target and the pursuit plane flies toward the approximate intersection of these sharply defined pencils of light, there is enough twilight and reflected light from the beams themselves to enable the aviator to see his target and attack it.

(8) The anti-aircraft batteries were to put up a heavy barrage at the extremities of each patrolled area for the purpose of forcing the enemy plane into the lighted area where it could be attacked by the pursuit plane. The anti-aircraft batteries were thus concentrated much more than ever before, and if a bombing machine flew over their area, the chances of bringing it down were correspondingly increased.

(9) At the limits of the patrols the personnel at the searchlights fired a stream of tracer bullets when the friendly plane approached. This indicated that the end of a patrol was reached, so that the plane would turn back over the proper course and avoid being lost or getting into gun-defended zones.

Combined air defense tactics

The general principles for combined air defense tactics may now be enunciated:

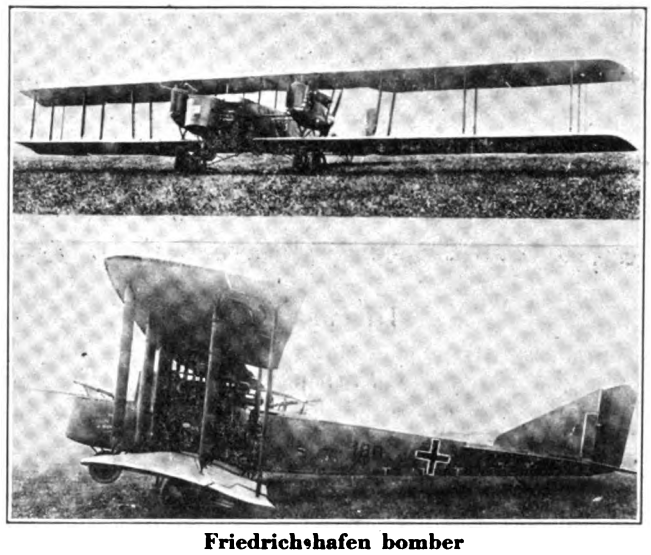
Territory. An area must be set aside for the operations. In this area there must be thorough liaison between pursuit planes, anti-aircraft batteries and searchlights. The area should cover a natural and usual approach of enemy bombing planes.

Anti-aircraft batteries. The anti-aircraft guns must not fire over the portions allotted to defense by pursuit planes. The guns should be grouped beyond the limits of the area, in order to insure a greater length of front being protected against enemy bombing planes, and to drive enemy machines into the zone defended by pursuit planes.

Pursuit planes. They should be flying at a suitable height to quickly attack any plane when illuminated. They should fly just in rear of the lighted area in order to prevent enemy listening posts from being aware of them, to avoid preventing the searchlight personnel from listening for the enemy planes, which is essential in order to illuminate them, and to be in a better position for observing the lighted area. The airdrome of the pursuit planes should be located just in rear of the center of the lighted area which is defended by them. This gives the following important advantages:

(*a*) Greater efficiency, since it will not take the planes as long to reach the proper point in the lighted area.

(*b*) Economy of planes and pilots, since here it would not be necessary to have a plane flying over the area except when the alerte was given, or definitely expected. No continuous patrol need be maintained when bombing operations are possible but not probable. If the field is suitably located, there is still sufficient time when an alerte is given for the plane



Friedrichshafen bomber

to rise to the proper height and reach the place for attack.

(*c*) Less chance of accident to machine and pilot, since the distances to be traveled to and from the landing field are greatly shortened, while the number and length of flights will be correspondingly decreased. When an alerte is finished, the aviator may land immediately, but if the airdrome is a great distance away, the patrol must be continued in order that the pilot may be ready for a second alarm.

Searchlights. They should cover as great a length of front as is consistent with making the defenses ef-

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fective. When resources are sufficient and a continuous band of light has been placed across the front allotted to the army, the remaining searchlights should be used to broaden the lighted area. The searchlights must illuminate enemy bombing planes for a length of time sufficient to allow the friendly pursuit plane to attack them successfully. The searchlight beams must not be exposed until the hostile machine is well into the lighted area. If beams are exposed too soon the bomber will turn back from the zone, while if searching is commenced only after the target is well into the area, the chances of illuminating him no matter how he flies, are excellent.

General. It is believed that, in the future, the principal use of army searchlights will be in conjunction



90 cm. Harley searchlight with paraboloid

with the air service to combat night bombers. The economy, as well as the efficiency, of this method of air defense is apparent after even a casual study. One pursuit plane can patrol an immense area. Two or three others, all manned by skilled pilots such as America has shown herself capable of developing, located at a convenient field to furnish reinforcement and relief, are all that is necessary.

Discussion

J. P. Hopkins

Colonel, C. A. C.; formerly Chief of Anti-Aircraft Service, A. E. F.

The author of this article was one of the searchlight officers in the Anti-Aircraft Service in the A. E. F., and knows his subject thoroughly. Whatever can be added has probably been considered by the author and deleted. With this warning to the reader and with apology to the author, the following remarks are submitted.

The gasoline engine for running the searchlight can be started and the light put in operation very quickly, but the beam is kept covered by a shutter until the proper instant for its exposure. A listening apparatus (supposed to be available) mounted near the searchlight, determines the direction to the plane. Of course the plane is always ahead of the direction in which it is heard and proper allowance is made for travel of the plane during the time of transmission of its sound. The direction to the plane is continually communicated to the searchlight so that the axis of the light can be made to follow the plane continuously. The shutter is opened at any desired instant after the light has received proper setting.

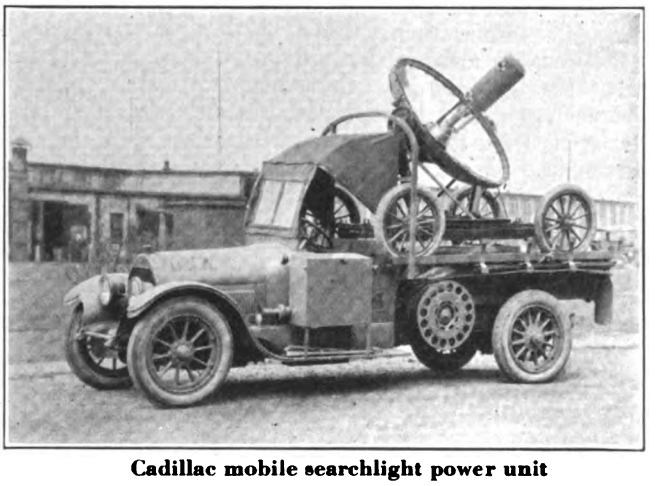
As soon as the light is flashed, an observer with field glasses can usually spot the plane. If the plane is not already covered, the observer directs the light on to the plane. If this fails, the light is continually directed from the listening apparatus so that the beam is always approximately on the plane.

Illumination which makes the plane visible from the ground is ideal but not essential. In addition to the "twilight" illumination it was found in the London defenses that the beam would penetrate a fog or mist so as to be effective for the pursuit plane even when observation from the ground was impossible.

The light is never flashed except when directed toward a hostile plane, so that the pursuit patrol knows there is always a hostile plane near a beam. Two intersecting beams locate a plane with fair accuracy.

A plane has less than one chance in ten of getting through a searchlight area without being illuminated. If the patrol can get sight of the bomber, the chance is ten to one that the enemy will be brought down. The difficulty is in having the patrol near enough to catch the bomber as he passes. Organization in depth of searchlight area, so that illumination can be continued by successive lights, adds to the pursuit patrol's chances of overtaking the bomber. A patrol may follow a bomber into gun area by giving a prearranged signal flare or light to prevent the guns from opening fire.

The defense of back areas is greatly strengthened by the use of protective balloons. These are simply obstacles which are effective because of the danger to the plane if it strikes the balloon or its holding cable. The British devised and used wire streamers suspended from wires connecting three successive balloons and kept taut with weights. The British, French, and Italians all found protective bal-



Cadillac mobile searchlight power unit

loons to be a complete success in that no bomber would knowingly take a path through them, and in an area where they were known to be used, would always remain at such a height as to insure safety. This reduced greatly the vertical space in which patrols would have to search for bombers in a beam. Incidentally it kept the bombers at such height that accurate bombing was impossible. The British overheard a German commander reporting upon his return from a raid over London that the route he took was "ballooned" and that he could not follow that route again.

There were two distinct plans for defense against night bombing. The plan adopted by the British and American

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anti-aircraft services was to use listening apparatus as a means for directing search lights; then to attack the illuminated target with anti-aircraft guns or with pursuit planes.

The French plan was in general to determine the path of the plane and its height by means of listening apparatus and plotting boards from two or more stations, and with data thus obtained, to place a barrage or successive barrages in the immediate path of the plane with all guns within reach. American anti-aircraft artillery was instructed in the French system as a supplementary means of defense. The French had developed the search-light system previous to the first raid on Paris in 1918. They changed to the other system immediately thereafter, and continued "fire by sound" to the end. In subsequent raids on Paris, only 26 planes out of an aggregate of 453 sent over, actually reached Paris. In the absence of anti-aircraft defense, each hostile plane might have reached its objective and delivered its load of bombs with fair accuracy, so it is fair to credit the anti-aircraft defense of Paris with being at least 94 per cent efficient. In addition, hardly a German plane returned from Paris unwounded; twelve were brought down: either shot down or forced to land in French territory from wounds received from the Paris defenses.

As for the other system, 34 German planes took part in the last raid on London on the night of May 19-20, 1918. Three of these were shot down by anti-aircraft artillery; three were brought down in England by pursuit planes; one crashed in England as result of engine failure possibly caused by anti-aircraft fire; and three were lost in Belgium in returning. Of the thirty-four planes in the raid, thirteen actually arrived over London, but eleven, or 30 per cent, were destroyed.

John C. Gotwals

Lieutenant Colonel, Engineers; formerly Commanding 56th Engineers, Searchlight, A. E. F.

Major Tompkins presents a phase of warfare which was seen for the first time in the World War, and one which was under development when the war ended. It is unfortunate that a deeper and more general impression could not have been made upon our army as to the efficacy of the methods described. Major Tompkins has performed an important duty in describing in this clear way, the really remarkable work done in France. There is no thought of looking backward in so doing, and reward has already been given in the consciousness of difficult work honestly and zealously performed, but we must look forward.

An aeroplane carrying twenty passengers has operated uninterruptedly between London and Paris daily for five months. Nor is this alone in the post-war aeroplane achievements. Lord Fisher recently said that floating battleships were obsolete in view of the possibility of attack by bombing planes. We must realize the amazing change which the present development of aeroplanes has brought about in warfare and the possibilities of the same in the future. We must realize now the power of the bomber and prepare a defense against him rather than wait until thousand pound bombs dropped from night bombers crossing the lines by hundreds in the next war, give us the dangerous proof of his power. The night bomber will cross the lines in such numbers and will drop bombs of such size in the next war. We may prepare for it now if we wish. The tactical, as well as the economic advantage of delivering explosives to the enemy in cheaply fabricated bombs, carried by a night bomber, is obvious. To combat the night bomber, we have the various means of defense, pursuit planes, searchlights, artillery, machine guns, smokes and camouflage. Experience in this defense has confirmed the following:

Combating the night bomber calls for an organization for carrying on war In the air at night.

This seems self evident, but the belated use of the pursuit plane against the night bomber in France, showed that this simple principle was not promptly recognized.

A word in reference to searchlight material seems worth while. The material for searchlights, while it should be brought to the highest possible state of perfection by electrical engineers, must not be such that only an expert electrical engineer can obtain service from the same. The more or less humorous picture still left of the operation of searchlights placed in the hands of troops before this war must never be seen again. Such a searchlight after protracted labor, much to the surprise of all observers, would finally strike the arc and thereafter promptly sputter away into darkness by virtue of the ingenious and cumbersome "automatic" control which had been so cruelly inserted between the entirely innocent power plant and the arc. The simple mechanisms and power plant with a simple, dependable mechanical pipe control developed in France, must continue in use or be improved upon in the direction of simplicity.

As to personnel, intelligent, well disciplined soldiers only are necessary. High technical attainments in electricity and physics are all worth while, but not indispensable.

A correct picture of the mobility demanded of searchlight units must be given. The method developed in 1918 and prosecuted in the closing months of the war of moving the searchlights forward with the advancing line will prevent an enormous amount of bombing. The demands made upon every one in the searchlight units to secure mobility are very great. Light and power plant must be dug in, movements made over crowded roads, searchlight positions selected, telephone lines and wireless set up and constant co-operation with the neighboring flyers and artillery secured. The conditions of service for searchlight units operating continually behind the lines are very similar to those of pioneer engineer regiments with combat divisions. The service of one searchlight company in France which was continually in advanced positions in very active sectors from May 1st until the armistice, has left a very distinct impression upon me of the demands made upon searchlight personnel. For this reason, searchlight troops operating just behind the lines must be relieved at intervals for rest and refitting. To make this possible the British army plans to attach searchlight troops to divisions and thus rest these troops with the division.

Finally it is desired to present the following, which I believe now to be axioms of procedure in combating the night bomber.

(*a*) The night bomber operates with comparative security until caught and held in the searchlight beam.

(*b*) The night bomber is a good target for the artillery when held in the searchlight beam.

(*c*) The night bomber is helpless if attacked by pursuit planes after being caught and held in the searchlight beam.

Major Tompkins has presented the successful use of searchlights and pursuit planes in a very clear manner and it is thought that this paper deserves careful study. His conclusion in regard to the future use of searchlights in war, that they will be used chiefly in conjunction with the air service to combat night bombers, is entirely sound.

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Tank Tactics

Extracts from an article, in "The Infantry Journal,"

By

S. D. Rockenbach

Brigadier General, Chief of Tank Corps, A. E. F.

I. History and organization

The present organization and doctrine of the American Tank Corps was developed during the late war, utilizing the experience of the French and British, and modifying their organization to suit our own needs and experience. Immediately after the arrival of General Pershing in France in 1917, a careful study was made of the Tank organization of the Allied Armies. The French at this time were using two types, the Schneider and the St. Chamond. These were artillery carriers rather than tanks, each carrying a 75 and two machine guns. As a matter of doctrine the French had, however, abandoned the idea of the tank as primarily an artillery carrier. The American Army concurred in this view, believing that the moment the tank goes into the artillery business it loses its idea, and must greatly increase its personnel for observation, special reconnaissance, indirect firing and other purely artillery functions. The French also believed a separate Tank Corps was necessary in order to maintain esprit and to insure proper training. They did not consider it practicable to have tank units an organic part of divisions, since only about 40 per cent of the Western Front was suitable for tank operations, and since further the limited supply of tanks made it impossible for them to be assigned permanently to divisions.

The British had developed a separate tank corps, and on account of the peculiarities of the terrain along their front were working with heavy tanks. They considered these tanks as belonging to the strategic reserve. Their theory of operation was that the tanks should be sent forward in a series of waves; the first going to the enemy's third lines, the second to the enemy's second lines, etc. Experience at the battle of Cambrai in 1917 showed that this method of attack was practicable, but that tanks could not hold the ground which they had captured and therefore the infantry must follow closely to take possession.

As a result of the study made by our officers, a definite organization for an American Tank Corps was recommended, and it was decided to adopt two types of tank—the Renault for a light tank, and a new model Anglo-American heavy tank. Two Renaults were sent to the United States as copies. For the heavy tanks it was decided to construct twelve hundred, England and America to cooperate in supplying the material, and the tanks to be assembled at Chateauroux and distributed among the American, British, and French Armies. Arrangements were also made for training tank personnel with the British, and for developing tank training centers in the A. E. F.

American tank units were present at St. Mihiel, using one hundred and fifty Renault tanks bought from the French. They also fought through the Argonne. During the latter part of October the effective American tank organizations had been reduced to one company, but by October 30 the Second Tank Brigade was prepared to enter the fight with one hundred and fifty light tanks.

As a result of A. E. F. experience, the proper tank organization was considered to be the following: General Headquarters of the Tank Corps at G. H. Q.; Tank Corps Headquarters with each army; tank centers for training and replacement; and ten tank brigades. Such an organization includes personnel of 21,800; 730 heavy tanks; 1,520 light tanks; 1,460 6-pounder guns (2.28″); 600 37-mm. guns. In connection with these figures the point should be noted of the great economy in personnel for a given amount of armament in the Tank Corps. The personnel to man the above artillery and machine guns, on the basis of personnel allowance in the field artillery and machine gun battalions, would be 145,000, simply for serving the guns. It must, however, be understood that a tank is not a substitute for artillery, and must have artillery support.

II. General combat principles

The tank is purely an offensive weapon, and if used during a defensive combat must be used for counter-attack only.

The tank is primarily an aid to the advance of infantry engaged in a vigorous offensive, either in the assault of semi-permanent works or in open warfare.

Tanks should never be used in operations where the other arms can advance without their aid. One reason is that what disables tanks is not so much the fire of the enemy as the wear and tear of operation. Another is that when infantry habitually attacks behind tanks it loses its initiative and morale—just as it does when it attacks habitually behind a barrage—and becomes a scavenger for the tanks or artillery.

Tanks can take anything, but can hold nothing, and there must therefore be the closest liaison between tanks and infantry, both before and during combat.

Tanks should be placed well in front of the most advanced line of the infantry, but in open warfare should be preceded by infantry scouts to locate machine guns and centers of resistance. They must, however, regulate their pace on the infantry skirmish line.

Tanks in an attack must be disposed in depth, the support tanks following the infantry support and the reserve tanks following the support tanks. This is essential to maintain the strength of an attack by the feeding in of supports and reserves; at the same time the support and reserve tanks can destroy centers of resistance overlooked by the first wave, and assist in resisting flank counter-attacks or in exploiting the success on the flanks.

The assault position should be arrived at if possible under cover of darkness. A tank attack should be launched at dawn and be a surprise attack. Otherwise, the enemy will place isolated guns to break up the attack.

Tanks should have supporting batteries to fire on anti-tank guns, in the ratio of one battery per one thousand yards of front, and should have airplanes detailed to assist them in the ratio of one per 1.000 yards of front.

Tanks must direct their fire on the elements most dangerous to the infantry, except that where anti-tank guns are located they must concentrate on these. Continuous fire should be used only in attacking batteries, as these are the

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most dangerous foe of tanks. Batteries should if possible be taken in the flank or reverse, never frontally except in great emergency. In a frontal attack on a battery a tank should follow a zigzag course and use smoke screens. Movement is the best defense of tanks and smoke the next best. If they halt to make repairs they must take cover.

Even if out of ammunition, tanks should advance as long as the infantry does, for the moral effect and to attract fire. Reconnaissance during combat should be made at every halt by tank personnel with the special purpose of avoiding surprise by hostile batteries.

Infantry operating with tanks must fight their way forward in all respects as if no tanks were present. If this is understood, tanks will be called on only when strong resistance is encountered. They should be used in large numbers or not at all. Demands for tanks to do trivial things must be invariably refused. A few tanks will destroy the independence of infantry without being able to make substantial gains. Large tank units should be held intact for major operations.

III. Tactical employment of light tanks

Light and heavy tanks, as a rule, will both be in an operation. The heavy tanks precede the light tanks and infantry, especially in the first stages of an attack on works, in order to insure passage and to cover the infantry and light tanks while they clean up. *The function of the light tanks* is then to fight in immediate touch with the infantry, destroying machine guns, cutting wire and breaking up other resistance which is retarding the infantry.

The light tank combat unit is a *platoon* consisting of five tanks, which habitually attacks in line on a front of 300 to 600 yards. A platoon follows the barrage by about 75 yards and precedes the infantry by about 50 yards. In the first stages of the assault the light tanks open fire on the enemy as the barrage lifts, and thus keep them down until the arrival of the infantry. Their next function is to cut the wire. On reaching the trenches they should not attempt to cross unless the trench is narrow, but should deluge the trench with fire, and prevent the use of front-line machine guns by patrolling the front of the trenches. At this stage they should also neutralize the fire of the enemy support trenches. The first trench having been occupied by the infantry, the accompanying engineers (half a platoon for each tank platoon) at once prepare one crossing per tank platoon. The platoon then passes over in column and deploys to continue attack.

In assaulting villages, light tanks avoid the main streets and attack by flank and rear, and after taking the village pass beyond to avoid the fire of the enemy artillery.

Platoon exploitation. In a platoon sector not exceeding 600 yards, the light tanks precede the infantry, and are preceded at 150 yards by infantry scouts, whose function is to locate centers of resistance. When a scout signals that one is located, the two nearest tanks converge on it. The infantry following the tanks at once initiates attacks on any centers of resistance attacked by the tanks. If the center of resistance contains field guns or anti-tanks guns, all tanks of the platoon converge on it, attacking by flank or rear where possible, and using smoke screens and a zigzag course. The supporting infantry should at the same time open fire on the center of resistance.

A light tank company consists of three platoons and additional units. In assault two platoons attack as described above, usually separately and the third platoon acts as support for one or both, either to supply replacements or to mop up defensive centers which have been overpassed.

Company exploitation. The two platoons remaining in the front line will here usually be more than the normal interval apart. The function of the support platoon in exploitation is primarily not for replacement but as a tactical support. The support platoon should accordingly advance from cover to cover, approximating normal distance only. The radio tanks remain with the company commander, and take every advantage of cover. Of the eight reserve and training tanks, one is a repair tank and should follow the support platoon at 500 yards. The others follow at about 1,000 yards, and are normally used as replacements at the end of the first day's fighting.

A light tank battalion consists of a radio tank and three companies. The battalion attacks with one company in reserve, at 1,000 yards behind the support platoon of one of the attacking companies.

IV. Tactical employment of heavy tanks

The principal function of heavy tanks is the reduction and destruction of works in trench warfare. They are seldom used in exploitation, advance, or rear or flank guards, due to their vulnerability and rapid depreciation.

The combat unit is a *platoon* of three tanks. It attacks in a wedge-shaped formation with center tank 50 yards in advance. Each tank must have a definite route, and regulate on the infantry and barrage, but action in attack is more or less independent. Platoon attack orders specify points where tanks are to cross trenches, and also the flank to which they will patrol, so that a definite sector of trench may be neutralized by each tank. After accomplishing their mission of reducing works, tanks push forward into enemy territory.

In attacking villages, heavy tanks attack by flank or rear to avoid obstacles. An attack on a village should be started in time to neutralize or reduce it before it becomes harmful to the approaching infantry. As soon as the tanks have reduced resistance offered to the infantry, they proceed to the rear of the village to prevent the escape of the enemy.

A heavy tank company consists of three platoons, six reserve tanks and the company commander's tank. Nine tanks are employed in a company operation, the remainder as replacements. In an attack the company puts two platoons in the front line and one in support at 200 yards.

The heavy tank battalion operates along the same principles as the light tank battalion.

A tank brigade consists of one heavy and two light battalions and a repair and salvage company. It is an administrative rather than a tactical unit.

V. Tanks in special operations

Pursuit. Tanks are very effective to pursue a broken enemy. Here they will attack without immediate support of infantry, being launched in small groups along roads, and across country where possible. Their object is to break up organized bodies of the enemy, obstruct roads by killing horses or wrecking trucks, and delay the retreat. In such an operation tanks act for the most part individually.

Light tanks may be used for *advance guard work,* but only in pursuit or in a reconnaissance in force. Two tanks precede the point of the advance guard and attack centers of resistance, the remaining tanks of the platoon accompanying the reserve of the advance guard.

The use of tanks in *rear guard actions* is not permissible unless the retreating force is demoralized. When used, they should be dropped behind at critical points, and as the enemy approaches should attack vigorously, and then retreat after doing as much damage as possible.

Night operations can be conducted by tanks with infantry

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support, under favorable conditions, but require very careful training of both tanks and infantry.

In stationary warfare, *tactical raids without a barrage* may be assisted by two tanks with the infantry. This will require a moonlight night, and the use of airplanes to drown out the sound of the tank motors. Tanks attack at 100 yards interval, cut wire and then move along the trench toward each other, clearing it of hostile troops. When they meet they return through the wire, and then cover the withdrawal of the infantry.

Tanks may be used in conjunction with *cavalry* on *strategical raids.* In this case each tank pulls a trailer wagon loaded with forage, etc., allowing the cavalry to travel with stripped saddles. The tanks are used where necessary to break up opposition to the cavalry.

Circumventing the white ant in building construction

Every race and every clime has its own difficulties. Manifestly it is part of the Creator's scheme of things that we should have them.

In our country the troubles of the engineer are due in large measure to Jack Frost and the teredo. In Formosa they are due chiefly to the termite or white ant.

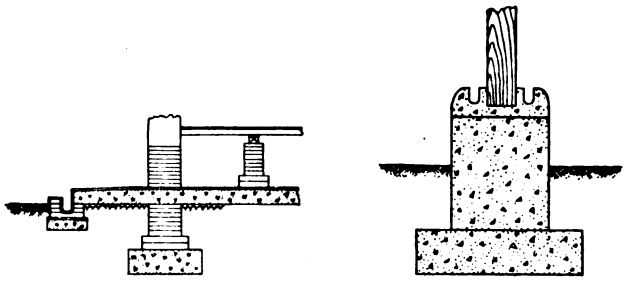
The Philippine Journal of Science devotes an issue to an account of this destructive creature and his stimulating effect on man's ingenuity—from which the following statements are culled:

Because of his subterranean and aerial habits it is very difficult to destroy the termite, or to guard against his insidious attack. Also he is highly civilized, very intelligent, has an excellent system of autocratic government, including universal training for all males and females of military age.

Wooden buildings fall an easy prey to the termite. It also attacks the lime mortar in the joints of brick buildings. If the building be protected by a layer of concrete covering the entire foundation, subterranean attack is of course prevented. In this case the termite builds a tunnel of mud over the concrete foundation to reach the superstructure. Railway ties are, of course, wide open to attack. Even ships are not immune, as the ants, who are winged at certain periods of their career, fly out to the ships in the harbor.

As it is impossible to eliminate all non-resistant timbers from a building, some method of excluding the termite is necessary. The first step is to treat the site of the foundation with a heavy crude oil. All footings must be of concrete, and a layer or shield of concrete must extend over the entire area of the foundation. Around the entire outer edge of this concrete base extends a channel or drain which is kept filled with water or non-volatile oil. Thus the termite is excluded from beneath. Should the drain go dry and he be able to cross it, his tunnel is easily detected. It is essential that the concrete shield be a monolith, otherwise the termite will penetrate the joints In the Philippine Islands the concrete shield is often dispensed with, buildings being erected on concrete posts, extending well above the ground, each protected by a continuous oil channel.

But even these precautions are not enough. Unable to attack under or over ground, the termite has recourse to the air, entering the upper portions of the building.



Termite-proof building construction

A very exhaustive test of many varieties of wood was conducted and only four were found to be entirely immune from damage. These were the Philippine woods, ipil and molave, and cypress and teak. These were hardly sufficient to meet the needs, and experiments were made in the treatment of timber with various chemicals. Camphor green oil was found the most satisfactory, rendering many other woods in large measure immune from attack.

Our Motto

Editor of THE MILITARY ENGINEER:

I note with interest your discussion of the motto "Essayons" in the Jan.-Feb. number of the MILITARY ENGINEER. I agree with you that "let us try" does not meet the requirements of a present-day motto either for military or civil engineers, and I would venture to suggest a more free translation which I believe would more nearly satisfy the requirements. Instead of "Let us try" why not translate "Let us go," which when used on the march or on any kind of engineering work is usually abbreviated to "Let's go," and really means "We go to accomplish regardless of what the task may be."

To illustrate the above I give the following: My brother was with the 23rd Inf., 2nd Div., near Belleau Wood, in June, 1918, before the German drive had been turned. He was badly wounded and taken a distance to the rear and placed in an emergency hospital in a French village. After he returned here I visited him and asked him what impressed him most while in the fighting zone and his reply was about as follows: The passing of thousands of truck loads of American soldiers going towards the front from which he had just returned, with the ever sounding call "Let's go" echoing down the streets. This cry meant more than "Let us try" or even "They shall not pass," it meant to the villagers and the wounded American soldiers "They shall go back," and they did. The young Frenchmen of the village got orders to mobilize for immediate active service and they took up the American's call "Let's go" which sounded more like "Lees go" as they rushed along the street, full of excitement and desire to accomplish.

I believe that the free translation of "Essayons" to mean "Let's go" would meet the requirements of a present day motto for engineers. "Let's go" carries with it the implied meaning "We go to accomplish."

ENGINEER RESERVE OFFICER.

[We like the spirit which our correspondent breathes. It is the spirit the engineers have, and which their motto should convey. "Essayons" appears to be an elastic motto as interpreted. In the foregoing it is equivalent to "Allons!"—"Let us go." It has also been interpreted as "Asseyons!" ("Let us sit down")—expressing quite a different mood.—ED.]

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Ranging Equipment of the U. S. Army

By

J. B. Cress

Lieutenant Colonel, Engineers

RANGING by sound and flash, to determine the location of hostile batteries and for other purposes, was one of the picturesque developments of the World War. It seemed to interest the average officer of another branch of the service as much as anything the Engineers were doing.

When the United States entered the contest, over two years of position warfare in Europe had brought about the development of remarkable ranging instruments. This development can be traced: first, to the advances of science; and, second, to the static conditions of the fighting fronts, which permitted the laying out of exact base lines and the use of complicated and delicate devices. It was, therefore, necessary, that if American forces were to use the ranging instruments of the Allies, a determination be made as to whether we should use foreign equipment of foreign manufacture, or adapt these instruments to American manufacture and develop improvements. The latter course was adopted with provision to utilize the instruments of our Allies until we should be able to put our own into production. The difference between our manufacturing methods and those of France or Great Britain involved difficulties in reproducing European matériel, appreciated by those who have encountered them. Further, any equipment to be produced in quantity in the United States should, as far as possible, be made up of American standard articles.

Ranging equipment may be divided into two general classes: the first, that which utilizes *sight*; second, that which utilizes *sound*. Sight ranging, or as it is usually called, "flash" ranging, has been used during the war both for the location of enemy guns and for the purpose of ranging for our own batteries by locating bursts. The theory of flash ranging is very simple: the methods used are based on the well-known principles of triangulation. The outfit consists of a central switchboard connected electrically to as many as six field observer stations. When an observer sees a flash, he presses a button which flashes a small electric light on the central switchboard. The observer then reads the azimuth and phones in his readings. Lights appearing simultaneously on the central switchboard indicate that the observers are on the same flash. Knowing the positions of the observers, a simple calculation gives the location of the flash.

The development of equipment for this work consisted principally of designing a telescope and a portable switchboard, American made. The problem was one of production rather than development.

Sound ranging is of several types: that which utilizes vibrations of the earth; aerial ranging, or that used with searchlights, for determining the location of aeroplanes; and, most important of all, what is commonly known as sound ranging, for locating enemy battery positions. Earth ranging is used almost entirely in mining operations. Our Allies developed a small instrument known as a geophone, which, if placed upon a rock, or solid earth, at the head of a mine, greatly increased the powers of the listener to determine what mining operations the enemy was carrying on. The American instrument, as developed and manufactured in the United States, is about 30 per cent more acute than any of the European instruments. In its improvement, special emphasis was given to making it *selective*, so that sounds, such as those produced by hammering, picking, shoveling or scraping, were distinguishable one from another.

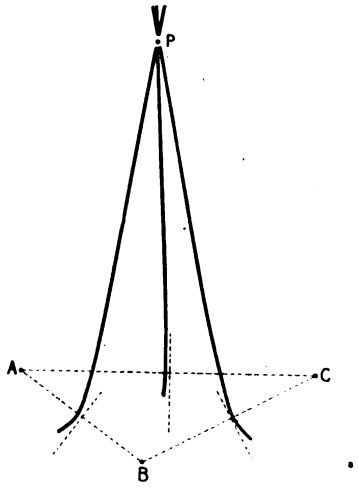
An electrical and mechanical development of the geophone, manufactured both by our Allies and ourselves, is known as the microphone listening set. In this instrument, the listening devices are electrically connected to a switchboard and battery box, provided with a telephone head set, which may be placed in a dugout a mile or so to the rear. The observer can then listen to sounds which are received at the head of the mine galleries, or from points in No Man's Land, while he, himself, is in a position of safety. Thus it is possible for one man to listen at six places instead of one. In the American microphone, the listening device is so designed that, if buried about 3 inches under the surface of the ground, it will register both earth waves and air waves, so that the sounds of mining, or countermining, footsteps, or even conversation in the vicinity, can be picked up by the listener, far in rear.

Reports from France indicate that the geophone was in a measure responsible for the abandonment of mining operations. Microphones were used to a

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certain extent during the war, but it is believed that they are suited to much broader utilization, particularly for determining what is happening in front of outposts or strong points when no patrols are out.

The increase in night bombing operations at about the time the United States declared war brought about the serious investigation of sound ranging devices for determining the position of aeroplanes at night. It was once thought that these devices might be of practical use in connection with anti-aircraft artillery fire, but their accuracy is not sufficient to give more than an approximate direction. However,



in the case of anti-craft searchlights, a successful listening device is of great advantage. Several types of these instruments have been developed by the British and the French. The American instrument, developed from a European design, consists primarily of a paraboloid, which reflects sound to its focus, where are placed a number of listening trumpets. These trumpets are connected for two listeners: the horizontal listener directs the paraboloid so that it has apparently the same azimuth as the source of sound (when he hears the sound equally with each ear); the vertical listener, similarly, moves the paraboloid until it has the same elevation as the sound.

The principal problem of development in the United States was the production of an instrument of greater portability, and, if practicable, of greater accuracy than those used abroad. The latest 9-foot American paraboloid weighs about 1,300 pounds as against 6,000 pounds for the French instrument of the same diameter. Its cost is about one-fifth and its accuracy equal to or greater than that of the French paraboloid. It is mounted on Ford axles and wheels, and can be readily run into place and set up. For shipment, it can be knocked down and boxed in a small space. All these are improvements over the French instrument, which is heavy and bulky and requires at least a day to set up.

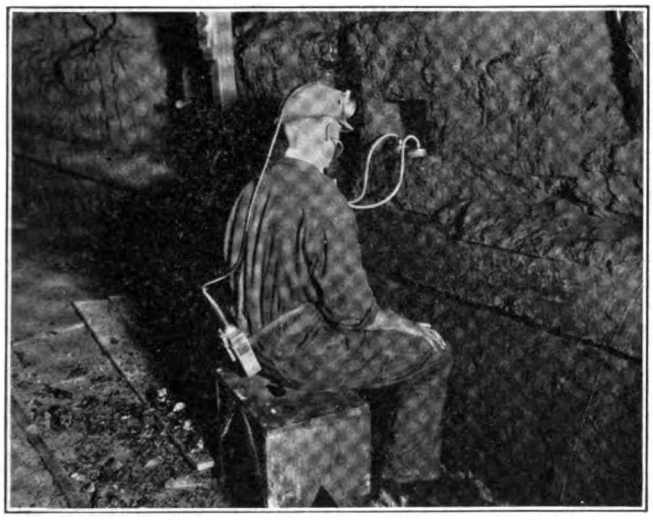
Developments in the so-called "long horns" which are shown in the illustration (page 279) have also been extensively carried on by the Army and Navy in the United States. These instruments have the advantage of an accuracy within 1 degree as compared to from 3 to 5 degrees for the paraboloid, but because of their great weight and size they are suitable only for fixed positions in rear areas.

Since the signing of the armistice, certain German listening apparatus has been secured which shows that while the Germans were not as far advanced as were the Allies in this development, it had not been neglected by them. The German listening device has one great advantage in that it is extremely light and portable.

By far the most important form of sound ranging, however—the one which has received the greatest attention and yielded the greatest return—is sound ranging for enemy battery positions. The theory of this method of location is not particularly complex. Suppose that a gun fires at some position, which may be called P (see figure), and that, at known positions A, B and C there are devices which will accurately register the *time* of arrival at A, B and C of the report of the gun fired at P. From the records obtained at A, B and C, we do not know the distance to the point P, nor its direction, but we do know the times at which the sound arrived at these points, and from these times of arrival we can determine the interval which elapsed between the arrival of the sound at A and its arrival at B. Similarly for the intervals between the arrival of the sound at A and C, and B and C. As sound travels some 1,090 feet a second, knowing the time interval we can compute how much further A is from the gun at P than is B; similarly how much further B is from the gun than C, and similarly for A and C. Turning to our analytical geometry or conic sections, we find that the locus of all points, the *difference* of whose distances from two fixed points is constant, is a hyperbola. The data obtained at A and B, that is the difference in the distance of the gun from the two stations, enables us to construt a hyperbola on A and B as foci, with the given fixed difference, and we know that the gun lies somewhere on this hyperbola. In the same way a hyperbola is constructed on A and C as foci, on which the gun also lies. Manifestly then, the location of the gun is the intersection of the two hyperbolæ. As a check on this location a hyperbola constructed on B and C as foci, should pass through the point of intersection of the other two. In practice, and to save time in plotting it is assumed that, except very close to the foci, a hyperbola coincides with its asymptotes, which assumption is sufficiently close for practical purposes. The asymptotes pass through the centre of the hyperbola, or the point midway between the two stations. From this point as a centre a circle is struck on the edge of the plotting board, and on this circle are graduations in seconds and fractions, corresponding to the time

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differences at the two stations concerned. A circle is made for each pair of stations, each circle having a distinguishing color for identification. A thread of the same color is fastened at the mid-point between the stations. When the time difference is known the thread is drawn taut across the proper division on the time scale of the circle. It then coincides with the asymptote of the proper hyperbola, and the asymptote itself need not be drawn. The intersections of two or more strings determine the location of the sound on the plat. In practice, in order to determine the interval between the arrival of the report at several points—A, B, C, etc.—electrical devices are set at these points, which, when disturbed by the sound waves, cause a chronograph record to be made by an instrument at a central station. In other words, each indicates the time of arrival of the sound on a central recorder; time intervals can then be readily determined at the station where the recording mechanism is located.



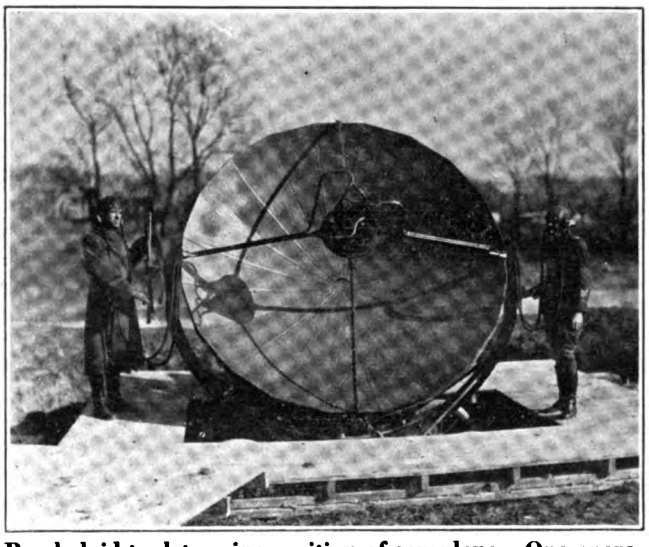
The Geophone in action

There were four types of the latter class of sound ranging equipment in use by our Allies when we entered the war. The British set, known as the "Bull-Tucker," was considered the best by the A. E F., chiefly because of its adaptability to work in periods of considerable artillery activity, and was, therefore, adopted for manufacture and use by the American forces. A survey of production and development facilities in the United States was then made, as a result of which a laboratory was installed at Princeton University for the manufacture of special cameras, by means of which photographic record of the sound arrivals is made; and designs were developed for the commercial manufacture of the remainder of the equipment. At the same time, the Bureau of Standards was requested to assist in the development of the French system, known as the "Telegraphe-Militaire." By the end of the war, American-made "Bull-Tucker" sets, capable of covering 80 km. of front, were in France, and other sets were ready for shipment.

About a month prior to the signing of the armistice, an American development of the French "Telegraphe-Militaire" was sent to France for comparative tests with the French, and "Bull-Tucker" instruments. This instrument arrived at the front too late for actual war test, but reports received indicate that it has many desirable qualities. It is more portable, costs less, and is more robust than the "Bull-Tucker."

The accuracy of sound ranging is entirely sufficient for directing artillery fire. A survey made in the A. E. F., after the cessation of hostilities, to determine German battery positions which had already been located by sound ranging devices, indicated that, while the individual locations in many cases were in error from 20 to 60 meters, the mean of six or seven locations could be counted on for an accuracy of within 10 meters. On the other hand, where an enemy gun fired and we immediately replied, the chronograph record from our bursts, if the latter were accurately placed, would be identical with that of the report of the enemy's gun. In this case, uncertain conditions, such as temperature, wind velocity, etc., were the same, and identity of record indicated a hit within 25 meters of the target.

The use of sound ranging had become very extensive before the fighting stopped. Reports state that some 80 per cent of all battery locations were made by this method. The number of locations which could be made in a given time depended upon the amount of firing on the front, but one section operating a single "Bull-Tucker" set located as many as 117 enemy guns in 24 hours.



Paraboloid to determine position of aeroplane. One operator controls the azimuth, the other the elevation

The sound ranging facilities of the Germans were far inferior to those of the Allies. It seems that they had succeeded in capturing two English "Bull-Tuck-

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er'' sets, which, after the armistice, were found at a school not far from the front. Apparently, however, the use of these instruments had not been developed by the Germans, and no other instruments of even comparable accuracy or speed had been put into service by them.

Discussion

R. G. Alexander
Major, Engineers; formerly Colonel, Chief of G-2-C (Intelligence Section, Topography), A. E. F.

As shown in the foregoing article very satisfactory progress was made during the war, in the United States The main difficulty arose from the great distance from the scene of operations. With the constantly increasing participation of American troops in the fighting, experienced officers were needed for new sections at the front and could not be spared for return to the United States. As a result developments in *material* were not always co-ordinated with front line conditions. Thus at one time sensitivity of sound ranging apparatus was so developed in the comparative quiet of the proving ground as to make the instrument almost useless in the greater sound activity of the battle field. Again the switchboard was equipped with conveniences and labor saving devices until it was so large and heavy it had to be taken apart and reassembled in France to accommodate it to the dugouts and other restricted quarters at the front. In the future all interested parties must work for better co-ordination.

The Bull-Tucker apparatus proved the best for sound ranging of any equipment available during the war. Its greatest defect lay not in the apparatus itself but in the fact that it required for its satisfactory use a double metallic circuit of high grade insulated copper wire. In addition to the cost the weight of wire was a great handicap. The wire for a section required two-thirds of all its transportation. The maintenance of the double circuit over shell-swept areas added greatly to the labor and danger of the wiring parties.

The most needed development was something to do away with the double circuit and permit of the use of a single line of light, cheap wire with ground return. The first T. M. set produced by the Bureau of Standards and sent to France effected this, but at the expense of other desirable qualities. The latest set sent arrived too late for field use, but offered much promise.

Although this article is on the subject of equipment it would seem of interest to add a few words as to the operating methods of sections at the front.

For quickly computing the location of a hostile gun when a record of its firing had been made by sound ranging, recourse was had to the use of a plotting board. On the board was stretched an accurate detailed or skeleton map of the sector in question on a scale of 1:20,000, divided into the customary kilometer squares. The positions of the microphones were carefully plotted. There were usually six microphones composing a section base, each two adjacent microphones constituting a sub-base. No personnel was stationed at the microphones.

In the earlier French plotting boards a set of hyperbolæ for each sub-base was plotted for regular successive time intervals of 0.1, 0.2, etc., seconds, up to 4 seconds (adjacent microphones were usually about 1,340 meters or 4 sound seconds apart). Each set of hyperbolæ was drawn for convenience in a distinctive color of ink. When a record was received the location of the gun firing was determined by approximating between the proper hyperbolæ already drawn on the board.

Later a simpler, but equally effective method was adopted, using the asymptotes instead of the hyperbolæ themselves. This could be done with sufficient accuracy, since the hostile guns were relatively much further from the microphones than the latter were apart, hence in the portion of the map where the hostile batteries lay, the hyperbolæ and the corresponding asymptotes were practically coincident.

Under this system the curves themselves were not drawn on the board, but the mid-point of each sub-base (intersection of all asymptotes for hyprebolæ on that sub-base) was made a pivot point for a plotting arm or string. The position of the string when coincident with the perpendicular bisector of the sub-base was marked as zero on the edge of the board. From this point as zero, a scale was extended round the edge of the board in both directions and graduated in units of time; that is, fractional parts of a second. The scale for each sub-base had a distinctive color corresponding to its string.

In practice, when a record was received, it was only necessary to lay the strings on their proper marginal scales to the readings corresponding to the recorded time intervals for the proper sub-base. Three or more strings intersected in a point for an exact location. For a poor location the failure to intersect or triangle of errror, indicated the degree of accuracy and represented the errors from wind, temperature, poor recording or reading of the film record, etc.

With American Sections in the field it was possible to telephone a new location within from three to five minutes after the hostile gun had fired. It was possible in less time to identify as firing a gun which had been previously located. In addition to the telephone report to counter-battery, a daily written report of all locations was submitted to the Artillery Information Service.

This report contained a great deal of useful information in addition to battery locations. A careful study of the film records disclosed at once the class of battery, that is whether howitzer or gun. With practice it also became possible for the reader to determine the caliber of the piece with reasonable precision. Since bursts of hostile shells were often recorded it was possible to gather much useful data as to targets selected by the enemy and batteries told off to fire on them. Forward observers stationed in advance and to the flanks of the microphone base for the purpose of starting the apparatus when wanted (thus saving film when there was nothing to record) also telephoned in much useful data as to kinds, calibers, and habits of the enemy artillery, and collected shell fragments, duds, portions of fuzes, etc.

These daily reports were studied by the Artillery Information Service and compared with information from the Air Service, statements of prisoners, captured documents, air photographs, and all other available sources. A location by sound was always verified when possible by study of the photographs and was often the first clue for finding the battery on the photo.

In one case this desire to corroborate the sound location was known to have saved a German battery from shelling. This battery was in the edge of a small clump of woods back of Mont Sec and was often located by Sound Ranging Section No. 1, and reported. It was very active up to the night of the Battle of St. Mihiel, when the guns were dragged out and stores of ammunition ready for firing left in place. Fresh wads and other signs told the story. A study of the ground showed that this battery had never been touched by an American or French shell. However

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just to the right and less than two hundred meters to the front was an old decrepit battery emplacement unoccupied for at least two years, but bearing all the evidences of having received a plentiful and accurate fire from our guns. This old battery was in the open and showed upon the air photographs. The locations of the sound rangers had always been considered as in error for this case and the true location never accepted because it could not be verified from the air photograph.

It is always a matter of general interest to know in how great a degree of artillery activity sound rangers can successfully work and whether it is not possible for the enemy to evade location by firing several guns simultaneously.

American sections have taken readable films in an activ-



Long horns to determine position of aeroplane

ity of six guns per second though, as a rule, little can be expected when the density of fire exceeds two guns per second.

As to masking fire, this can successfully be done only by increasing the general density of fire. Unless the two guns fired simultaneously are very close together, they cannot be equally distant from all microphones though they may be from any one or two. If very close together they form one joint target for our artillery. If apart, the record may show coincidence for possibly two microphones but sufficient interval on the others to enable the two locations to be distinguished.

The ability to pick out the proper breaks on a confused film is the result of considerable ability coupled with good training and much practice. The problem is greatly facilitated by placing the microphones in a straight line or preferably on the arc of a circle of large radius with center about the center of enemy artillery activity opposite the front in question. This results in the sound of a hostile gun reaching the microphones in a regular succession and the corresponding breaks on the film being placed in a more or less regular pattern, the shape of the pattern assuming certain well known forms. In a confused film it is thus possible to identify the corresponding breaks, when it would be impossible were the microphones placed indiscriminately in the sector.

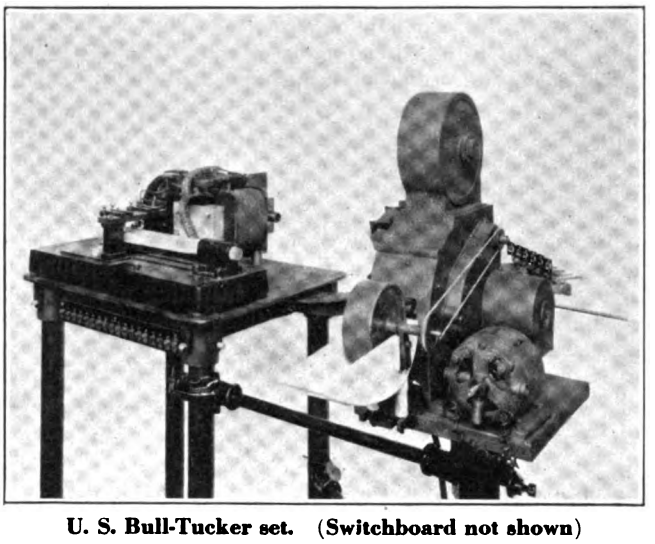
The life of the sound rangers was varied and seldom monotonous. In quiet times there would be dull days with the apparatus idle because the enemy artillery was apparently taking a holiday, or because an unfavorable wind swept all sound away from the microphones. During such times ranging shots were arranged for our own artillery if conditions were favorable. Nights were often hectic. Harassing fire would bring repeated calls from counter battery to locate or identify the offending batteries so they could be silenced. At such times the central force worked steadily and continuously while wiring parties mended broken lines and dodged shells throughout the night.

One section near St. Benoit became too ambitious and advanced its central to the line of microphones to save wire with the result that a large caliber gas shell struck the central building squarely and seriously wounded seven members of the section.

Prior to an attack or general forward movement the sections worked hard in order that the "hostile battery map" might be as complete and accurate as possible on the day of attack, thus increasing the effectiveness of our own artillery plan and thereby lessening the task for all attacking troops.

Meanwhile the flash rangers were equally active, working on enemy batteries at night when the flashes were clear and distinct and in the day time also searching the sector every minute to discover working parties or other transitory human targets. These sections were the eyes of the artillery and in general the only means of reporting a temporary target with sufficient accuracy to enable the artillery to open immediate fire by the map with a good prospect of hitting. The Germans opposite the Chateau Thierry sector may well remember the keenness of the American flash rangers and the accurate shooting of the Second Division's artillery. This combination scattered death and confusion in many an indiscreet working party or group of reinforcements moving without due regard for cover.

Flash Section No. 1 moved from Chateau Thierry to the Vesle, operating all the way. At times too zealous members in search of good observation posts found themselves in



U. S. Bull-Tucker set. (Switchboard not shown)

advance of our infantry and forced to take shelter from hostile rifle and machine gun fire.

While at times the flash and sound sections duplicated each other's work, in general their work was mutually supplementary. In times of fog or rain, all too common in France, the sound rangers had excellent working conditions and constituted the main source of information. At such times visual observation was impossible, as were also airplane reconnaissance and aerial photography. On the other hand, on bright clear days and nights, accompanied all too often by high winds, the sound rangers could do little while the flash rangers had excellent working conditions. The latter were also the main reliance in war of

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movement, since the enemy batteries were then on the move and occupying only transient positions.

One must not overlook the necessity for extreme accuracy in location of microphones and flash ranging observation posts with reference to the triangulation system of the map. On such careful tying in to the triangulation points, depended the accuracy of all battery locations. The work could not be done by rough and ready field methods but required careful instrumental work by skilled men capable of quick but accurate results under the unusual conditions prevailing in a sector under fire. The close union of Engineer map and ranging troops in France was a great advantage.

A staff officer of G-2-c, G. H. Q., in company with an experienced British ranging officer, visited a green American flash ranging section just installed, about a month before the armistice, on the heights overlooking the Woevre. The night was clear and the horizon illumined at intervals by flashes from the German artillery busy at harassing fire. The young section commander was in despair as his intersections on the plotting board were uniformly poor. On the advice of his visitors he telephoned his observation posts to each set the telescope on a certain low lying bright star and mark the reading as a new zero for further work. Upon resuming work with the new zeros the intersections on the plotting board at once became good, showing that the directing lines of the posts had not been parallel and probably the posts themselves poorly surveyed. A re-survey confirmed both errors and good results were thereafter obtained.

While good instruments for both sound and flash ranging are essential, it must not be forgotten that the best of apparatus is valueless if inefficiently operated in the field. Experiments should be conducted from time to time to improve equipment, keeping in mind that refinements carried beyond the degree in keeping with the allowable error in the field are useless. Efforts should be directed toward making equipment compact, robust, and fool-proof.

It is even more essential to secure a nucleus of trained and experienced men. In the A. E. F. green men were always fed into experienced sections for actual front line training before becoming themselves members of new sections.

In time of peace a limited personnel should be maintained for the service. In addition to study of equipment and technical methods of operating, including problems of computation, plotting, and survey, there should be frequent field practice, not on a proving ground, but at an artillery firing ground. It is essential that the artillery know and appreciate the possibilities of the ranging service in order to fully utilize it.

Commercial Use of the Geophone

[The engines of war find their application in peace. The following notes on the commercial development and possibilities of the geophone were prepared by Alan Leighton, Assistant Chemist of the U. S. Bureau of Mines. They will be of interest to all engineers.—Ed.]

The geophone, a listening instrument invented by the French during the war to detect enemy sapping and underground mining operations and for the location of enemy artillery, is now being used by the U. S. Bureau of Mines as an aid in locating miners who have been entombed by accident and for other purposes in mining and tunneling. The instrument was developed by United States engineers during the war and is now used by the Bureau according to plans drawn by these engineers. It is manufactured by the Globe Earphone Co., Reading, Mass.

The instrument, though small, is essentially a seismograph, since it works on the same principle as the ponderous apparatus with which earthquake tremors are recorded.

It consists of an iron ring about three and a half inches in diameter, in the center of which is suspended a lead disc which is fastened by a single bolt through two mica discs, covering the top and bottom of the ring. There are two brass cap pieces, one having an opening in its center to which is fastened a rubber tube, leading to a stethoscopic ear piece. These cap pieces are fastened with bolts to the iron ring and serve also to hold the mica discs in place.

The instrument is thus essentially a lead weight suspended between two mica discs cutting across a small air-tight box. If placed on the ground when there is pounding or digging in the vicinity, energy is transmitted as wave motion to the earth, and the earth-waves shake the geophone case. The lead weight, on account of its mass and because it is suspended between the micas, remains comparatively motionless. There is thus produced a relative motion between the instrument case and the lead weight. The result is a compression and rarefication of the air in the instrument. Since the rubber tube leading to the stethoscopic ear piece is connected with this space in the geophone, this rarefication and compression is carried to the ear drum.

When two instruments are used, one for each ear, as is usual, the sound is apparently louder from the instrument nearer the source. It is evident then that by moving the instrument a point can be found where the sound will be of the same apparent intensity in both ears. The direction of the sound is then on a perpendicular to the line connecting the centers of the two instruments either in front of or behind the observer, further observation will show which. Direction is quite accurately determined in this way. The sound is not actually louder in one ear than in the other, but the ear is capable of distinguishing the difference in time at which the sound arrives in the two instruments. Accordingly, even persons who are slightly deaf in one ear are still able to determine direction.

During the period of the War, engineers of the Bureau of Mines were engaged in determining the distance that different mining machines could be heard through the clay, shale, coal and the mine cover. Measurements were made also of the energy required in blows that they be heard definite distances through clay, shale and coal, as well as the distances at which the shock waves resulting from the discharge of various explosives could be heard. A brief investigation of the factors influencing the transfer of energy from a mining tool to the clay and coal was also made in

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order that recommendations could be made as to the type of mining machine which could be used to accomplish the most work with the least noise.

In this connection it was found that sounds were transmitted only about half as far in clay as in shale strata, and about one quarter as far in clay as in coal. To give some idea of the sensitiveness of the instrument it may be said that the pounding of a pick on bituminous coal can be detected at 900 feet, and the direction determined, and that the pounding of a sledge can be heard at 1,150 feet. The explosion of a one-ounce charge of dynamite was detected at a distance of over 2,000 feet through the shale strata. One interesting feature of the instrument is that the sound as transmitted to the ear is very characteristic of the instrument producing the sound. To illustrate: Twelve mining and carpentering operations were carried out on the coal rib. An engineer of the Bureau who had never used the geophones and who did not know what tools were to be operated was able to recognize and name nine of the instruments at a distance of several hundred feet through the strata. The other three sounds were accurately described, but the machines were not identified.

Now that the War is over the Bureau work has turned to the development of the instruments for peace-time uses. In this connection, it is thought they may be of great value to mine rescue crews who may be entering mines for exploration and to locate miners who may have been entombed after a disaster. The tests so far made in the vicinity of Pittsburgh show that a man pounding on the coal rib with a pick, piece of timber, or a sledge can be detected and located from a point 600 to 1,200 feet distant. This distance depends greatly on the character of the coal but intervening open spaces seem to have surprisingly little effect upon the distance or the determination of direction.

Pounding with a sledge can be heard from two to three hundred feet through the mine cover, depending upon the quietness of the day outside, since any wind greatly interferes with the successful operation of the instruments. It will at once be seen that when mines are not too deep they can be "explored" from the surface and it will thus be possible to find and locate a miner who is pounding. At the Experimental Mine in Bruceton, Pa., a man has frequently been located through one hundred and forty feet of cover within fifty feet of his actual position. A study is being made of the distance that pounding on rails and pipes can be heard.

In metal mines expensive surveys have sometimes to be made in order that approaching tunnel headings may be brought accurately together. Since direction can be determined so well with the geophones, they can be used to guide such work. It would only be necessary to enter each heading and locate the direction of pounding in the other heading.

It is also thought that they will be of value to prevent accidents from explosions when breaking through. In this connection an interesting incident happened recently. Observations were being made at a tunnel heading. The pit boss happened along and asked to be allowed to listen. He put the ear pieces in his ears and remarked: "Mac is tamping in a charge, we had better move away." He spoke as naturally as if watching "Mac," and it is quite evident that he did not realize the sound was 300 feet distant.

Observations were made recently of a mine fire burning from twenty to forty feet below the surface. A low rumbling noise could be heard as if air were being drawn in along crevices, and occasionally sounds could be heard from the snapping and falling of pieces of coal or rock. It is believed the fire area was accurately located, but since the fire cannot be approached from the inside this cannot be verified. It is interesting to note that similar sounds could be heard from only one point inside of the mine and this point was the one nearest the area as located on the surface.

It has been found also that the instruments can be employed quite advantageously in locating knocks in automobile valves and cylinders, not only the cylinder but even the trouble area. For this purpose it is well to mount the instruments on a short iron rod that can be easily inserted in and around the machinery.

After the experimental work has been completed a course of instruction in the use of the geophones will be developed and recommendations will be made as to the proper procedure for a rescuer carrying their instruments, as well as for the entombed miner.

Longest concrete arch span.—A 400-ft. concrete arch constitutes the main channel span of the Franklin Avenue bridge over the Mississippi at Minneapolis. The arch is elliptical, with a rise of 88 ft. It consists of two ribs having a thickness of 8 ft. at the crown.—*Eng. News-Record.*

World's production of petroleum, 1918, and visible supply.—The total production of petroleum in 1918 was 514 million barrels of 42 gallons each, of which the U. S. produced 356 million, or nearly 70 per cent. The Geological Survey estimates that in our western states there are oil-bearing shales sufficient to produce at least 75 billion barrels.

The channel tunnel.—Military and naval authorities are reported to be in favor of the Channel Tunnel Project, connecting England and France.

It will take five years to complete the work at an expense of approximately $150,000,000.

The value of the proposed tunnel to industrial development has been recognized by all branches of the British government.

The project was first suggested in 1802, but due to political difficulties, it never received serious consideration until now.—*Jour. West. Soc. of Engrs.*

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The Military Engineer

Dedicated to the National Defense

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Progress in Society organization

IN conducting a campaign it is a military maxim and in all human endeavors it is ordinary common sense, to recognize the main issues and devote one's energies thereto, avoiding the temptation to fritter them away in too much attention to details.

A society cannot accomplish the purposes for which it was organized until it possesses a strong and influential membership. Accordingly, the main issue for the Society of American Military Engineers at this time is to build up its membership, and our energies have thus far been devoted almost exclusively to this end. The results attained have been gratifying, and applications for membership are steadily flowing in.

During the months of April and May there has been a steady and very encouraging increase in the rate of growth, and ultimate success seems assured. The aims of the Society, as set forth in its constitution, have received unanimous approval, and this journal has proved interesting to its subscribers.

The labors incident to the readjustment of our military establishment to new conditions are very arduous, and as a consequence the temporary Board of Directors, most of whom are officers on duty in the War Department, have not thus far been able to take action on the large number of applications for membership which have been received. An examination of the applications, however, indicates that all applicants thus far are eligible for membership.

Steps are being taken to effect a better working arrangement, pending the permanent organization of the Society following the first regular election of officers.

It is hoped that all applications will receive final action soon. In the meantime charter membership in the Society remains open, and it is hoped that many new members will avail themselves of the opportunity thus afforded.

All charter members are urged, at this vital epoch in the Society's existence, to lend their best efforts to the accomplishment of the main purpose now before us: that of building up a strong membership as rapidly as possible. Each of our members has many acquaintances, even close friends, who are also eligible for membership. Tell them of our society and its aims, show them this magazine (it will interest them), and invite them to join us without delay. Membership application blanks and copies of the constitution will be sent on request to any member who desires to give them to eligible friends. It is hoped that every charter member will secure at least one additional charter member before the permanent organization is effected, probably early in July, 1920.

Organization of local posts. Article IV of the By-Laws of the Society provides for the organization of local sections or posts. These local posts, in bringing our members into close personal touch with each other, are believed to be essential to the realization of our fullest usefulness. The number of members is now such as to warrant the organization of these posts. Preliminary plans and arrangements have been completed and the actual organization will be undertaken in the very near future. Dates for local meetings will be duly announced, and all members in each locality are urged to attend these meetings and to invite all friends who are eligible to membership to do likewise.

Society emblem. Our Board of Directors is considering a number of designs for an appropriate emblem for our Society. It is expected that this will be fixed upon very shortly, and orders for its fabrication will be placed at once.

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National defense still a live issue

AN esteemed but not too thoughtful contemporary, in an editorial comment, commends the purposes of THE MILITARY ENGINEER, and we were mightily encouraged as we read the opening lines. But it promptly deals a heavy blow to our high hopes and aspirations in recommending that engineers who took part in the war make our journal the repository or crypt in which to bury their grievances and disappointments and the priceless military lessons they learned during the conflict, thus keeping them out of the live current periodicals where they are merely an irritation to the engineering profession. Twenty years hence, says our contemporary, these experiences may be dug up again, presumably when we find ourselves entering once more unprepared into a great war on which our existence as a nation may depend.

We are extremely desirous of receiving the contributions referred to, but we are very sorry to see this fresh manifestation of indifference, even of impatience towards the national defense, which should be a matter of chief concern, of lively and current interest to every patriotic citizen. It is this very spirit of indifference which is responsible for our having entered every war unprepared. It is responsible for the waste of billions of dollars and thousands of precious human lives.

This journal is dedicated to the national defense, and it is our mission to make it a *living issue* in the mind and heart of every engineer, a vital part of his everyday existence. It is our aim to keep constantly in his mind the relation of his peace-time activities to the duties he will surely be called upon to perform in the next war, which is sure to come. Whether that war will be twenty years hence, ten years hence or *two* years hence, we do not know. But we *do know* that in putting all thoughts of the relation of engineering to national defense out of his mind until war is actually upon us, the engineer is deliberately evading his patriotic duty.

The Daughters of the American Revolution, in convention assembled, recently passed resolutions favoring a system of universal military training as a measure of national defense. These ladies, whose principal purpose is to "keep the home fires burning" in peace and happiness, have shown a keen appreciation of our national needs and the ways in which they may be met. With them patriotism is a living issue, fresh and vigorous. We hope their splendid spirit may pervade to some extent those more faint-hearted patriots who, "fed up" on the war and reacting badly to the efforts of those who seek to promote the national defense, are too willing to drop back into indifference and apathy towards these things so vital to the welfare and safety of our country.

War promotes industrial and scientific development

IT has been said that there is no such thing as an unmitigated evil, that everything that *is* has its purpose. And this is true of war. As peace hath its victories so hath war its compensations, and they are many, varied and far-reaching.

The methods and inventions of peace find their application in the conduct of war. But the debt is not all on one side. Invention and development have received a powerful stimulus from war, and this is especially true of the late war. The aeroplane, for example, would not for years have reached its present stage of development and usefulness, except for the war. Aerial photography is exclusively a war-time development. High-speed construction and quantity production in manfacture have developed under the stimulus of war more rapidly than they ever developed during an equal period of peace. Transportation of all kinds has been given a great stimulus. War has contributed to the advancement of medicine, surgery and sanitation quite as much as peace.

Many of the devices developed for purely military purposes will find useful application in the gentle arts of peace. Amongst these is the geophone, described in this issue. Devised for the purpose of detecting the subterranean operations of the enemy it now finds a new field of usefulness in mining engineering.

Our service contemporaries

ONE of the encouraging proofs of the fact that the spirit of the army, though tried to the limit, is still strong, is given by the vigor of the journals representing the various branches of the service. All of them show renewed signs of life. Those representing the two branches of the artillery have broadened their scope and increased their helpfulness to the service. The *Military Surgeon* is better than before; the *Infantry Journal*, always a leader amongst service periodicals, is stronger and more aggressive than ever, and plainly intends to make sure that the infantry shall remain as heretofore, "the queen of battles."

During the war we heard little of the cavalry, because the peculiar conditions of the conflict allowed small scope for its time-honored activities. And so our cavalry officers turned their attention to other fields they were qualified to fill, such as exercising high command, performing important staff duties of all kinds, organizing the tank corps, commanding infantry and artillery units, etc., thus gracefully and efficiently filling into the situation as they found it. But now after a lapse of two years the *élan* of the cavalry reappears to the world in the rehabilitated *Cavalry Journal* whose first issue is dated April, 1920. It contains a large number of carefully selected up-

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to-date articles and items, which, while of special interest to the cavalry, no doubt, are almost equally so to any soldier who aims to keep abreast of his profession. It is with pleasure we note that all these articles are short and very "snappy."

We have greatly missed our contemporary of late, and we welcome it back to life and service.

Civilian Engineers in the Army Engineering Corps

Employment in any department of the public service is unsatisfactory at best. But employment as a civilian engineer in the army engineer corps furnishes little satisfaction except that of having a job that is all work and no recompense. One cannot wonder at the dissatisfaction existing among the civilian engineers. The marvel is that any of them remain in the service. Their persistence in staying with the army organization is not that they cannot find employment elsewhere. As a matter of fact, most of them have opportunities to associate themselves with private organizations; all of them can find more remunerative employment outside of the government service, and some of them, discouraged over the prospect of receiving adequate recognition, are leaving the service after devoting many years to it.

More pay for these engineers is a necessity if the service is to maintain anything like an organization or is to function properly. To appeal to their patriotism as a means of retaining their services is at all times foolish, in these time idiotic. The government pays the market price for material commodities; it should pay likewise for engineering and all other service. It is reported that the commissioned personnel of the engineer corps is opposed to permitting salary increases for the civilian engineers because of the desire of the former to receive more remuneration than the men whose work they direct. This is a natural desire, but, since the direction is nominal only, it should not deprive the civilians of fair treatment. This they are not getting now.—*Eng. World.*

[We heartily indorse the views of our contemporary. There is no class of men in our country who perform more and better service and receive less pay for doing it than the civilian engineers of the U. S. E. D. Heretofore and up to now they have been men of the highest attainments, but such men can no longer be attracted to the service at the wages of a common laborer. The reason many of them remain in the service is because their work is varied and interesting, and their relations with the officers of the Corps of Engineers pleasant. From a knowledge of the facts, however, we wish to correct the impression that the Corps of Engineers is in any way responsible for the low wages paid its civilian assistants. This impression is the opposite of the truth, and this would be a most short-sighted policy even from a selfish point of view. The Corps of Engineers advocates better wages and the privilege of retirement on pension for civilian employees, especially the higher employees of the "educational" class. The "misery loves company" feeling has no place in the relations between the commissioned and civilian personnel of the Engineer Dept.—ED.]

The successful life

The following advice and suggestions to those who seek success in life, by an admittedly successful American, cannot fail to be helpful. They are extracts from a "talk" by Charles M. Schwab to the students of Princeton University. We say a "talk" because we believe Mr. Schwab himself would not wish to call it an "address."

Money is often a matter of chance or good fortune and is not the mark of a successful life.

If I were to say the most important thing that leads to a successful life, I should say that first of all was integrity—unimpeachable integrity—that is the foundation of a successful life.

You may think the opportunities of the past will not be the opportunities of the future. In that, boys, you are mistaken.

Boys, did you ever stop to think that a great man in life who has won great acclaim and great reputation is the very man who is willing to share and give the honor to the others in the doing of the things that made him great? You must learn to let others share with you in that which you are doing, and honor and credit will be reflected upon you for so doing.

Marshal Foch, the great commander, said to me a short time ago, when I congratulated him upon the wonderful work of the war: "This great military staff is like an orchestra, and each one fills his place. Each is equally important in the functioning of the whole. If the baton is in my hands it is merely the matter of chance, but we shall see to it that each man in the staff gets recognition for what is due."

If a man is of the character that you must find fault with him to get the best out of him, he is not a man to be desired in an organization.

A man to carry on a successful business must have imagination. He must see things as in a vision, a dream of the whole thing. You can cultivate this faculty only by an appreciation of the finer things in life; beauties of art, literature, and music will help any man in his career.

Let me give you a piece of advice. If you have any influence in the world to get you a start in life, do not use it. Start on your own merits, and start in some lowly position, no matter what it is. Be a laborer, if you will. I do not know but that is the best way to start.

You must make up your mind in advance whether you want a good time in life, or success; you cannot have both.

Concrete ships. In a committee report of the Concrete Institute on the construction of concrete ships, the following information is noted:

Speed of construction expected was not realized. Average time of constructing hulls, seven months; outfitting three to four months.

The boats have proved good sea boats. Vibration less than in steel ships. Period of roll in concrete ships much less. No leakage in any vessel has been reported.

The most serious defect in the concrete construction as affecting plant suitable for the work of the Corps of Engineers is its inability to stand the blows incident to handling. Impact which would not probably have damaged wooden or steel boats has produced a shattering of concrete. In case of nearly every barge constructed for the Railroad Administration the shell has been injured and repairs required. Should concrete barges and hulls be used for construction work adequate fender timbers appear necessary.

In cases of barges and canal boats the two obstacles to successful introduction are: cost and liability to injury by shock in handling.—*Eng. News-Record.*

Europe to India by Rail.—The project of effecting railway communication between Europe and India is now well on the way to fruition, owing to the construction and development of military railways in the Mesopotamian theatre of war. There are now approximately 1,000 miles of line in Mesopotamia.

In addition, a line is now operated between Bagdad and Quaritu on the Persian frontier, while construction is proceeding on an extension to Khermanshah. There appears to be every probability of considerable railway development in Persia in the near future. With the tendency of the Indian lines to extend into Persia, and the possibility of the completion of the channel tunnel in a few years, direct rail communication between England and her Far Eastern possessions would now appear to be well within the range of practical politics.—*Railway Age.*

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Water Resources in Relation to Military Operations

By

Charles H. Lee

Captain, 26th Engineers (Water Supply), A. E. F.
M. Am. Soc. C. E.

The important relation which water supply bears to the successful execution of military operations has long been realized. Never before the World War, however, has specific provision been made, in technical personnel and material, for the supply of potable water to armies in the field. This innovation was not alone the result of the arid conditions under which it was attempted to carry on certain campaigns such as those of the British at Gallipoli and in Palestine and the Italians in Eastern Italy; an even greater reason for special provision for water supply was the inadequacy and often the pollution of local supplies in the humid regions of Northern France, where troop concentrations along the Western Front surpassed anything previously recorded in military history. Existing wells and developed springs were so inadequate in certain early operations on this front that the failure to attain success was often directly ascribed to the lack of sufficient water for the troops and animals engaged. In other instances the use of polluted water resulted in sickness and loss of morale among the troops. These experiences led to the organization, in the various allied armies, of specialized troops and technically experienced officers for water supply service.

In this connection, the military importance of regional water resources at once became apparent and geologists and hydraulic engineers were drawn into the service. The conditions, however, demanded a special type of experience, namely, that of a hydraulic engineer and a practical ground water geologist combined. This type of technical military service tended to develop a broadened type of hydraulic engineering, which, following the French practice, could be called "hydrologic engineering." Along with growth in the knowledge of hydrology in the United States there has been, during the past fifteen years, a growing need and demand in civil life for exactly this type of experience. The many public water supply, irrigation and water power projects, well designed structurally, but partial or complete failures because proper study was not given to the water supply, are eloquent examples of this need. It is believed that there will be a distinct gain in this branch of engineering as a result of the war and that with the increased investment of American capital in foreign countries, its field of usefulness will grow rapidly. The experience and practice along these lines during the war is therefore, like nearly all operations of military engineering, of great civil interest as well.

The writer was assigned to the 26th Engineers, but was later detached for service with the Water Supply organization of the American Expeditionary Forces in France where he handled matters involving water resources and choice of sources of water supply. From November, 1917, to June, 1918, he was attached to the Water Supply Section, Office of Chief Engineer, A. E. F., reporting to Col. F. F. Longley, Engineers, Chief of the Water Supply Service. In July, 1918, he was assigned to the First Army Water Supply Service, reporting to Lieut. Col. F. W. Scheidenhelm, Water Supply Officer, First Army, and continued on this duty until after the armistice.

Lieut. Col. Alfred H. Brooks, Engineers, was in charge of the Geologic Section, Office of Chief Engineer, A. E. F., and Maj. Edward H. Bowie, S. C. of the Meteorologic Division, Signal Corps, A. E. F.—Ed.

Military Water Supply Requirements

THE water supply requirements of an active army and its auxiliaries are varied. In France the important requirements of the American military forces were as follows:

1. Potable water for combat troops in the field.
2. Drinking water for animals accompanying combat troops in the field.
3. Water for drinking and general uses in relatively permanent camps, barracks, hospitals, depots, etc., in rear of the active armies.
4. Military railways, light and standard gauge.
5. Supplemental supplies for towns or cities extensively occupied by military forces in rear of an active army.

The consumption of water for these requirements varies widely both in quantity and regularity. For animals and combat troops in the field, where the practice is to establish water stations or "water points" at intervals of two to three miles, the demand at any station is mostly during the daylight hours and ordinarily varies from less than 5,000 to 30,000 gallons per day, although in cases of great horse concentrations away from open water it may be as great as 75,000 gallons per day. The stations supplying the greatest quantities are usually those at which motor truck tank trains are filled. The demand usually fluctuates widely from day to day, depending on troop movements. The per capita rate of daily consumption for men seldom exceeds three gallons, and for horses nine gallons. An essential feature of a source of supply in the army zones is immediate availability. This eliminates drilled wells except under highly stabilized conditions of warfare.

At permanent camps and hospitals in the rear the demand is more regular from day to day. Depending upon the size of the camp, the total consumption varies from a few thousand gallons daily up to 100,000 and even 250,000 gallons. The per capita rate of consumption varies from 5 to 10 gallons daily at ordinary barracks, depots, etc., up to 15 or 20 gallons daily at hospitals and may exceed 25 gallons daily where flush toilets and other conveniences are installed.

At light-railway filling stations the maximum total demand at terminals seldom exceeds 50,000 gallons per day and at stations along the line is very much less. For standard-gauge railways the demand is much the same as in civil practice on busy roads.

The demand for supplemental city supply depends entirely on local conditions and may require the development of a complete new source of several million gallons per day.

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Problems Encountered

The following are indicative of the military problems whose solutions require a more or less detailed and comprehensive knowledge of regional water resources:

1. Preparation of general operation plans involving choice of the theatre of operations. This type of problem is important where great troop concentrations are contemplated or where either our own or the enemy's theatre of operations includes a poorly-watered region.
2. Preparation of special operation plans involving choice of line of march, camp sites or billeting areas for troops, positions for attack or defense, etc. Much hardship, delay, and unnecessary moving and labor can often be avoided among troops by the intelligent use of detailed water supply information.
3. Selection of camp, barrack, hospital, or other sites involving the erection of more or less permanent buildings or other construction. The saving in time, labor, and material which can be effected by considering water supply in the choice of a site is often very considerable.
4. Selection and development of a specific source of water supply for a camp, barrack, hospital or depot site previously chosen without regard to water supply. It frequently occurred, in all the Allied Armies that sites for important stations, such as large hospitals, training camps, depots, etc., were chosen by representatives of the branch of the service most interested and from consideration of the features most obvious to those concerned, but without particular attention being given to the question of water supply.
5. Selection of types, sizes and quantities of water supply materiel required by an army or smaller unit in a given theatre of operations. The water resources of a region are especially important in connection with the quantity and sizes of pipe and pumps needed and special equipment such as well-drilling machinery, filters, etc.

Data Required

The solution to these problems can seldom be reached merely by a superficial inspection of the ground made personally or from aerial photograph. Such an inspection must be supplemented by a broad knowledge of the hydrology of the region and the consideration of all possible local data. Hydrology, as here used is intended in its broadest sense, namely, as including both surface and underground waters. The two are so closely interrelated physically and their relative value as sources of supply often so difficult to judge, that it is absolutely essential to consider them as merely different phases of the same thing—the movement toward the ocean of water falling on the earth's surface as precipitation.

Viewed from this standpoint, the data required for the study of the water resources of a region is as follows:

1. Precipitation; its average depth for various periods of time and its monthly and annual variation from the average; also its geographic distribution and the form in which it occurs.
2. Evaporation; its depth as measured under specific conditions and its variation from month to month during the year.
3. The land surface; its topography, drainage basins, streams, vegetation, and permeability.
4. Geology; the material, thickness, sequence and exposure of the various local formations, the structural irregularities such as folding, faulting, etc., and especially the character, extent and position of saturated formations which are sufficiently porous and permeable to be considered "water bearing."
5. Stream and spring flow; its amount and variation at different times during the year and from year to year.
6. Lakes; their size, depth, and permanency.
7. Wells; their type, location, depth, size, formations penetrated, yield, water level, etc.

The American publications on practical hydrology emphasize surface water and give attention to the subjects of precipitation, evaporation, land surface, stream flow and lakes. The French, on the other hand, treat largely of underground water and devote much space to geology, springs and wells. The writer's experience which has extended to both phases of the subject leads clearly to the conclusion that the engineer assigned to the study of water resources and the selection of specific sources for military supply must have a practical familiarity with both surface and ground water hydrology in order to successfully solve the varied problems which arise.

Sources of Information

As a beginning for the study of water resources of any region there should be available as complete as possible a collection of published data relating to the region, together with topographic and geologic maps, geologic sections, and maps showing forests, streams, lakes and, if possible, springs and wells. The information thus obtained should as soon as practicable be visualized and supplemented by field observations. The latter must usually be done piece-meal in connection with specific problems, but if possible field trips for the purpose of general observations should be made. With the American Expeditionary Forces in France the Geologic Section, Office of Chief Engineer, and Meteorologic Division of the Signal Corps, coöperated with the Water Supply Section, Office of Chief Engineer, both in obtaining maps and data from French sources and in making mutually available all data secured. This procedure proved of value to all concerned.

The principal sources of published data in France are the various government services, such as the *Ministre des Travaux Public du Service de la Carte Geologique de France*, the *Service Geographique de l'Armee*, the *Bureau Central Meteorologique*, and the *Ministre de l'Agriculture;* geologic societies, especially the *Société Geologique de France* which has an unusually complete geologic library at Paris; and publishes books and reports of geographers, geologists and especially engineers. The whole of France is covered by detailed geologic maps of variable ac-

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curacy on a scale of 1 to 80,000; but few geologic sections are available. Topographic maps of various scales are available which show accurately the locations of permanent springs, streams, and lakes. Precipitation data is very complete but there is little reliable evaporation data. Stream flow data is complete for only a very few streams and is of limited value on account of the short periods of record In general, water resource data is far from being as complete as in the United States, and geologic mapping although covering a larger proportionate area is not as accurate and comprehensive. There are but few countries of the world, however, in which available information of this sort is as complete as in France. In a region such as Northern Mexico, any one studying water resources should have had a broad practical hydrologic experience in both surface and underground water to enable him to form useful judgments based on hasty field observation and meagre general data.

To facilitate the collection and preservation of data from the field, various blank forms were used by the Water Supply Service.

Hydrologic Provinces of France

The first step in studying water resources for a large region is to define the limits of areas with similar hydrologic characteristics. This done, a more detailed study of each district or province can be made to ascertain the typical sources of water therein, their characteristics and best methods for development. The details of such a study and its practical application are illustrated by work carried on as part of the activities of the American Water Supply Service in France. The Geologic Section coöperated more or less in this work.

There are three distinct types of hydrologic conditions in France, on the basis of which the country can be divided into several districts or hydrologic provinces.

The first type is represented by elevated igneous rock masses flanked or partially overlaid by metamorphic rocks and receiving an average annual precipitation of 35 to 60 inches.

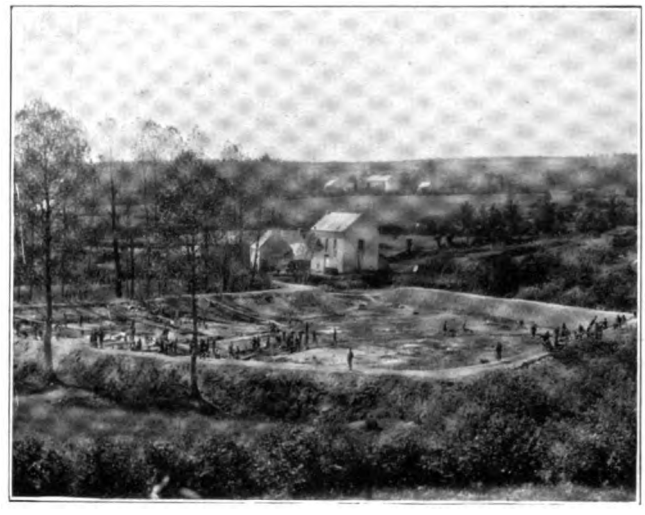
The second type is similar to the first, being composed of elevated and highly tilted and folded sedimentary rocks and receiving about the same precipitation.

The third type comprises the geologic structural basins embracing the valley and plateau areas and receives an average annual precipitation of from 24 to 35 inches. These basins are filled with comparatively soft, regularly stratified sedimentary rocks (Secondary and Tertiary series) and are bordered by the upturned and exposed edges of the various strata.

Falling within the first type are; (1) the Brittany Peninsula; (2) the assembly of ranges in Central France, known as the Central Massif; (3) the Ardennes; (4) the Vosges Mts.; (5) the Pyrenees and (6) the main chain of the Alps. The second type is represented by (7) the Jura Mountains and (8) the Sub-Alpine chains, bordering the Rhône Valley on the east.

The principal rivers of France have their sources in these ranges. The igneous and metamorphic rocks are dense and unfissured, except very close to the surface, and below the surface have no stratification nor alternation of porous and impervious formations. The uplifted sedimentary rocks are more or less fissured and sometimes cavernous, but the rock is seldom porous. Portions of the American Line of Communication lay within the Brittany Peninsula and the western portion of the central Massif.

The Paris and Aquitaine Basins and the Rhône



A hastily constructed reservoir

Valley are the principal basins of France. They are traversed by the rivers from the highlands and contain the most highly developed industrial areas and most densely populated regions of France. The sedimentary formations of the Paris Basin apparently have the form of half a gigantic onion cut perpendicularly to the core. Paris lies at the center of the concentric rings and the outside ring lies against the surrounding highland areas. The extreme bottom of the onion is at great depth below the surface, possibly in the vicinity of Paris. The concentric layers are composed of all types of sedimentary rocks from late Tertiary alluvium at the center, in regular sequence down to the Carboniferous rocks of the upper Primary series. Certain layers are pervious and have water bearing capacity. Among these are fissured or jointed sandstone, fissured or jointed limestone, porous sandstones (lower Cretacious or Eocene), upper Cretacious chalks and quaternary river valley gravels and sands derived from the hard rocks of the highland areas. Interbedded with these are impervious non-

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water bearing formations such as unfissured Triassic sandstone, unfissured limestone, shale (marnes), clay and most tertiary alluvium. The extreme northeastern and eastern portion of the Paris Basin included the army activities of the American Expeditionary Forces, while the line of communications lay within the southeast and southern borders. A portion of the latter also extended into the upper Rhône Valley.

The sedimentary formations of the Aquitaine Basin do not correspond in structure to those of the Paris Basin but are folded into a series of buried synclinal troughs and anticlinal ridges with a northwest-southeast direction. Along at least one of these troughs, represented by the line of the lower Gironde River and Garonne River immediately below the junction of Lot River, there has occurred faulting with marked depression of formation to the southwest and corresponding elevation of those to the northeast. The types and character of sedimentary rocks in the basin, however, correspond closely with those in the Paris Basin. The activities surrounding the American Base Port at Bordeaux lay in the Aquitaine Basin and certain of the important docks and terminals were situated just west of the line of faulting.

The Rhône Valley is underlaid by more or less porous alluvial débris deposited by streams flowing from the adjacent mountains.

Each of the eleven provinces thus described has certain typical sources of water supply which generally result from its distinctive hydrologic characteristics.

Sources of Water Supply

The important natural sources of water supply in France are as follows:

1. Flowing streams.
2. Shallow lakes.
3. Springs.
4. Water bearing river valley deposits.
5. Shattered limestone or chalk at margins of certain river valleys and bottoms of certain types of ravines.
6. Deep water bearing formations.

These included all classes of water supply developed for use by the American Expeditionary Forces.

Flowing streams occur throughout almost all of France and with certain exceptions have a dependable flow throughout the year. The exceptions are; first, a considerable portion of the Brittany Peninsula and the Central Massif where the rainfall is relatively light, the formation impervious and sloping, and vegetation limited; second, flat or gently sloping clay and shale areas of the Paris Basin; and third, tributaries and upper reaches of streams having their source in elevated limestone formations of the Paris Basin. Artificial storage is necessary to develop an important water supply from streams in the first two of these areas and was undertaken for the purpose of supplying the Base Port at St. Nazaire. River water was used for the supply of several large hospitals in Central France and also at certain points in the area covered by the Argonne-Meuse and St. Mihiel offensives.

Shallow lakes (*étangs*) occur in flat impervious formations of the Paris Basin, principally on the clay zone locally known as the Woevre (Toul Sector and northward to Stenay), and on late Tertiary alluviums (southeast of Tours). Many of these lakes have been increased in size and permanency by low earth dams for use as fish preserves. The water is more or less stagnant and often colored, but can easily be rendered potable. Water from such lakes was practically the only available supply during the St. Mihiel offensive for troops advancing northward from the vicinity of Xivray and Mont Sec.

Springs are widely distributed throughout France and many have a large flow and are reasonably dependable. The largest recorded has an average flow of 9,000 gallons per minute. Many permanent springs have average flows of 25 to 50 gallons per minute. The "contact" type of springs is a very important one in the northeastern portion of the Paris Basin. These issue from fissured limestone interbedded with layers of shale or clay, these latter serving as an impervious base upon which the water absorbed from precipitation may accumulate, occupying the fissures, cracks and joint planes of the overlying limestone. With the hydrostatic level in the limestone above a certain elevation, the water finds an outlet through some fissure, and issues as a spring at the contact plane, where the latter is above the level of the adjacent surface drainage channels. The "crevice" type of spring occurs where the contact plane is below the local drainage level. The latter type also occurs in fissured sandstone, which usually occurs without interbedding with impervious formations. Springs were the most generally used sources of water supply in the Argonne-Meuse offensive. They were also extensively used for small hospital and camp supply in rear of the Army Zone.

Water bearing river deposits consist of porous sand and gravel transported from the highland areas. They occur in shallow beds filling the bottoms of river valleys and usually yield water readily. The principal streams along which such gravels are found are the Moselle, the Upper Loire, the Cher, and the Rhône Rivers and their tributaries, and the tributaries of the Dordogne and Garonne Rivers. The French usually develop water from such deposits either by means of large dug wells or galleries. For military supply, however, the most practical method is by use of small dug, driven or drilled wells. This source of supply was used by the American forces at several hospitals and other permanent stations in

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rear of the Army Zone. It could only form an important supply where the stream traversing the valley had a permanent flow not insulated from the gravels.

Shattered limestone at the margins of river valleys with water-bearing alluvial deposits, and occasionally in ravine bottoms where the water plane is shallow, sometimes yielded large quantities of water from dug wells. The success of such a well is somewhat a matter of chance. One such well at Sorcy Gare, the railhead for the Toul Sector, produced considerable water as did also the wells dug by the French in ravines in the vicinity of Verdun during their offensive of 1916.

Deep water-bearing formations consist of porous strata, lying at various depths below the surface exceeding 100 feet, from which water may be obtained in considerable quantity by means of drilled cased wells, either with pumping or by artesian flow. Deep water-bearing formations do not occur in the highland areas. There are important deep water-bearing formations, however, in each of the three basins. In the Paris Basin the fissured sandstone (*Gres Vogien*), whose intake area is along the western slope of the Vosges Mountains, is reached in the vicinity of Nancy and Lunéville at a depth of 2,500 to 3,000 feet and large artesian flows occur from wells located in the river valleys. Farther west in the same basin and, in fact, practically circling the whole inner basin is the intake of a porous lower Cretacious sandstone (*sable vests*). This formation has a depth of 1,500 feet near Paris and is progressively shallower toward the exposed edge of the stratum. Large artesian flows are obtained from wells in river valleys. The famous artesian wells furnishing part of the supply of Paris penetrate this formation. The upper chalks in the northern part of the Paris Basin are also an important water-bearing formation which the British Army extensively developed by means of drilled wells 200 to 300 feet in depth. In the Aquitaine Basin to the southwest of the line of faulting described above, the porous Eocene sandstones are locally depressed to a considerable depth and contain water under pressure. Large artesian flows occur from depths of 600 to 900 feet in wells drilled along the river valleys in the vicinity of Bordeaux and southwest of the line of faulting. Other less important deep water-bearing strata exist in both the Paris and Aquitaine Basins. The time required for drilling wells precludes the use of deep water-bearing strata as a source of supply in the Army Zone, particularly in a war of movement.

A number of successful deep wells were drilled by American forces in the vicinity of Bordeaux and also near Tours. These wells were drilled by American "oil country" drillers with American machines, and, much to the astonishment of the French, were completed in as many weeks as similar wells drilled by themselves had required months and even years to finish. These wells all penetrated recognized water-bearing strata. In other locations where wells were drilled without consideration of the geology and in unfavorable locations, either dry holes or very meagre yields were obtained. There was an idea prevalent even among engineers, that a well rig possessed a certain mysterious charm capable of curing all water supply ills, and that by drilling deep enough, water in abundance was bound to be reached at any nicely located camp, hospital, or depot. As a matter of fact, however, the highland areas and certain portions of the basins are not underlaid by water-bearing formations and efforts to drill wells in such areas were foredoomed to failure. By the application of the principles of ground water hydrology it is possible in many instances to predetermine the probability of success and so obviate the needless loss of effort and time. The practice of ground water hydrology has now passed beyond the stage of supposition and when judiciously applied is of much value in practical water development.

General Hines appointed Superintendent of Inland Waterway Transportation.—The Secretary of War has delegated to Brigadier General Frank T. Hines, Chief of the Transportation Service, U. S. Army, control of the inland waterway transportation systems which were transferred to the jurisdiction of the War Department under the Transportation Act which returned the railways to private control. General Hines has announced that the same service will be maintained for the present and that he will utilize the existing organization and personnel in administering the work.—*Railway Age.*

The English Channel tunnel.—In order to expedite decision respecting the construction of a tunnel under the English Channel, a deputation of the Channel Tunnel Committee of the House of Commons recently called upon the Prime Minister. His attention was called to the fact that no serious engineering difficulties were anticipated; that the time necessary for completion would be five years; and the total cost would be $155,728,000, or double the pre-war estimate. There was said to be great enthusiasm for the scheme in France.

The Prime Minister, in replying, stated that the problem would be carefully examined from the engineering, military, naval, and air points of view, and "if the military advice is favorable, the Ministry will certainly be prepared to support the plan on general grounds."—*Railway Age.*

New railroad line for Mexico.—The Rio Grande border town of Ojinaga, which has figured prominently in revolutionary affairs in Mexico in recent years, is to obtain a railroad outlet according to official announcements. It is stated that the Department of Communications and Public Works has authorized the construction of a railroad from Juarez to Ojinaga, 250 miles, and that the survey for the proposed line has been ordered. The route of the road will follow closely the course of the Rio Grande.—*Railway Age.*

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Retirement of Engineer Officers

General Sibert

Major General Wm. L. Sibert, U. S. Army, whose portrait appears as our frontispiece in this issue, was at his own request placed upon the retired list April 3, 1920. By his retirement the service loses one of its ablest officers, to whose energy and skill as organizer, executive and engineer, the successful completion of many important public works is due.

He was born in Gadsden, Alabama, October 12, 1860, graduated from West Point in 1884, and was commissioned in the Corps of Engineers. Until 1907 he was engaged chiefly in river and harbor work in the United States, but served also in the Philippine Islands during the insurrection in 1899, where he achieved his usual success as Chief Engineer of the 8th Army Corps in an expedition against hostile natives. For this service Sibert (then a captain) was recommended for promotion to the grade of Brigadier General.

General Sibert's career has been characterized by sound judgment, great practical ability and resourcefulness, and a willingness to assume responsibility while giving his subordinates full power of action. An incident occurring during his tour of duty in charge of the important Pittsburgh district shows the nature of the man. During the construction of a dam in the Ohio River a flood occurred which, because of the obstructions in the river incident to the building of the dam, threatened to flood a large area and cause millions of dollars of damage. General Sibert on his own initiative, without any authority, unhesitatingly destroyed nearly $100,000 worth of construction, thereby releasing the flood waters and preventing the threatened disaster.

In 1907 the U. S. Government placed the construction work on the Panama Canal in the charge of the Corps of Engineers of the Army. General Sibert was then a major, but even at that time he was recognized as the peer of any construction engineer in the U. S. Accordingly, in March of that year he was ordered to Panama as a member of the Panama Canal Commission, construction engineer on the "Big Ditch," and second in command to Gen. G. W. Goethals.

At Panama Sibert was assigned the difficult tasks of damming the Chagres River, constructing the Gatun locks and dam and the breakwater at Toro Point. This was Sibert's great opportunity, and all the world now knows that he proved more than equal to it.

In 1914 his work on the canal was successfully finished, Sibert received the thanks of Congress, was promoted to Brigadier General, and later (in 1917) to Major General.

Sibert the soldier is the equal of Sibert the engineer. When America entered the World War, Major General Sibert was selected to organize, train and command the first American combatant troops sent to France, the famous 1st Division Regulars. That the fighting efficiency of the 1st Division was never exceeded by any other organization in any army was due in large measure to the training received at the hands of General Sibert and the spirit absorbed from him.

In the spring of 1918 our government was beginning to appreciate the great importance of a new combatant arm, chemical warfare. The spasmodic efforts to organize this service had produced no satisfactory results. To General Sibert was entrusted the grave responsibility of placing the new service on a basis of practical working efficiency. This he proceeded to do with his characteristic skill and energy, and his success in building up the Chemical Warfare Service is perhaps the best proof of his ability and force of character.

For his services in the Great War, General Sibert was awarded the Distinguished Service Medal and was made Commander of the Legion of Honor of France.

He has five sons, all of whom, like their father, served in the armed forces during the war in grades from corporal to lieutenant colonel.

General Sibert's last active command was the 5th Division at Camp Gordon, Ga. He retires from the government service in order to devote his attention to private business affairs, including the development of oil resources on his estate in Kentucky.

To few men still in the bloom of health, is vouchsafed the privilege of looking back upon a life so full of varied achievements. The name of Sibert is justly honored in the history of the Corps of Engineers and in the annals of the engineering profession, not in his native land alone, but throughout the world.

Colonel Shunk

Col. Francis R. Shunk, Corps of Engineers, was, at his own request, placed upon the retired list March 6, 1920.

Col. Shunk was born in Pennsylvania, November 25, 1862. He graduated from West Point at the head of his class in 1887, and was commissioned in the Corps of Engineers, rising through the various grades to that of Colonel in 1917.

Colonel Shunk's career is an excellent example of the versatility demanded of the engineer in these days, and the wide territorial range of his activities. Few engineers have been able to perform with consistent success such a wide variety of duties as fell to his lot in so many different places. He has served his country with conspicuous fidelity and ability from Maine to Porto Rico, and from the At-

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lantic Seaboard to the Philippine Islands. He has been an active member of Boards for the consideration of a great variety of engineering projects, including membership on the Board of Engineers for Rivers and Harbors; he has improved rivers, built locks and dams, harbors, lighthouses and fortifications. He has been instructor at West Point,



Photo by Harris & Ewing

Francis R. Shunk
Colonel, Corps of Engineers, U. S. Army

and Department Engineer officer, and has commanded engineer troops at home and abroad.

His last assignment on active duty was as District Engineer in charge of the important district of Boston, Mass.

Colonel Harding

Col. Chester Harding, Corps of Engineers, Governor of the Panama Canal Zone, was retired from active service March 31, 1920, with the rank of Brigadier General, in recognition of his services as one of the builders of the Panama Canal. He will continue his duties as Governor of the Canal Zone.

General Harding was born in Mississippi, December 31, 1866, the son of Horace Harding. He is the descendent of a line of soldiers who served in the Indian and Revolutionary Wars. He graduated from West Point in 1889, number four in his class, and entered the Corps of Engineers, in which he rose to the grade of colonel, in 1917.

General Harding's career has been active, varied and successful. He served in the U. S. Engineer Districts in New York, Chicago, Newport, St. Louis and Grand Rapids, as instructor at the Military Academy, and Commissioner of the District of Columbia.

His chief claim to fame, however, is as a builder of the Panama Canal, where he was for two years engineer of the Gatun Locks division. He subsequently held the important posts of Engineer of Maintenance of the Panama Canal, President of the Panama Railway, and Governor of the Canal Zone. For his services as a builder of the



Photo by Harris & Ewing

Chester Harding
Brigadier General, U. S. Army

Panama Canal, General Harding received the thanks of Congress.

General Harding, who is but 54 years of age, and in vigorous health, will continue his work as a professional engineer upon the completion of his term as Governor at Panama.

The Chief of Engineers, U. S. Army, and the railways.—The Chief of Engineers, U. S. Army, exerts a most profound influence on certain matters of real importance to the railroads. Through the authority of the War Department over navigable waters, the decision of the Chief of Engineers must be obtained to plans for bridges, docks, and other engineering work when the interests of the railroads are thrown in contact with those of the waterways. He is thus in a position to require an expenditure of many thousands of dollars in excess of the amount which the railway officers may deem adequate at the inception of the undertaking merely to meet the railway requirements. In the establishment of dock lines, the determination of bridge span lengths for river channels, and regulations governing the design, maintenance and operation of movable bridges, the Chief of Engineers exercises control in the public interest of navigation.—*Railway Age.*

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Possibilities of the Next War

From a lecture before the Royal United Service Institution

By

Maj. Gen. Sir Louis Jackson

Following the Great War, peoples cry aloud for disarmament and a reduction of expenditures for defense. The temptation to listen to them is very great. But should we do so we would presently be exposed to dangers even greater than those which confronted us in the late war.

As to the possibility of future war, Germany has frequently informed us, through many mouths, that she hopes for revenge some day. Let us recognize war as an inevitable accompaniment of human life. And if we are to prepare let us prepare thoroughly. We are on the eve of the most extensive changes in the art of war known to history, and the developments of the late conflict are only the beginning.

In these days nations take all possible advantage of secret preparations and attack suddenly without warning or without previous warning. This is an advantage a combatant is not likely to forego.

In the future wars, due to the development of the tractor, mechanical transport of artillery and supplies will be independent of the roads. Caterpillar tractors will be able to negotiate any terrain and surmount ordinary obstacles at a speed of 6 miles an hour. There will be no more congestion of roads and the entire transport of a division will follow it, deployed in open order. This will powerfully influence the tactics of the future. Roads will still be used for fast wheeled transport, but we will not be dependent upon them.

With regard to the use of gas in future wars, there is no more reason to forbid its use than to forbid the use of rifles. There were gases which killed painlessly, and it is easy to conceive cases in which it would be more humane to use gas than explosive shells. This is especially the case with punitive expeditions. It might be possible to come to some agreement that no gas would be used which would cause unnecessary suffering. Commercial progress and prosperity in the twentieth century will depend on chemistry, and chemical productions must have a great effect on all future warfare.

It is in the air that we are face to face with the problem of the future. It was in the air that we have made the most important advance in the art of war. We need not trouble ourselves yet with flying destroyers, or flying concrete forts, but in twenty years' time the air force estimates might be the most important part of our preparations for war. Bombing and reconnaissance machines will be developed commercially, for the machines used in commerce could easily be adapted to war purposes, and civilian pilots could be taken over with the machines. For fighting machines special types are required and highly specialized training is necessary for the personnel. For both machines and the men to man them, that side of flying must be developed by the government. One result of return to open warfare would probably be that bombers would not have the same targets near the front of the armies and would secure better results by going farther afield and bombing the centers where munitions were manufactured, stores were accumulated, and troops were trained.

There is room for great simplification of the means of communication, and the open warfare of 1918 led to the elimination of some forms of communication which had been used previously. Wireless telegraphy will be the principal means of communicating with aircraft. The development of the electrical listening posts used in trench warfare, and a ground wireless system will become the standard means of communication between advanced infantry and the headquarters controlling them. Smoke and light signals, a pillar of cloud by day and a pillar of fire by night, will be used by troops to show the positions they have reached.

There has never been a war in which such an extreme variety of weapons was employed. The long rifle has seen its day and should be replaced by a short carbine which would be accurate to 500 yards. Each man should also carry a good dagger which might be made attachable to the carbine like a bayonet. The automatic pistol will not survive, and the grenade may also go. It is doubtful, too, whether the Stokes mortar will survive. For our artillery we must be guided by the definite idea of the tactical possibilities of the future. If we assume the full exploitation of mechanical transport greater mobility in artillery would be required in order that the guns could keep up with the more rapid advance of the troops. The artillery must be of a character that it could be brought to the required position in the shortest possible time. Caterpillar traction should be employed, and for a daily advance of 12 miles the guns must be capable of an effective barrage up to 13,000 yards. A short 4.2-inch gun with an accurate range of 12,000 yards and a long 4.2-inch gun with an accurate range of 20,000 yards, might meet the requirements of the future.

The soldier of the future must be absolutely different from his predecessor. The days have gone when initiative was considered not only unnecessary, but dangerous In addition to his rifle, he should be able to handle a Lewis or machine-gun and to help the artillery. He should know something of explosives, have a general knowledge of fuses, understand signalling, and be capable of handling a ground wireless set. The soldier of the future must be a "handy man."

The question of invasion being primarily a naval question was outside the scope of this paper, though the possibilities of attacking transport by aircraft carrying torpedoes might come within it. Six months before the war the author was regarded as an alarmist because he spoke of the possibility of London being bombed. The Germans had made a mistake in using explosive instead of incendiary bombs. With the greater range of aircraft the position has become more dangerous for us, for we may be sure that every lesson has been learned from the failures as well as the successes of the last war. It is clearly impossible to provide anti-aircraft defenses for all the large towns in the country, and they would have to rely for protection upon our air forces. London could not rely solely upon our fighting machines and a large number of anti-aircraft guns with well-trained personnel would be required for the defense of London. The expense involved is a necessary insurance.

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Railroad Trestle Building in Military Operations

By

Billings Wilson

Captain, Engineers

Note. In a presentation of this subject the writer realizes that most experienced engineers will see only a "rehash" of the existing fund of information, and this is necessarily true to a large extent. The main idea is to furnish a ready reference of actual working figures for the younger engineer officer of the army. Any civil engineering handbook will give various sizes and limiting dimensions for the timbers that go to make up a railroad trestle but the first time a young designer encounters these tables, he is apt to be at a loss as to the exact sizes to select. Frequently he will attempt to select values by rough computations of his own, using his cut and dried beam and column formulas—all of which is waste of time. The writer clearly remembers the time he was promoted from the "ranks" to be Assistant Resident Engineer and immediately called upon to make up designs and bills of material, in twenty-four hours, for about six grade crossing elimination projects, involving many underground "hazards" in the way of sewers, water and gas mains, electric light conduits, canals, etc. A knowledge of the standard market sizes of timber, combined with handbook information and a few leading questions saved the day. Senior engineers are apt to assign such problems, simple of solution with experience, to a new man to test his initiative and resourcefulness. It is hoped that these notes will be of some assistance, not only to the younger man, but perhaps at some time to the senior confronted with a problem of this kind who wishes to brush up hurriedly on such elementals and write down the answer.

The recommendations made herein are primarily for military engineering where *speed* in construction is the essential factor, and permanence with its *high factors of safety* is subordinate. In a rapid advance into enemy territory railway communications must be restored immediately. Wooden bridges will be burned and steel spans dynamited, and the timber trestle, with crib piers or frame and pile bents, is the quickest and often the only possible solution of emergency bridge problems. In such cases, for example, the one item of five-pile instead of six-pile bents, for ordinary heights, may save *hours* in effecting a crossing, and hours have a tactical equivalent value in mobile military operations. The value of *time* in war is so great that economies in money cost are of far less importance than in peace time operations, and if carried too far may actually defeat the aims in view.

FOR rapid emergency construction, if the material is at hand in each case, crib piers can be built more rapidly than trestles for heights of 15 feet or less (18 feet to base of rail). From 15 feet up to 25 feet frame bents are the fastest construction, and above 25 feet (28 feet to base of rail), pile-bents are almost invariably the quickest type of pier. In cases where rock bottom will not permit the driving of piles frame-bents should be built for all heights over 15 feet, unless running water is present; in which case crib-box piers should be built on shore, floated into position and sunk with one-man stone. It will be recognized that this latter method has its limitations and should only be used when other types of emergency piers are out of the question. Regarding "shooflies," it can be said that they are the fastest method of crossing wide, dry openings, but where and where not to use them must be determined for each case in the field, and the relative speed for effecting a crossing will, as in all cases, depend on the experience and judgment of the reconstruction engineer.

A combination pier, consisting of framed bents resting on cribs may often be employed to advantage.

Caps should always be 12 by 14 inches, laid on edge, for permanent operation. Twelve by 12 caps will do in an emergency, but should be replaced by 12 by 14 inch as soon as possible. Caps and sills should when possible extend beyond the outer posts (1 to 2 feet), to strengthen the "grip" of the sway bracing, which greatly increases the lateral stability of the bent.

Posts, sills and intermediate sills for frame bents should be 12 by 12 inches. (Ten by 12 inch and 10 by 10 inch posts may be used in an emergency, but have a factor of safety too low for continued operation.)

Sway braces, sash braces and longitudinal X-braces should all be at least 3 by 10 inches in section, and the sash braces preferably 3 by 12 inches. They should not be erected at a steeper angle than 55 degrees from the horizontal (the nearer 45 degrees the better). For sway bracing, *on pile bents,* this will mean:

No bracing required on bents less than 10 feet high;
Single-story bracing on bents from 10 to 17 feet high;
Two-story bracing on bents from 17 to 32 feet high;
Three-story bracing on bents 32 to 48 feet high;
Four-story bracing on bents from 48 to 64 feet high.

There is an exception to the recommendation for no bracing on bents less than 10 feet high. It quite frequently happens that piling will encounter an impenetrable stratum a few feet below the surface and the penetration will be insufficient to prevent the piling from spreading. The A. R. E. A. recommends in this case that the "strength should be determined as a column or beam; omitting the resistance, if any, due to skin friction." Stiff bracing is very important here and should always be used—particularly a heavy sash brace flush with the surface of the ground, or as near low water as possible. The depth of penetration required to give sufficient stiffness to the foot of a pile bearing on a hard stratum varies with the character

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of the soil penetrated. Practical considerations, however, permit the recommendation that bracing, including a lower sash brace, should be used in all cases where the penetration is less than 8 feet.

For frame bents, the same holds true regarding the slope of the bracing, but another consideration enters. For heights over 24 feet high, it is better to build a second deck, and in all frame bents of more than one deck, providing materials are obtainable, the maximum economical height of each deck (that is, distance between intermediate sills) is about 24 feet. For this height of deck double-story sway bracing is necessary between intermediate sills. It is customary in multiple-deck frame trestles to make the height of the decks the same on all the bents, and each as nearly a factor of the total height as possible. This means:

Single-deck frame bents up to 24 feet high;
Double-deck frame bents 24 to 48 feet high;
Triple-deck frame bents 48 to 72 feet high, etc.

When longer timber is obtainable at a reasonable price, it is recommended that 30-foot posts be used as a maximum instead of the 24-foot lengths here listed. It is often possible, in certain sections of the country, to obtain 12 by 12 inch timber in 30-foot lengths at a small increase in cost, and the saving in time required to reopen a damaged line will almost invariably well repay the additional expenditure for the extra length. It is suggested, therefore, that a stock of these longer timbers be kept on hand for emergency repairs--but for reconstruction on a large scale, 24 feet is considered as the maximum economical length of post.

Sway bracing on each deck will be single or double story, as the distance between intermediate sills is less or greater than 16 feet.

Longitudinal X-bracing or "tower bracing" should be placed on every other span of trestles between the heights of 14 feet and 42 feet. For heights above 42 feet all spans should be tower-braced, but the bracing on every third span should extend down to within 6 feet of high-water mark only, to allow for passage of drift. This tower bracing is quite frequently slighted and the writer believes it to be a serious omission. The backward pressure of the driving wheels of a locomotive against the track, when working steam, or the forward pressure, when brakes are applied, creates a thrust force in the trestle deck perpendicular to the planes of all the bents and tending to overturn them. This thrust becomes dangerous in high trestles and for that reason tower braces are very necessary.

A sash brace must always be placed between each story of sway or longitudinal X-bracing.

Sway bracing should be through bolted at each intersection, including the outer ends of caps and sills.

Stringers should be 8 by 16 inches, placed on edge. For spans of 13 feet or less (center to center of caps), three-ply stringers under each rail should be used; four-ply for spans 13 to 16 feet; and steel stringers, or girders used on all spans over 16 feet. These spans may be exceeded by one foot in emergencies.

Longitudinal girts and guard timbers should be 6 by 8 inches, and dapped at least 1½ inches over each tie or sash brace. Girts are required on heights over 24 feet only.

Piling should be at least 12 inches in diameter at ¼ of the length from the butt and not over 20 inches diameter at the butt. The minimum diameter of the point should be not less than 9 inches for piles not over 30 feet long, 8 inches for piles from 30 to 50 feet long, 7 inches for piles over 50 feet long. A line drawn from the center of the butt to the center of the tip should lie wholly within the body of the pile.

Supporting power of bents is usually a function of the supporting power of the soil rather than of the timber. For 13-foot spans the maximum pier reaction of an E-60 locomotive is 74 tons under each rail or 148 tons total on the pier. For 16-foot spans, the maximum pier reaction under each rail is 86 tons or 172 tons total on the pier. The safe supporting power of a 4-post (12 by 12 inches) *frame bent* based on strength of timber, is 263 tons for Douglas fir, long or short leaf yellow pine and western hemlock of standard or standard heart grade. A *4-pile bent* has a safe supporting power, on the same basis of 172 tons total or 43 tons per pile. This means that 4-post bents are sufficient for any modern loading, so far as timber stresses are concerned. However, the supporting power of many soils is insufficient when only 4-piles are used. With the exception of stiff clay, hardpan and certain grades of sand, a pile penetration of over 25 feet is usually necessary to obtain a safe supporting power of 43 tons per pile. It is recommended, therefore, that 5-pile bents be used on main lines where heavy traffic prevails, and that 6-pile bents be used on these same lines where the height from ground to base of rail is over 30 feet. Four-pile bents are sufficient for heights under 30 feet in all emergency construction and in permanent work on branch lines, or on main lines with light traffic. Above 30 feet, 5-pile bents are recommended in these latter cases, but it is impossible to make rigid specifications for this class of work and the field engineer must determine the safe number of piles in all cases, by a judicious examination of subsoil conditions at the site of the work. Frame bents of one story require only 4 posts under all conditions, care being taken to provide ample bearing on mud sills. Frame bents of more than one story should preferably have 6 posts in the lower stories to increase the rigidity

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of the structure. A summary of the foregoing in tabular form, is:

Frame bents, of one-story; 4 posts recommended.

Frame bents, more than one-story—

4 posts in upper story.

6 posts in lower stories.

Very high frame bents require special designs in each case.

Pile bents; on main lines, height under 30 feet—

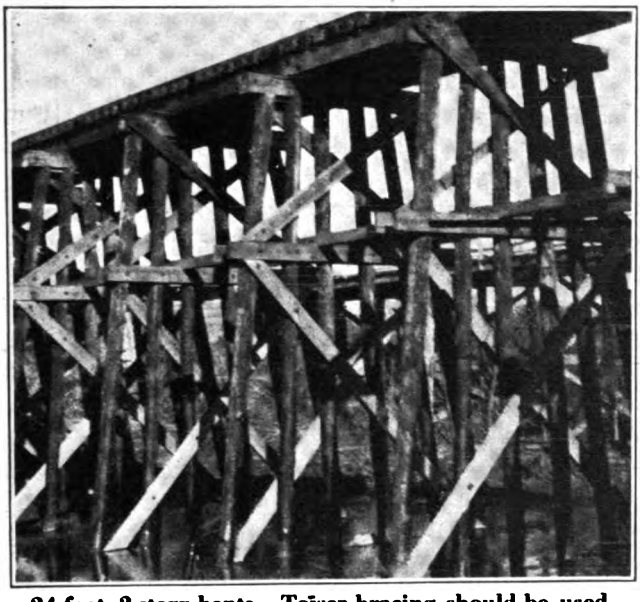
5 piles recommended.

Pile bents; on main lines, height over 30 feet—

6 piles recommended.

Pile bents; emergency work, and branch lines, height under 30 feet—

4 piles recommended.



24-foot, 2-story bents. Tower bracing should be used on trestles of this height

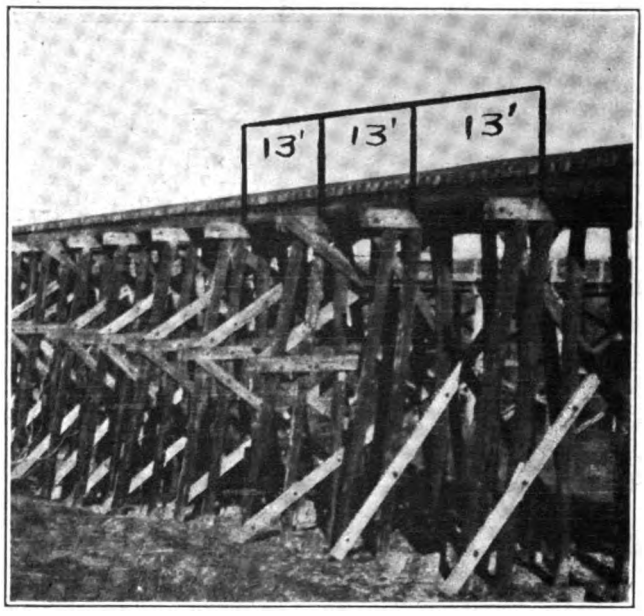
Pile bents; emergency work, and branch lines, height over 30 feet—

5 piles recommended.

The following is a theoretical discussion of supporting reactions in pile foundations, and is submitted, not as an original study, but rather as a concise presentation of known conditions for the benefit of those engineers who have not previously considered the subject in detail.

The function of a pile is to transfer a concentrated load to the subsoil in a diminished unit concentration, or to carry the concentrated load through a soft strata to one capable of carrying the greater unit concentration. In doing this, skin friction exerts supporting power varying considerably with different kinds of soil, but apparently a variable function of the direct bearing value of the soil (the variable element being in most cases water content). As a pile is driven it creates a "cone of bearing" about itself, this cone diverging downward and its rate of divergence dependent on the relation of skin friction to bearing value in the particular soil. If piles are driven too close together, these cones overlap and consequently overload areas of subsoil and decrease the safe unit-pile supporting power. The writer recommends a minimum spacing of piles of 2 feet 6 inches on the ground surface and a batter sufficient to prevent extensive overlapping of these "cones of bearing."

Batter serves two purposes: (1) to stiffen the bent against side thrust, thus assisting the sway bracing, and (2) to spread the foundation over sufficient bearing area, and at the same time have the heads of the piles close enough together to keep down the size of cap necessary. (The first consideration is the more



Change from single story to double story sway bracing when height reaches 24 feet

important in frame bents, and the second in pile bents.) A fair summary of observations and test reports at the writer's disposal, shows the following:

Table 1.

Nature of subsoil.	Direct bearing lb. sq. ft.	Skin friction lb. sq. ft.	Average Ratio DB to SF	Average Ratio SF to DB
Soft River Mud	400– 800	360	1.66	.602
Marsh	800– 1,800	600	2.16	.463
Alluvial Mud	1,600– 4,000	800	3.50	.286
Stiff Clay	8,000–12,000	1,800	5.55	.180
Sand, unstratified	4,000–12,000	1,000–3,000	4.00	.250
Sand, stratified "in situ"	12,000–18,000	2,000–5,000	4.80	.208

The last column represents the theoretical square feet of subsoil under load outside the perimeter of the pile, the load being transferred to this area by the skin friction on one square foot of pile surface.

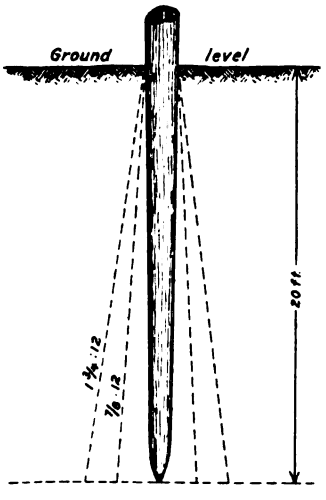
Assume, for purposes of comparison, a pile with a

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9-inch tip driven to 20 feet penetration, the diameter of the pile at the surface of the ground being 15 inches. The surface area of the pile in contact with the soil will then be 63 sq. ft. and by simple computations we obtain the following:

Table 2.

Nature of subsoil.	Area of indirect bearing sq. ft.	Area of direct bearing sq. ft.	Total area of bearing (base "cone of bearing") sq. ft.	Diameter of "cone of bearing".	Batter of cone surface per vertical ft.
				ft.–in.	
Soft River Mud	37.9	1.2	39.1	7 1	1¾ in.
Marsh	29.2	1.2	30.4	6 3	1½ in.
Alluvial Mud	18.0	1.2	19.2	5 0	1⅛ in.
Stiff Clay	11.4	1.2	12.6	4 0	⅞ in.
Sand, unstratified	15.8	1.2	17.0	4 8	1 in.
Sand, stratified	13.1	1.2	14.3	4 3	⅞ in.



In Table 2, column one represents the subsoil area in bearing as a result of transfer of load from the pile by skin friction. Column two is the subsoil area in direct bearing, being the vertical projection of the cross sectional area of the pile at the ground surface. Column three is the sum of columns one and two, and represents the area of "spread footing." Column four gives the diameter of the circles whose areas are given in column three. The last column is the slope of the surface of cones 20 feet high with base diameters those in column four. This last column represents the theoretical difference in batter required between any two adjacent piles to avoid overloading any portion of the subsoil. Since the load carried by a pile can only be transferred to soil *outside* of the perimeter of the pile by skin friction, it follows that the higher the supporting power of the subsoil the less the area of the cone of bearing required to support the load transferred away from the pile by skin friction. And conversely, in the softer and more fluid soils, where skin friction is a more important supporting factor, a larger cone of bearing is required to support the same load. These cones of bearing must not be confused with the truncated cones of direct bearing underneath, and inside the perimeter, of the pile. The divergence of the load in these latter cones is simply that of the ordinary reaction of a soil to a superimposed load and is a fairly well known function of the coefficient of friction of the individual particles in the soil.

In railroad trestles, or in any pile support where all the piles are driven in one plane and no other piles driven alongside within say 10 feet, it is permissible and better to allow the bases of the "cones of bearing" to overlap slightly. This will reduce the amount of batter required and diminish the spacing of the piles, making for more economical construction. Also the percentage of overlapping area in each cone base is relatively small when the combined middle ordinate does not exceed one foot (being about 14 per cent in stiff clay, and 6 per cent in soft mud).

In cases where very deep penetration is necessary to obtain a sufficiently large and, at the same time, safe supporting power for a pile, it is evident that the foregoing theory would demand abnormal batters or rather large pile spacings. (By "very deep penetration" is meant penetration over 70 feet.) In these cases, almost invariably, there is a great deal of water in the subsoil and the foregoing values for direct bearing and skin friction do not apply. It is probable in this class of foundation that there is little, if any, load transferred from the pile to the subsoil in the upper quarter of its length and that the rate of transfer in the lower three quarters is considerably less than any values derived hereinbefore. This would mean a steeper "cone of bearing" than any here worked out, with a consequently smaller allowable pile spacing and batter. Reliable data on pile supports in soil of this character being exceedingly limited, it is difficult to predict, in a purely theoretical discussion, the nature and amounts of the subsoil reactions. Test piles must be driven, not singly but preferably in groups of three or four, and loaded as a group, to derive a safe working figure for the foundation support as a whole.

Based on the foregoing theoretical discussion and certain practical considerations, the following batters are recommended for railway trestle bents in average soils—

4—Pile bents (spacing, 2½, 3, 2½ feet).
2 inside piles plumb.
2 outside piles battered 2½ inches; 12 inches.

5—Pile bents (spacing 2¼, 2½, 2½ feet).
Center pile plumb.
2 intermediate piles battered 1 inch; 12 inches.
2 outside piles battered 2½ inches; 12 inches.

6—Pile bents (spacing 2¼, 2½, 2½, 2½, 2¼ feet).
2 center piles plumb.
2 intermediate piles battered 1 inch; 12 inches.
2 outside piles battered 2½ inches; 12 inches.

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The spacings here given are to be taken as a minimum.

It must be borne in mind that batter piles driven to the same depth as plumb piles have greater supporting power because of their greater penetration. In the foregoing discussion it is assumed that all piles are driven with the same penetration. In actual practice they are frequently driven to the same depth, but the difference in supporting power, because of this is neglected here, the error being on the side of safety, and less than 3 per cent.

Believing that many field engineers do not give sufficient attention and consideration to pile driving, the following principles of practice, as recommended by the American Railway Engineering Association, are quoted for guidance:



Pile spacing, 24 foot bent. Note absence of lower sash brace, not required if penetration is 8 feet or more

There is danger from overdriving when the hammer begins to bounce. Overdriving is also indicated by the bending, kicking or staggering of the pile.

The brooming of the head of the pile dissipates a part, and in some cases all, of the energy due to the fall of the hammer.

The use of a cap is advantageous in distributing the impact of the hammer more uniformly over the head of the pile, as well as in holding it in position during driving.

The steam hammer is usually more effective than the drop hammer in securing the penetration of a wooden pile without injury, because of the shorter interval between blows.

In general, the resistance of piles, penetrating soft material, depending solely upon skin friction, is materially increased after a period of rest. This period may be as short as fifteen minutes, and rarely exceeds twelve hours.

Before testing the penetration of a pile in soft material where its bearing power depends principally, or wholly, upon skin friction, the pile should be allowed to rest for 24 hours after driving.

Where the resistance of piles depends mainly upon skin friction it is possible to diminish the combined strength, or bearing capacity, of a group of piles by driving additional piles within the same area.

Where a pile penetrates muck or a soft yielding material and bears upon a hard stratum at its foot, its strength should be determined as a column or beam; omitting the resistance, if any, due to skin friction.

Where piles will foot in a hard stratum, investigation should be made to determine that this stratum is of sufficient depth and strength to carry the load.

Piles should not be pointed when driven into soft material.

Shoes should be provided for piles when the driving is very hard, especially in riprap or shale. These shoes should be so constructed as to form an integral part of the pile.

Piles should be driven to a firm bearing; or until five blows of a hammer weighing 3,000 lbs. falling 15 feet (or a hammer and fall producing the same mechanical effect), are required to cause an average penetration of ½ inch per blow, except in soft bottom where special instructions must be given. (Note: This rule will give a safe bearing value of about 30 tons per pile.)



Framing details, upper story. Note dap of longitudinal girt on sash brace

Batter piles should be driven to the specified inclination, and should require but slight bending before framing.

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Table 3—Working Unit-Stresses for Structural Timber, Expressed in Pounds per Square Inch.

Note.—The working unit-stresses given in this table are intended for railroad bridges and trestles. For highway bridges and trestles the unit-stresses may be increased twenty-five (25) per cent. For buildings and similar structures, in which the timber is protected from the weather and practically free from impact, the unit-stresses may be increased fifty (50) per cent. To compute the deflection of a beam under long-continued loading instead of that when the load is first applied, only fifty (50) per cent of the corresponding modulus of elasticity given in the table is to be employed.

Kind of Timber	Bending			Shearing				Compression						
	Extreme Fiber Stress		Modulus of Elasticity	Parallel to the Grain		Longitudinal Shear in Beams		Perpendicular to the grain.		Parallel to the Grain.				
	Average Ultimate	Working Stress	Average	Average Ultimate	Working Stress	Average Ultimate	Working Stress	Elastic Limit	Working Stress	Average Ultimate	Working Stress	For Columns under 15 Diams. Working Stress.	Formulas for Working Stress in Long Columns over 15 Diameters.	Ratio of Length of Stringer to Depth.
Douglas fir	6,100	1,200	1,510,000	690	170	270	110	630	310	3,600	1,200	900	1,200 (1-L/60d)	10
Longleaf pine	6,500	1,300	1,610,000	720	180	300	120	520	260	3,800	1,300	980	1,300 (1-L/60d)	10
Shortleaf pine	5,600	1,100	1,480,000	710	170	330	130	340	170	3,400	1,100	830	1,100 (1-L/60d)	10
White pine	4,400	900	1,130,000	400	100	180	70	290	150	3,000	1,000	750	1,000 (1-L/60d)	10
Spruce	4,800	1,000	1,310,000	600	150	170	70	370	180	3,200	1,100	830	1,100 (1-L/60d)	
Norway pine	4,200	800	1,190,000	590*	130	250	100	---	150	2,600*	800	600	800 (1-L/60d)	
Tamarack	4,600	900	1,220,000	670	170	260	100	---	220	3,200*	1,000	750	1,000 (1-L/60d)	
Western hemlock	5,800	1,100	1,480,000	630	160	270*	100	440	220	3,500	1,200	900	1,200 (1-L/60d)	
Redwood	5,000	900	800,000	300	80	---	---	400	150	3,300	900	680	900 (1-L/60d)	
Bald cypress	4,800	900	1,150,000	500	120	---	---	340	170	3,900	1,100	830	1,100 (1-L/60d)	
Red cedar	4,200	800	800,000	---	---	---	---	470	230	2,800	900	680	900 (1-L/60d)	
White oak	5,700	1,100	1,150,000	840	210	270	110	920	450	3,500	1,300	980	1,300 (1-L/60d)	12

Adopted, 1909, by American Railway Engineering Association.
These unit-stresses are for a green condition of timber and are to be used without increasing the live load stresses for impact.
*Partially air-dry.
L equal length in inches.
d equal least side in inches.

Results of Federal control of railroads.—There has been so much adverse criticism of government control of railroads, much of it unjust, that it should afford some relief to the average citizen to hear the other side of the story as related by those who know the facts. Federal control made practicable a War Transportation Service that could not have been otherwise obtained; its unification practices have increased the utilization of the inadequate supply of equipment so that an exceptionally large transportation service has been performed in the busy periods of 1919 with a minimum of congestion; it met the emergency of the unprecedented coal strike in a way which private control could not have done and absorbed a heavy financial loss on that account which would have proved highly disturbing to private control; it provided more additions and betterments and equipment than private control could have provided during the difficult financial period of 1918 and 1919; it dealt fairly with labor and gave it the benefit of improved and stabilized working conditions which were clearly right; it not only did not cost more than private control would have cost during the same period but cost considerably less on account of the economies growing out of unifications, and the total burden put upon the public (through rates and taxes) on account of railroad costs was substantially less than would have been necessary if the railroads had remained in private control and rates had been raised enough to preserve their credit; it protected the investment in railroad properties, whereas without federal control those investments would have been endangered; and it turns the railroads back to private control functioning effectively with a record of exceptional performance in an exceptionally difficult winter, despite the disruption caused by the coal strike, and in condition to function still more effectively with the normal improvement to be expected in the weather and in other conditions.—*Report of the Director General of Railways.*

Train Ferries for African Lakes.—A proposal to employ train ferries for the great lakes in the African continent, as part of the Cape to Cairo route, has been offered. The project is reported as especially desirable, for a considerable time must necessarily elapse before the Cape to Cairo Railway is an accomplished fact, and anything, therefore, that is practical and calculated to expedite transport in the regions to be traversed should be welcome. For the purpose of train-ferry service, the Nyasa, Tanganyika, and Victoria-Nyanza systems have the great advantage that they are not tidal—although this does not mean that provision need not be made at the dock for appreciable changes of level, which may be due either to rainfall or to long-continued winds.

The lake routes indicated run practically north and south and represent, in the aggregate, about 850 miles. At present prices, it would cost about $20,000,000 to construct railways over this distance, as against a cost of $6,000,000 for train ferries, a saving of $14,000,000.

The use of train ferries on Victoria Nyanza will not be restricted to north-to-south routes. It is expected that, in days to come, there will be quite a number of other ferry services, notably between Kisumu (Port Florence) and the ports on the northern and western shores, for the purpose of developing the valuable agricultural regions in the vicinity of the lake, and particularly those lying to the west, northwest and north, by giving them better communications with the shortest route to the east coast via the Uganda Railway.—*Geographical Journal.*

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Professional Notes

of Military and Engineering Interest

Commissions in new army.—To fill vacancies in the Army which will be created by the Army reorganzation bill, the War Department requests that applications for such appointments be made without delay by all emergency officers, who, on the termination of their war services were recommended for reappointment in cases of vacancies. These applications should contain a brief summary of the officer's civil and military experience. Forms may be obtained from the War Department.

The reorganization bill provides for 17,000 officers and will call for appointments in nearly every grade in the Army. Owing to the present shortage of personnel the War Department will make every effort to fill these vacancies as quickly as possible, and it, therefore, behooves every emergency officer who desires to obtain an appointment in the Regular Army to submit his application at once.

The dangers of specialization.—Mr. Morley Roberts once delivered himself of the aphorism, "Few men know their own business, for it cannot be understood without knowledge of things outside it." The comment is worth some thought, because at a time when the world is specializing more and more we find the common-sense of specialists so frequently impugned. The question concerns engineers, they are experts—at least it may be hoped that they are, and considering the enormous range of their subjects, there is no reason why they should not specialize, but in specializing it is essential that they should preserve their sanity. As human beings we are endowed with many faculties, and if we bring into concentrated employment any one faculty to the exclusion of all others, we are liable to become incapable of sound judgment on any subject, and possibly least of all on the subject which is peculiarly our own. There is an obvious advantage in possessing an intimate knowledge of some one branch of work instead of a smattering of many, but we lose that advantage if we fail to understand our own business from ignorance of things outside it.—*Indian Engineering (Calcutta).*

Largest concrete blocks.—In his presidential address, read before the Institution of Civil Engineers on Nov. 4, Sir John Purser-Griffith referred to the complete success which had followed the use of what are claimed to be the largest concrete blocks ever used. These blocks each contained more than 5,000 cubic feet of masonry and weighed about 350 tons. They were used in the construction of the North Quay extension of the Port of Dublin. The blocks were built above high-water level and when sufficiently set were lifted by a floating shears or crane and deposited on a bed prepared by dredging; they were leveled by men working in a large diving bell, entered through a tube fitted with an air lock. The same floating plant was used for laying similar large blocks for breakwater protection, and for the foundation of one of the lighthouses at the entrance of the harbor. These great blocks proved a complete success, both from structural and economic point of view. By their use it was possible to build the extension quays without costly cofferdams or heavy pumping.—*Concrete and Constructional Engineering.*

How to blast hardwood stumps.—The great majority of the best grade of wild land in the northern part of this country is "hardwood land" and consequently, the great volume of stumps to be gotten rid of are hardwood stumps. By "hardwood stumps" we mean maple, beach, birch, hemlock, and basswood.

There are several reasons why the use of dynamite is prevalent, the main one of which is economy. And since economy is the object of blasting, it naturally follows that the economic use of blasting supplies is of paramount importance.

It has been found that in the blasting of hardwood stumps, detonation is the best, and cheapest, done with cap and fuse; occasion but rarely arises where a blasting machine is required.

The charge is placed under the center of the stump, or the point of greatest resistance. The ability to calculate this, and the amount of charge, correctly, is obtained only by practice. It will readily be seen that correct location and amount of charge is the secret of economy.

It is best to use a bar made from a piece of steel shafting, about five and a half feet long, and weighing 23 pounds. One end of this bar is drawn to a point, and the other flattened like a chisel. Use the pointed end to punch the holes for the charge, and the chisel end to cut off small roots that sometimes interfere. When a stump is to be blasted, the calculation of the amount of the charge is greatly facilitated by "sounding" it; this is done by swinging the bar endwise and striking the stump with the chisel end. It can readily be seen that, unless the stump is a solid one, it can be shaken more or less with a bar of this weight.

In blasting on heavy clay, when it is wet, the bar sometimes sticks so that it can not be used to advantage. In this case, it is better to have a one and a half inch auger, with a 4 or 5-foot shank, with which to bore the holes.

As a rule the proper dynamite for hardwood stumps is a medium slow powder of 40 per cent strength. In old stumps on clay soil the use of dynamite of twenty per cent strength is recommended and on lighter soil and fairly green stumps sixty per cent is better.—*The Excavating Engineer.*

Open mouth for Mississippi River.—Under this title there was a paper by Allen E. Washburn read at a recent meeting of the Louisiana Engineering Society. Mr. Washburn outlined in a very interesting manner the history of the various projects for the maintenance of a navigable channel at the mouth of the river from the time of the early French settlers of 200 years ago down to the present development of the Southwest Pass. A number of proposals were made to side-track the difficulties due to sedimentation of the natural channels and bar formations at the mouth of the river, as well as to shorten the distance to New Orleans, by the construction of a ship canal. During a vigorous discussion of various canal projects in the early seventies James B. Eads became interested in the problem, and finally in 1874 made a proposition to Congress to build jetties at the mouth of Southwest Pass at his own risk and cost, he to be paid as results were accomplished. A bill was passed in 1875 authorizing him to build his jetties in South Pass, and the result is known to all—for the past 40 years South Pass has been the navigable channel and entrance to the port of New Orleans.

New Orleans has shown a singular lack of gratitude in that it has never recognized the work of James B. Eads by any sort of memorial to him.

South Pass is still a very excellent channel with a depth of 32 feet but owing to the natural formation of the bar the approach from the gulf has been shifted so far to the eastward that vessels must make a rather difficult turn just at the mouth of the jetties. With the expiration of the Eads contract consideration was given the problem of providing a larger channel from gulf to river. It was then decided to make use of Southwest Pass and to provide it with jetties in order to have a channel with a width of 1,000 feet and 35 feet depth. Construction of these jetties was begun in 1905.

Mr. Washburn calls attention to the phenomenon of "sand waves" as a retarding factor in the improvement of Southwest Pass. The volume of material and the speed of advance of these sand waves is of such magnitude at times as to cause a shoaling of 20 feet in 24 hours. There is apparently need for considerable extension to the study of this problem of sand waves, for while some points were brought out in the discussion of the paper, there appears to be a lack of definite data as to the periodicity of the waves, which of course would be a very important item in the question of the control and maintenance of the depth in the channel. A paper upon this very interesting phenomenon of the Mississippi River would be of interest to many.—*Eng. World.*

Chateau-Thierry honored.—Chateau-Thierry, the little French town on the Marne, famous in the annals of the American Army in the World War, is to be awarded the French Legion of Honor.

Commercial uses of the geophone.—The geophone is of special value in locating the positions of tunnel headings coming together when ordinary survey methods are difficult. A determination should be made from each heading, and if they agree the result may be accepted. The human voice in ordinary tones can be detected through 150 feet of solid coal, and conversation understood through 50 feet.—*U. S. Bureau of Mines.*

Motorized terminals.—B. F. Fitch, in *Engineer World* describes the motorized terminals now being employed in Cincinnati. He opens with the startling statement that the joint terminal charge to the carriers alone for New York and Chicago, equals the cost of the main line haul between the two cities.

The transfer of freight between terminals of different roads has been generally accomplished by the shifting around of "traps",

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"transfer" or "ferry" cars. This procedure is characterized by the vast amount of "switching" which is such a common sight in every large city, and the cost and delays incident to this switching are the reasons, according to Mr. Fitch, for excessive terminal charges.

The "motorized terminal" as employed in Cincinnati eliminates this switching of freight cars. Its essential feature is a demountable motor truck body.

At each freight station there is one or more of these demountable bodies on hand for each station to which freight is to be transferred. These demountable bodies are moved about by electric cranes and placed conveniently to receive the freight discharged from the incoming trains, or load into outgoing cars. As freight comes out of the cars it is trucked to and loaded in the demountable body tagged with the name of the station for which destined. As soon as the demountable body is filled it is picked up by a crane, carried to and placed upon the chassis of a motor truck, and proceeds at once to the station for which destined, instead of knocking about the rail yards for two or three days or more.

The author states that within a 10-mile radius the cost of the carriers of this interchange of freight between stations, is less than $1.00 per ton. The great advantage of the system is the simplicity of its application, there being no excessive real estate charges, no difficult engineering problems or large construction projects, and little need for the co-ordination of conflicting interests involved. In most large cities a union freight terminal is an appalling problem which grows more appalling each year. By the motor transfer system a number of widely separated stations may enjoy the benefits of the union terminal.

Mr. Fitch is very keen to apply his solution to the largest and most scandalous of freight terminals, New York, which he regards as a check on the industrial expansion of the nation, and as largely responsible for the H. C. of L., not only for New Yorkers (who deserve it) but for the rest of us as well. He outlines a plan for terminal freight handling at New York, and utters the threat that unless something is done about it a long suffering nation will abandon that too conservative city to its own follies and proceed to create new transshipment ports.

Flood protection for Winnipeg.—Though exposed to devastating floods of the Red River of the North, Winnipeg has been mercifully spared during her recent rapid growth and development. But river floods are as sure as taxes, and Winnipeg dreads a repetition of the great flood of 1852, whose visible effects still remain. On this occasion the site of the city was completely inundated, the nearest dry land was four miles away, and this condition persisted for two weeks. A like occurrence at this time would cause millions of dollars of damage.

The causes of the Red River floods are readily perceived: a wet fall followed by a freeze-up, heavy winter snows, and a sudden burst of warm weather in the spring, accompanied by melting snow and heavy rainfall. A contracted channel between Winnipeg and Lake Winnipeg, the outlet of the river some 40 miles below, is responsible for the sustained flood period in 1852.

Mr. Douglas McLean, a Canadian engineer, proposes a sane project for flood prevention, based on a combination of the now well recognized methods of flood abatement. These would include—

(*a*) Reservoirs in the upper reaches of the Red River valley and the valley of the Assiniboine.

(*b*) Enlarging the capacity of the river channel below the city.

(*c*) Local protection by means of levees or dikes.

The estimated cost of these precautions is not given, but the most expensive item, the reservoirs in the Red River valley, is placed at approximately $25,000,000—*Canadian Engineer.*

General Goethals replies to criticisms of the concrete block tunnel.—Replying to criticisms of the concrete block tunnel, Gen. Goethals submitted a memorandum to the joint tunnel commission of New York and New Jersey, on April 2. After discussing his connection with the project and the preliminary studies which led him to recommend the 42-foot double deck, concrete block design, direct replies were made to the conclusions of the chief engineer and chairman of the board of advisory engineers.

(1) The 22-foot 6-inch roadway on each deck, provides for two continuous lines of traffic and a third passing line, and its capacity is much greater than a two-line roadway.

(2) The stresses in the concrete of the block tunnel would not be excessive under the actual loads determined from pressure observations on the Pennsylvania tunnels; though under the loading assumed in the chief engineer's analysis, both the existing Pennsylvania tunnel and the proposed cast iron tunnels would be unsafe, with tensile stresses in the cast iron of more than 9,800 lbs. per square inch. The concrete blocks are bolted together longitudinally and the block type tunnel has greater longitudinal strength and resisting moment than the 29-foot cast iron tunnel or the Pennsylvania Tubes.

(3) Regarding the difficulty of securing water tightness and consequent danger of disintegration, the example is cited of the Christopher St. McAdoo Tube, 2,000 feet of which was constructed of brick laid in Rosendale cement 35 years ago, and which is still in service.

(4) The original cost estimates were based on 1917 prices and the experience of the O'Rourke Engineering Construction Co. in work of this character. The cost of real estate was omitted as not affected by the type of construction. The question of relative costs could have been settled in 1917 by carrying out Gen. Goethals' recommendations that bids be called for upon competitive designs to be submitted by the bidders.

(5) The estimate of three years for completion was based upon the data of an experienced prospective bidder.

Gen. Goethals concludes that a vehicular tunnel providing for less than three lines of traffic in each direction would be inadequate. Concrete, unassisted by cast iron, is suitable for tunnel construction, and the concrete block tunnel is sound in engineering principle, practicable, safe, will not float or sink, and is far more economical than cast iron.—*Eng. News-Rec.*

Reconstruction of the Poughkeepsie Cantilever bridge for heavy traffic.—This is the only bridge over the Hudson south of Albany. Built in 1882, its total length, including approach viaducts, is 6,767 feet 8 inches. The river spans constitute a deck cantilever system of two 525-foot fixed spans, three cantilever 546 and 548-foot spans, and two 201-foot anchor spans. It was originally designed to carry train loads of 3,000 lbs. per linear foot with engine axle loads of 24,000 lbs. on both of its two tracks. In 1907 it was strengthened to carry train loads of 3,600 lbs. per linear foot with engine axle loads of 45,000 lbs. on both tracks. That strengthening was accomplished by the addition of a third central truss in each span, similar in outline to the original trusses but about 50 per cent heavier. In the river spans these trusses were supported on their own towers which rested on steel cylinder piles driven through the old pier cores, the new portion forming almost an independent structure. In the viaduct approaches, the original latticed trussed spans were replaced by girders and the additional central girders were added without providing separate supports.

The second extensive reconstruction, recently completed, was required by the necessity of providing for train loads of 6,000 lbs. per linear foot with engine axle loads of 60,000 lbs. In the studies preparatory to the reconstruction, three plans were investigated: (1) Substituting single for double track and distributing the single track loading over the three trusses; (2) Reinforcing the trusses for the new loading on both tracks; (3) Rebuilding the bridge. In general, method (1) was adopted for the main spans and method (2) was adopted for the approaches, though a portion of the latter were single tracked.

For distributing the load over the trusses of the main spans stiff floor beams were adopted in preference to an articulated system for equalizing the truss deflections. To provide for observed irregularities in the elevations of the upper panel points, five different depths of floor beams and various bolsters or fillers were employed, so that the floor beams act as rigid cross girders assuring approximately equal deflections in the three trusses under all loads. In the new floor system, the floor beams are designed to carry double track loading when spanning the 30 feet width of a proposed future two-truss span. Only the inside stringers of the two future pairs are placed in the single track portions.

On both approaches double track was retained for the most part. In about one-third of the east approach and 600 ft. of the west approach, original latticed trusses had been replaced in the 1907 reconstruction by viaduct girders which, with slight changes, were adequate for the new loadings. In the bents, however, neither the king-post trussed caps nor their two supporting columns were sufficiently strong. To meet this difficulty, two stiff diagonals from the center of the cap to the feet of the columns were added to take the outer girder reactions, relieving both the cap and the columns of that load. In the westerly two-thirds of the east approach, center line columns had been added in 1907, and the only deficiency in strength was found in the side columns, which were stiffened by two angles riveted to the web of each column.

In the truss spans of the east approach, the single track of the main spans was continued eastward over the 800 feet of trussed spans, and the latter required only the remodeling of the floor system after the plan used in the main spans. In the two 145-foot truss spans of the west approach, the spacing of the tracks was reduced from 14 feet 8 in. to 13 ft. between centers. This reduced the load on the outer trusses to safe figures and reinforcement was required only in the center span. This reinforcement was effected by side plates on the top chords, by loop rods on the tension members, and by a complete riveted tension system built around the bottom chord. Initial stress was forced into the new tension members in order that dead load stresses in new and old material might be equalized. To accomplish this, the gusset plates at field splices had full sized holes while one end of each member connecting to them was left blank. After pulling the new steel firmly into place against the old pins, the blank end of the member was marked for drilling, and then drilled with full size holes sufficiently offset to give the desired elongation. The joints were temporarily bolted with a few undersized bolts, and finally drawn up into place by a number of drift pins driven by succes-

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Deming

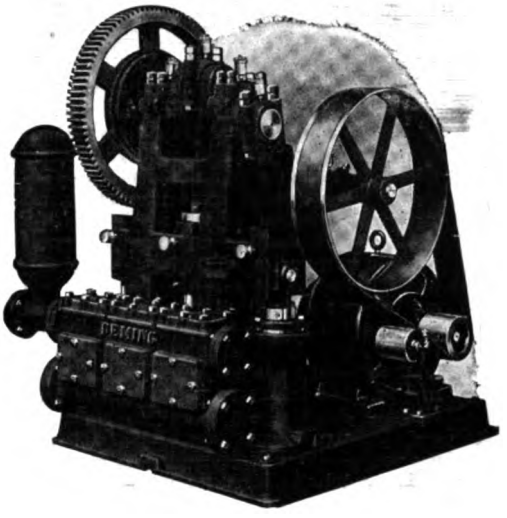


Fig. 50. Single-Acting Triplex Pump 5 1-2 x 8 Type, "C" Drive

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sive moderate blows on each pin, to avoid deforming any holes. The actual elongation was measured by an extensometer of local manufacture which remained clamped to the member while it was being drawn into place for final riveting.

This method was not applicable to the bottom chord reinforcement because of the difficulty in shifting the members for drilling after putting them in place. Instead, it was determined that the initial stresses desired should produce an elongation equivalent to that of a change of temperature of about 17° F. The members were lightly bolted in place and heated by small wood fires, distributed along the member, until the desired expansion was secured, when the joints were completed.

After the completion of the work, the behavior of several members in the different spans was checked by means of a Berry strain-gauge and also by an improvised gauge constructed locally. The results of the gauge readings were in close accord and showed that the assumptions as to load distributions in design were borne out in the remodeled bridge.

The work was begun in January 1917, but due largely to the difficulty of securing material during the war, it was not completed until August, 1918.—Clement E. Chase in *Eng. News-Rec.*

Resistance of Greenheart to marine borers.—Greenheart timbers immersed for six years in waters of the Gulf of Mexico, infested with xylotra, limnoria, and pholas, were not attacked by xylotra. One specimen was slightly attacked in the sapwood by limnoria, and all were attacked by pholas, the surface being covered with burrows ¾ inch or less in depth.—*Eng. News-Rec.*

"Plastic fill" method of embankment construction.—In building the section of the Taylorsville dam of the Miami Conservancy District, it was necessary to construct a cross dike to enclose one end of the core pool. This cross dike was built by the "plastic fill" process—a method apparently little used hitherto.

The material from a borrow pit was dumped by trains alongside the unloading track, then picked up by a drag-line bucket and dumped in a windrow along the west side of the cross dike site, but well inside the west limit of the dike. This windrow was built up dry to a height of 10 feet.

A 10-foot length of ¾-inch gas pipe, connected by hose to a steam pump, was then used like an hypodermic needle, piercing the windrow vertically in row of holes about 2 feet west of the top of the material and about 3 feet apart, and water thus introduced throughout the west half of the mass.

The water thus introduced made the dry material plastic, and, it flowed slowly in a westerly direction, as had been planned, as the western limit of the dike was beyond the reach of the dray line from its location near the unloading tracks.

By dropping fresh material on top of the windrow, the stiff dough in the west slope was kept moving very slowly till it reached the limit staked out for it—the west limit of the cross dam—thus transporting itself a maximum distance of over 40 feet. If the material slowed up too much, a fresh injection of water or a new load of earth on top started it again.

A word of caution needs to be said about this method, however. The material used was largely glacial fill, containing such a percentage of clay that the water could escape. A material which would hold on to the water would no doubt give trouble if used for plastic fill.—*Eng. and Const.*

Note: A method similar to the foregoing was used in 1910 at New Orleans, La., in enlarging the levee section on the land side from the usual 1 to 3 slope to a 1 to 10 slope. The material, taken from the river side by drag-line excavators, was dumped just back of the levee, and then by wetting with a hose it flowed out to the limit of the new land side slope, a distance of probably 100 feet.

Japan's submarine tunnel.—Several months ago announcement was made that the Imperial Government railways of Japan intended to build a tunnel under Shimonoseki Strait. This strait separates the main island of the Japanese group, Hondo, from the smaller island of Kiushu at the south. It is now crossed by a car ferry which is rapidly becoming unable to meet the demands made upon it. Two years are to be spent in studying the geological formation of the sea bed in the strait and in drafting the general plan of work in preparation of the actual undertaking of tunneling, so that the real work will not commence until 1921. Engineers and workmen will be sent to America and Europe to make a study of what has been achieved in these countries in the way of tunnel engineering. The line is to be seven miles long, one mile of which will be entirely under the sea. The approximate cost of the undertaking will be about $10,000,000 and the work is expected to be completed in 1928.—*Scientific American.*

Laying a long steel pipe under water.—An interesting piece of engineering work has been done at the point where the Jersey City water supply line crosses the Passaic River. A pipe with an internal diameter of six feet and measuring 452 feet in length has been laid in a single piece in 26 feet of water. The pipe is encased in three inches of wire-reinforced concrete, placed with a cement gun. The concrete-cased pipe weighs about a ton per foot. A launching way was laid in a trench dug on shore and the pipe as it was complete was supported on cars running down a track in the trench. In order to deposit the pipe without strain in the submarine trench which had been dredged across the river, two parallel trestles were built between which the pipe was slung from timbers that were carried by cars placed at 25-foot intervals, opposite cars being connected by each to each by means of cables and were moved out across the river as the pipe was being built, and when completed the pipe was sunk by admitting water into it. In order to hold it down it was weighted with castiron blocks at each end. A goose-neck rises from the submarine section at each end and connects with the shore sections.—*Scientific American.*

Gyro compasses and oxygen heaters for aeroplanes.—For the first time in the history of aviation a gyroscopic compass was used successfully as a navigating instrument in an airplane at McCook Field, Dayton, Ohio, recently. Gyroscopic compasses embodying practically the same principles have been used for several years on American and foreign war vessels as well as the merchant marine, and particularly on submarines which depend almost solely upon an instrument of this kind when submerged. The gyroscopic compasses as used upon water craft weigh 2,000 pounds, and are quite bulky.

The chief problem in adapting a gyroscopic compass for aerial navigation was to design a similar apparatus where weight and bulk commensurate to airplanes with the same accuracy and dependability of the marine type as a result of laborious experimentation that looked hopeless, a model was made weighing only 17 pounds, and in size was 14 by 13 inches. It was tested in flight. The chief advantages over all former types or magneto compasses are: compass card free from spinning; indicates a true geographic north; no magnetic effect.

The test was successful in every respect and has definitely proved that a gyro compass will be the compass used for future aerial navigation.

Tests are being conducted at Dayton, Ohio, of a new apparatus for heating oxygen at high altitudes to prevent a recurrence of failure at high altitudes, such as experienced by Maj. Rudolph Schroeder recently in his record climb at Dayton, which came so near to costing him his life.

Tests so far have proved the new invention to be of material value.—*War Dept. News Bureau.*

Liquidation of War Department contract and sale of surplus material.—The value of all contracts liquidated to the end of March, 1920, is approximately $2,800,000,000. These included 18,860 formal contracts in the amount of about 1,550,000,000 and 5,385 informal agreements in the amount of about $1,250,000,000. It has cost about $360,000,000 to liquidate these contracts.

The saving effected by liquidation to March 27 amounts to $2,425,011,000. Of this, $1,364,648,000 was saved on formal contracts and $1,060,363,000 on informal agreements.

Value of contracts suspended	$3,944,369,000
Value of contracts liquidated	2,779,973,000
Saving effected	2,425,011,000
Percent saving effected	87

There are 2,469 contracts remaining to be liquidated. The value of these so far as known is $1,164,396,000. Assuming that in the future liquidation can be effected at the same rate as has obtained in the past, the cost of liquidating the contracts of known value may be estimated at $123,000,000. This would make the total cost of liquidation $536,000,000.

Total sales of surplus material to the middle of April amounted to approximately $800,000,000. Of this about $42,000,000 was transferred to other government departments.—*War Dept. News Bureau.*

Long-life creosoted piles.—A pile trestle approach to the L. & N. R. R. bridge over the Ohio River at Henderson, Ky., built in 1884, had 177 bents of creosoted piles. It recently became necessary to rebuild the trestle, as about 15 per cent of the piles were in condition to require early removal, and, in addition, the trestle was becoming too light for the increased loads.

Only about 10 per cent of the piles requiring renewal showed serious rot at the ground line. The most serious cause of decay was due to the fact that in rebracing the bents in 1896 many of the old piles were deeply adzed, exposing the less heavily treated wood. The part of the trestle which was not constructed of creosoted piles had piles of red cedar which gave a life of 18 years. These were replaced by untreated pine piles, which have been renewed at least once, so that the creosoted piles have given at least twice the life of untreated wood.

The long life—35 years—of the creosoted piling is clearly the result of the use of good timber, correct treatment, and continuity of the shell of protected timber on the exterior of the pile.—*Eng. and Const.*

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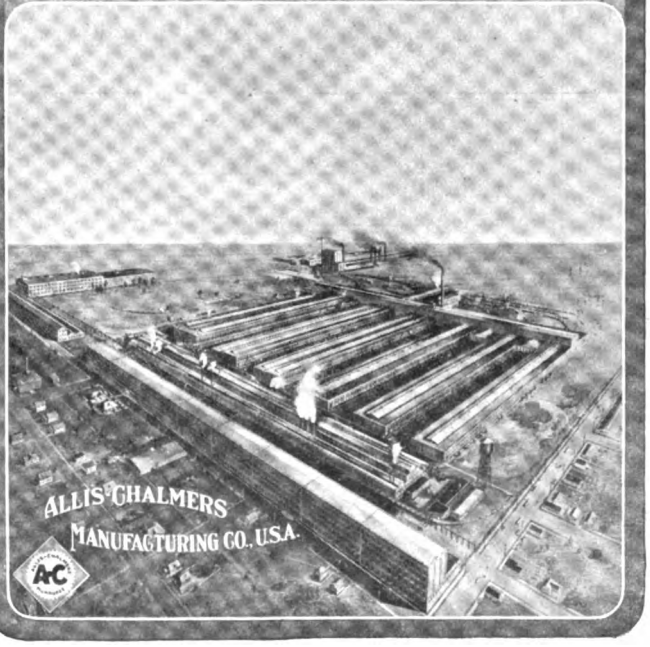
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The new one-inch and quarter-inch maps of the British Ordnance Survey

The original 1-inch maps of the Ordnance Survey were commenced in 1791 and the first sheet was published in 1801.

In 1872 an entirely new series of engraved maps was commenced, based on a new survey. Until 1894 the ordnance survey had produced only maps in the engraved form, the aim being to produce the best engraved article possible; a prejudice existed at this period against extending the work of the survey to lithography, and the attitude was that the survey was a map-producing rather than a map-publishing establishment.

In 1912 the whole question of the 1-inch map again came into the melting pot, as great strides had been made in reproducing methods in the twenty years since the first lithographic maps of the survey had been begun. A committee of both military and civilian users of maps considered an improved road classification, with particular reference to motor traffic. During the Great War, all the resources of the ordnance survey were devoted to the production of war maps.

Now that affairs have begun to assume their normal course, it has been determined to publish the regular 1-inch series of the following types:

A. The 1-inch Popular Maps;
B. The 1-inch Outline Map;
C. The Tourist District Map.

On the new popular 1-inch map, the road classificaton stands out in a very marked degree, the contours are uniformly at 50 feet vertical intervals, rivers, streams, and the sea are printed in solid tint, and parish boundaries have been omitted.

The new type of outline map is from stone, is a combination of the outline, water, and contours of the "popular" edition, and is printed on stout paper in order to make it more useful for engineering purposes. The new tourist district map is not yet on sale. The chief points to note are:

(1) The increased size of the sheet;
(2) The adoption of a broad layer system, printed in very transparent colors;
(3) The small number of printings for the effects obtained.

The quarter-inch maps were commenced originally in 1859, discontinued, and resumed in 1884. In 1902, the revised quarter-inch was published in its fully colored form in small sheets, and in 1912 it was produced in large sheets, ten sheets covering England and Wales.

This map was never satisfactory. It was far too crowded in many parts, and in particular the roads were badly shown. The water has always given trouble. There were no contours and the hill shading was very generalized and misleading.

The chief points about the new series are:

The abolition of the hill shading and the substitution of contours;
The introduction of the "layer system;
The comparative clearness of the detail;
Only main roads colored;
No green wood symbol.

Water, being on a separate plate and not overprinted, is much clearer.—*Geographical Journal.*

Map-making bureaus co-ordinated.—The United States Board of Surveys and Maps, created on December 30, 1919, by an executive order of the President, has perfected a permanent organization and held its first public meeting in March. The object of this Board, as outlined in the President's order, is to co-ordinate the activities of the various map-making agencies of the executive departments of the government and avoid the unnecessary duplication of work which may come about very readily when maps and surveys are being made by independent branches of the government. The Board has established a map information office in the Interior Department Building, where it will collect and catalogue as rapidly as possible information concerning maps, surveys, etc., prepared under the direction of the federal government or other governmental and private agencies. The Board is composed of one representative each of the Corps of Engineers, the Coast and Geodetic Survey, the Geological Survey, the General Land Office, the Topography Branch of the Post Office Department, the Bureau of Soils of the Department of Agriculture, the Reclamation Service, the Bureau of Public Roads, the Bureau of Indian Affairs, The Mississippi River Commission, the U. S. Lake Surveys, International Boundary Commission, the Foresty Service the Hydrographic Office of the Navy.

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Governmental Investigation of River and Harbor Improvements

Continued from Page 264

favorable reports before Congress which could properly serve as bases of appropriations.

The river and harbor Act of March 2, 1919, adopted 80 projects. Another bill containing a similar number of new projects would more than exhaust all pending recommendations of the Department, including some described above as obsolete. The facts show, therefore, that instead of there being from five hundred to six hundred projects before Congress recommended by the Department, there are actually less than one-fifth that number remaining to be acted on.

By reference to the table, it will be noted that the percentage of favorable reports was considerably greater prior to 1910 than since that time. This may be partially accounted for by the fact that in the earlier years proposed examinations were carefully scrutinized by the committees of Congress, and all clearly unworthy cases were rejected; while in recent years Congress has relied more and more upon the Board to eliminate the unworthy cases.

Recommendations for abandonment of unworthy projects

The Act of March 4, 1915, called for review of ten specified projects and directed the Chief of Engineers to report upon any other projects, river or harbor, the further improvements of which under present conditions is undesirable, or in which modifications of the plans or projects should be made. Under this act, the Board has recommended the modification of 34 projects, and the complete abandonment of 38 projects. It can scarcely be contended that the Board's recommendations in these cases were designed especially for the gratification of Congress or any of its members. While none of the recommendations for abandonment of projects have been adopted, the expenditures on some of these projects have been materially reduced.

Savings of public funds effected by Board of Engineers

It is appropriate here to present some information showing the importance of the service rendered by the Board of Engineers for Rivers and Harbors, and the savings made possible by its recommendations.

Notwithstanding the care exercised by District Engineers in their investigation, the Board is frequently unable to concur in their findings. These differences of opinion are largely due to the broader view that the Board is able to take because of its contact with commercial and transportation conditions in all parts of the country, and with other projects involving similar engineering or commercial problems.

From the organization of the Board in 1902 to the present time, the improvements recommended by District Engineers were estimated to cost $192,695,463.62 more than the final recommendations of the Board on these same projects. Deducting from this the sum of $4,476,358, being the estimated cost of work recommended by the Board, which had not been recommended by District Engineers, gives a net total of $188,219,105.62. This represents the saving in the estimates resulting from the review of the reports by the Board during a period of eighteen years, or $10,456,617 a year. The expenses of the Board during this period have averaged about $20,000 a year.

Other economies effected

Further important savings to the United States have resulted from the policy adopted by the Board of encouraging local coöperation. There are many cases where, in addition to the general public benefits to be derived from improvements, local interests will obtain substantial direct benefits from the proposed work, and in such cases the Board has felt that the interests immediately benefited should share in the expense involved. Its recommendations in cases of this kind have involved the contribution of over $11,000,000 in cash by local interests, donations of rights of way, participation in the construction work, and many other forms of coöperation which have made possible important savings to the Government.

In a number of cases the Board has recommended that the work be conditioned upon the establishment of adequate terminals by local interests, and this attitude has had the effect of materially improving terminal conditions.

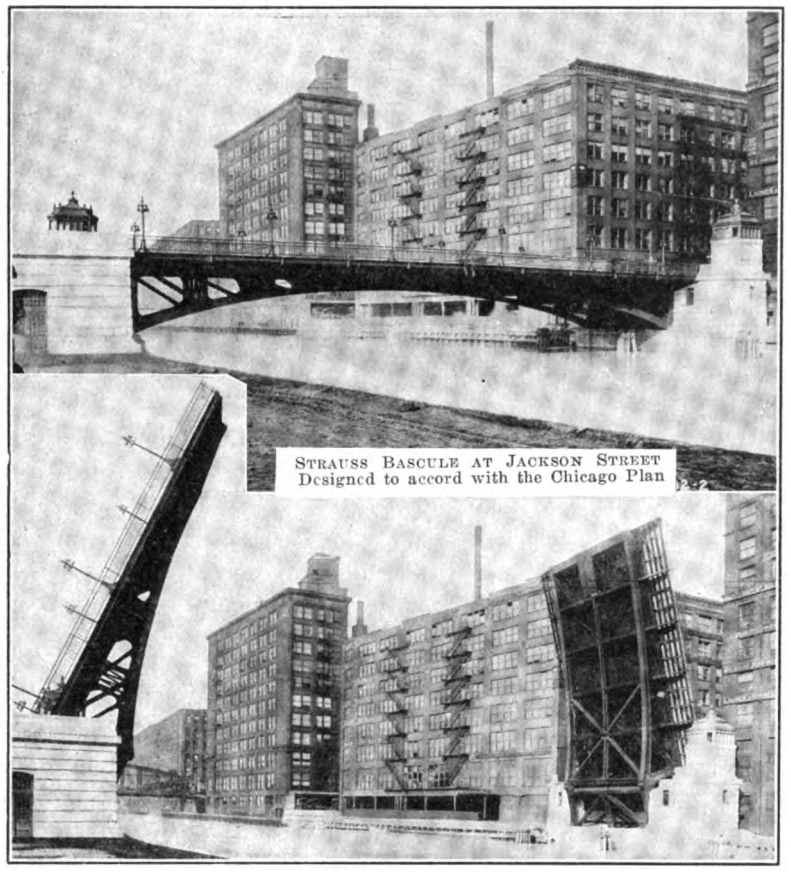
Aid to local communities

In the river and harbor act of March 2, 1919, the following appears:

> It is hereby declared to be the policy of the Congress that water terminals are essential at all cities and towns located upon harbors or navigable waterways and that at least one public terminal should exist, constructed, owned, and regulated by the municipality, or other public agency of the State and open to the use of all on equal terms, and with the view of carrying out this policy to the fullest possible extent the Secretary of War is hereby vested with the discretion to withhold, unless the public interests would seriously suffer by delay, monies appropriated in this Act for new projects adopted herein, or for the further improvement of existing projects if, in his opinion, no water terminals exist adequate for the traffic and open to all on equal terms, or unless satisfactory assurances are received that local or other interests will provide such adequate terminal or terminals. The Secretary of War, through the Chief of Engineers, shall give full publicity, as far as may be practicable, to this provision.

In carrying out the requirements of the law, the Chief of Engineers has assigned to the Board the duty

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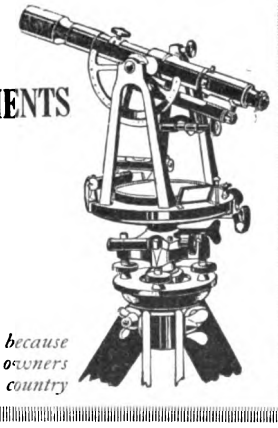
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of assisting local communities in the planning of their terminals, in order that they may prove adequate for the important uses for which they are intended. In connection with these duties, the Board has taken over part of the work and personnel of the former Port Facilities Commission of the Shipping Board. This work gives promise of meeting an important public need. From the first few cases referred to the Board, it is evident that purely local issues may often determine the character, extent, and location of facilities required for transacting the nation's business, and that there is a real need for an impartial study of these propositions by competent Federal authorities. The Board does not carry its work to the point where it might infringe upon the legitimate business activities of terminal engineers, but confines its advice to the general location, plan and layout of the terminal and its connections, leaving the details for determination and execution by local authorities.

Discussion

C. Keller
Colonel, Corps of Engineers; Resident Member, Board of Engineers for Rivers and Harbors

The preceding pages describe quite clearly the manner in which projects for river and harbor improvements arise and the laws and procedure under which the Board of Engineers for Rivers and Harbors, or as it is sometimes called, the Board of Review, operates.

The laws quoted by Mr. Ritter show the limitations of the authority confided to the Board. It is specifically authorized only to consider and report "upon examinations and surveys" provided for by Congress and "all projects or changes in projects for works of river and harbor improvements theretofore or thereafter provided for." It is also authorized and required to review prior reports on examination and surveys whenever called upon to do so by Congress.

The Board is therefore a creature of the law and its formal acts have hitherto been confined to those which it was affirmatively permitted to perform. It has generally been held that it could not, of its own motion, enlarge the scope of any inquiry, nor usually consider, in any given case, anything but the question that was immediately before it as expressed in the provision of law calling for the inquiry.

It is quite obvious that this rule must occasionally work badly, and that it may be in the interest of Congress and of the public to take a broader view. Particularly has this been felt to be the case since our entrance into the World War, which not only developed many acute transportation difficulties, but also witnessed the acquisition of an American mercantile fleet whose success must in great part depend upon the wisdom with which waterway facilities are provided and employed. Dispatch, or as it is now called, "turn-around," acquired to us a new and vital significance during the war, and our future as a commercial and manufacturing nation will largely depend on any special efficiency that we are able to develop in the operation of our vessels.

Quick "turn-around" may be promoted by many factors, such, for example, as the installation of apparatus for burning oil in place of coal, the better or more skillful handling of the ship, the provision of wharves conveniently arranged for the reception and temporary storage of cargo, and the application of efficient mechanical processes in loading and unloading; but an indispensable prerequisite is the provision of safe, adequate and convenient channels at a sufficient number of ports to enable freight to be assembled and distributed most economically and conveniently.

A proper general policy as to river and harbor improvements would be one which, visualizing the traffic of the nation as a whole, would provide for its transportation by land or water at a minimum cost, implying thereby the elimination of congestion, unnecessary transshipments, delay and needlessly long or difficult hauls.

It is obviously easier to state the principles upon which a correct general policy should be based than to formulate that policy definitely, since certain extraneous conditions, such as existing trade and financial practices and preferences, prevent an ideal solution. In any event, however, it is desirable and necessary to consider much more than the immediate locality and to endeavor to base decisions upon the broadest possible knowledge of the traffic of the country, its nature, volume, sources and destinations. In this way only can we provide wisely for our present prosperity and our future growth.

The study of this policy and its final determination is properly a function of statesmanship, and until recently the matter has not apparently received much thought. The Board of Engineers for Rivers and Harbors has, however, experienced so much difficulty in the performance of its functions that it has been forced to consider and to discuss this question and it has attempted to arrive at an agreement upon a general policy to guide its course. The question is at this very moment under consideration, certain proposals have been formulated, and eventually it is hoped to secure some expression on the subject from Congress, aided by such suggestions as the Chief of Engineers may approve.

What precedes leads to an attempt to describe the tests or criteria upon which the Board bases its judgment as to the worthiness or advisability of a proposed improvement. The ultimate test is usually the same as a railroad would apply in considering the construction of an extension into new territory, or the improvement of an existing line, namely, will it pay? In other words, will there be enough new traffic or will the economies in the carrying of the existing traffic justify the contemplated expenditure? In a few cases, the answer whether positive or negative, is plain. In most, however, the evidence is not conclusive, and the best that can be done is to exhaust all available sources of information and then to judge as experience and the preponderance of evidence may dictate. It should be observed, too, that in one respect the position of the Government may differ from that of a railroad in that often the traffic proposed to be accommodated by a new or a further improvement of navigation facilities may already be moving to market and the plan may be simply to change its routing.

The traffic data derived from the preliminary examination, together with such other similar information as the Board may have, will usually serve to show what would be the returns from an investment of funds in the improvement under discussion.

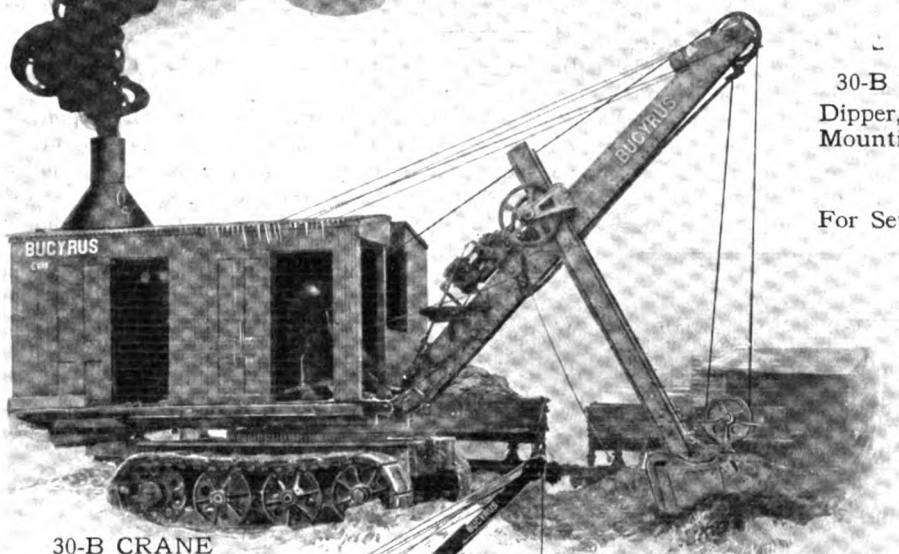
In many cases, of course, the information is inadequate or obviously unreliable, and then the Board is forced to originate new lines of investigation and to extend the scope of the original inquiry, always with the desire to protect and promote the interests of the United States and its citizens. Thus, in a certain case involving the proposal to construct a canal at a cost of about $2,000,000, it was urged

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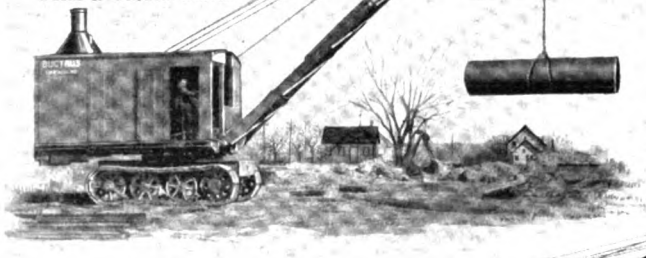
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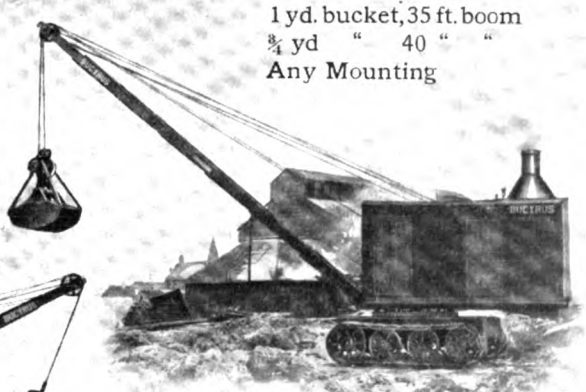


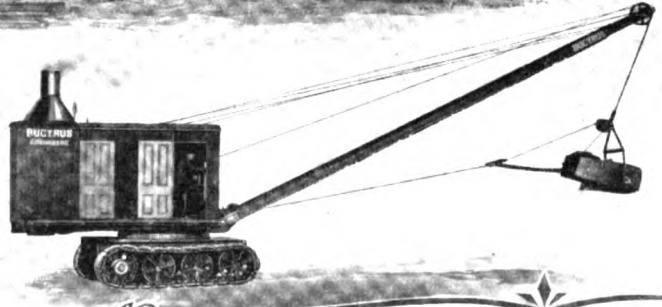
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that the canal would afford an economical route for the transportation of oil in barges, and this was the principal traffic predicted. The report of the local officer left the Board in ignorance as to the probability or necessity of this traffic, the saving that would be rendered possible by the canal, and the relative advantage, or otherwise, of a pipe-line. Accordingly, the Board returned the report with the request that these matters be investigated.

In a recent case, the question to be decided was the advisability of constructing a 30-foot channel, giving access to a bay on which local interests and authorities proposed to construct extensive terminals. In this case, no doubt existed as to the necessity for additional modern terminal facilities to accommodate the large commerce of the port, but the investigation failed to show that the particular locality under consideration was the most desirable one for immediate improvement, or that the shore development and connections would be such as to insure the adequate utilization of the desired channels. The Board was constrained to withhold favorable recommendation and to suggest the desirability of an investigation covering the port as a whole, under which the relative importance of this improvement, as part of a comprehensive plan for the development of the port, might be determined and the execution of the work, if found advisable, might proceed in its proper order.

It will be seen from the above that while the activities of the Board have been considerably enlarged in recent years, the scope of its investigations so far as the improvement of channels is concerned is still limited to the language of the specific items of law calling for preliminary examinations and surveys, and hence, it is unable in certain cases to report upon the real needs of the locality. The investigation of terminal facilities, under the general authority of the Act of March 2, 1919, and the recent railroad act, obviously requires study of each port as a whole. The port problem includes not only the provision of a sufficient number of properly located terminals with adequate connections, storage and handling facilities, but also the provision of suitable channels to meet the requirements of the character of vessels which will use these terminals. Hence, the several facilities referred to as essential to a proper terminal development should be considered conjointly, without restrictions which might make it impracticable to formulate a complete and systematic plan. It would be helpful in this direction if the items calling for preliminary examinations were made sufficiently broad to permit consideration of each harbor as a whole, even in cases where report on a particular part of the harbor is especially desired. Perhaps the purpose in view could be attained more advantageously by the modification of existing laws to provide that in connection with the study of plans for terminal development at the ports of the United States, the Chief of Engineers is authorized to consider and report upon the channel improvements deemed requisite to the proper utilization of such terminals.

What is the Essence of Discipline?

Two correspondents contribute the following:

The first writes:

Lowell Thomas tells a story which has all the ear-marks of truth, if the many accounts we have heard of the lack of "discipline" among the Australian troops can be believed: General Birdwood who first commanded the Australians (know to them as "Birdie") was one day inspecting a regimental post under his command. He approached what was supposed to be a sentry post, but all he saw was a lone "Aussie" standing with his hands in his pockets and enjoying a cigarette. A rifle leaned against a wall some fifty yards away. Said the General to the soldier who hadn't moved, "Well, my man, who are you?" The Aussie replied with marked frankness, "I am a bit av a sentry, an' who may you be?" Said the general (who was by way of being a good sport), "Well, I am a bit of a General." Whereupon the Aussie looked him over and said casually, "So. Well if you will wait for a much as a minute till I get my rifle I'll turn you out a bit av a salute."

All reports go to indicate that this attitude towards military etiquette was characteristic of the Australians,—and yet as fighters were they not among the best? Good authorities say that they were. What is the answer? Would they have been better soldiers if extreme rigidity of military etiquette had been forced upon them? Some officers, perhaps many, think that they would have been harmed rather than benefited by such strait-jacket methods. Is not some of the hostility toward the Regular Army so plainly discernible in our country today easily traced to the ill-advised adoption of and the rigid insistence upon *non-essential details* of military etiquette so loved in continental countries and yet so utterly unsuited for our own?

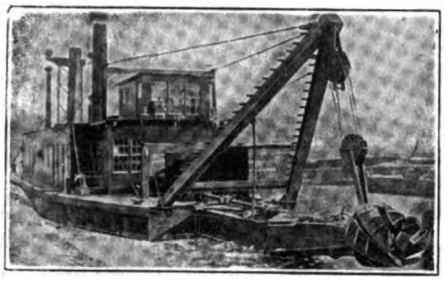
The second correspondent, to whom the foregoing letter was submitted, has this to say:

In the early days of the A. E. F., General Pershing, than whom no man knows the American soldier better, announced: "The disciplinary standards of the A. E. F. will be those of West Point." These standards are rigid, even formal, yet they have produced results when men have remembered and understood the *end* in view, and not simply the *means* by which this end is supposed to be attained. The salute appears a foolish formality to those who do not understand its deep significance. It is useless, even harmful, to force men to salute when they do not understand what it means nor how important it is. Yet the initiated know that an organization whose members take a pride in rendering a snappy salute is always a good organization in all respects, one to be depended on in any emergency. There is perhaps no better test of the discipline of an organization than the manner in which its members render the salute—an apparently trivial formality.

Clean shoes seem an unnecessary refinement for a soldier in time of war. On a certain occasion Gen. Pershing was inspecting a number of enlisted candidates for commissions, in a school in France. One of them appeared with his shoes dirty. "Send him back to his organization," directed the C. in C. "A man who has not enough pride and self respect to clean his shoes when his general is to inspect him, is not fit to command American soldiers." Such was the importance placed upon an apparently trivial matter by one who knows what is trivial and what is not in matters of discipline and morale.

The writer once accompanied a British army commander in an inspection of a unit in the front line. After passing a few yards of trench we found two men on duty. "Let me see a clip of cartridges," said the general. Each produced a clip. The general examined the cartridges and passed them to me. They were bright and shiny. "You are good soldiers, boys," said the general, as he smiled and patted them on the back, "Britain is proud that her front line is held by men on whom she can depend." As we passed on he said to me: "Perhaps you think I give too much attention to minutiæ. But I have found by experience that minutiæ are the test. A man with clean cartridges is always a good soldier. The man who neglects the little things soon neglects the things not quite so little,

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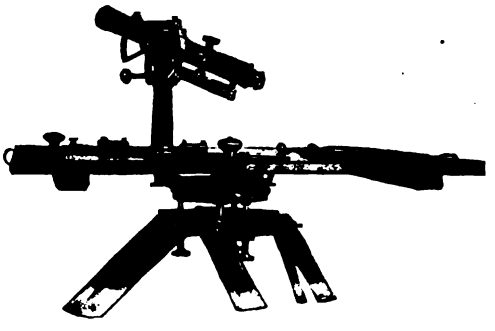


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and he rapidly passes on to neglect of big and bigger things. Discipline consists of attention to a multitude of details, most of them of no great importance in themselves." This general knew discipline as Pershing knows it, and he knew the British "Tommy" as Pershing knows the "Yank."

The disciplinary methods of the American army are not the work of martinets. They represent the accumulated experience of all our greatest soldiers from Washington to Pershing. None of them are unnecessary.

If enlisted men do not understand the reasons for the things they are required to do they naturally regard many of them as unnecessary, and rapidly cultivate the *habit of neglect*. Officers who do not understand the fundamental principles of discipline naturally fail to secure real discipline, which in its essence is simply a fixed habit of *doing things right* under all circumstances. Such officers punish their men for neglecting apparently trivial matters instead of taking the time and exercising the patience necessary to convince their men that none of the things they are asked to do are either trivial or unnecessary. If the men are convinced that what they are asked to do is *necessary and important*—and it is very easy to convince most of them if one will only take the time—they can be depended upon to do it. An officer when training his men should convince them of the necessity for everything they do. This begets their confidence. When, in the stress of battle, such men are told to do things there is no time to explain, they *do* them, because they have learned by experience that their commander never asks them to do anything that is unnecessary or unimportant. Such is the essence of discipline.

There is little to be added to these two letters, so sharply in contrast. The first of our correspondents utterly fails to grasp the meaning of discipline, probbly because nobody who *knew* ever took the trougle to explain it to him. The story he relates is no doubt founded on fact, it may even be literally true. But every trained soldier will take exception to the statement that is was "characteristic" of the discipline of the Sustralians. Such a statement is an (unintentional) reflection on our splendid Allies. Soldiers *on duty*, who stand around with their hands in their pockets, smoking cigarettes, 50 yards away from their weapons, and who make flippant would-be humorous remarks to their superiors, are not the kind of men that Britain or any other country should be proud to have in the front line, where vigilant attention to duty is the price of victory.—Ed.

Strengthening a county bridge to carry motor truck traffic

Several highway bridges in Mercer County, New Jersey, on the Brunswick Pike, near the Middlesex County line, with original capacities of only 4 or 5 tons, recently required strengthening to accommodate practically continuous traffic of loaded motor trucks which were forced to detour from the main artery between New York and Trenton and Philadelphia during the improvement of the latter route. One of these bridges had a trussed span of 142 feet 6 inches, comprising 9 spans of 15 feet 10 inches each. The floor, approximately 17 feet 6 inches wide, was carried by a center and two outside channels all 6 inches deep, and eight 6-inch I-beams, equally spaced between the center and outside stringers. The flooring consisted of two layers of white oak totaling 5½ inches in thickness.

On examination, the trusses proved to be in good condition and capable of carrying the new loads under a stress of 23,000 pounds per square inch, which, in view of the temporary conditions imposing the increased loading, was considered safe. In one of the lower chord members a lateral deflection of 2½ inches was observed. Its cause was found in the insufficient length of the slotted holes for the anchor bolts in the expansion shoe and was corrected by lengthening these slots to permit further expansion.

The floor beams were found to be over-stressed and deflected laterally in some cases as much as 1½ inches. Each beam was reinforced by trussing with two 1⅜-inch rods with sleeve-nuts, passed under two 9-inch I-beam posts, 2 feet 10½ inches on either side of the center line of the bridge. The maximum depth of this trussing is 3 feet between center lines of the rods and the floor beams. The rods are fastened to the web of the beam under the outer stringers by clips. The lateral deflection of the floor beams was corrected by four tightly fitting 3 by 3-inch stiffener angles on each side of the web, at the ends and directly over the truss rod posts.

Examination of the stringers showed that they were already stressed beyond the elastic limit and had acquired permanent set. Two new outside stringers of 15-inch channels were placed against the old outer stringers, 8 feet 9⅞ inches from the center line, and two interior lines of 15-inch I-beam stringers, each 2 feet 10½ inches from the center line, were added. The old stringers were left in place as not worth using elsewhere, but they were neglected in calculating the capacities of the new floor.

The two layers of floor planking were thoroughly spiked together and fastened to the new stringers by ⅝-inch lag-screws and clips, producing the effect of a single layer continuous over the supports and of capacity equal to that of the stringers.

The reinforced bridge has a capacity of 12 tons at 16,000 pounds unit stress. All work was carried on without interference with traffic and the efficacy of the reinforcement is very evident in the almost complete elimination of noisy rattling formerly caused by the passage of vehicles.—*Eng. News-Record.*

Planning and progress on a big construction job

A writer in *Eng. News-Record* (Chas. Penrose, Progress Engr.) describes in interesting fashion the methods by which the operations of the building of the Philadelphia Army Base Depot were forecast, and recorded graphically for the administrative information of the directorate of the work. A progress department divided into graphical chart and statistical divisions was the organization which handled the work of progress and planning. The details of the methods by which data was collected, charted, recorded, and indexed are given. The size of the project and the special circumstances of construction are claimed to have warranted the elaborateness of the work. As a rule, the charts shown are curves platted on the rectangular co-ordinate system with time abscissæ and quantity ordinates, expected quantity and time element being shown on the same chart as the actual work or results accomplished. On a piece of work of the magnitude and importance of this, where war conditions required speed as a prime consideration, the detailed progress charts were essential. The reproduction of the charts is of course essential to a full discussion of the subject.

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An American Army sawmill in the Vosges

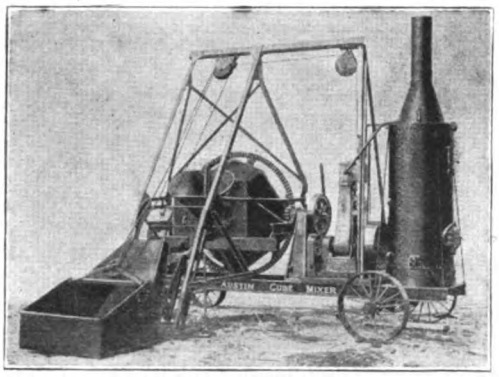
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IN THIS ISSUE

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Experiences of an Engineer Battalion Commander
Congress Investigates Army Construction

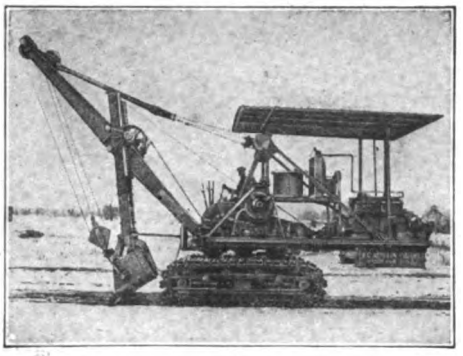
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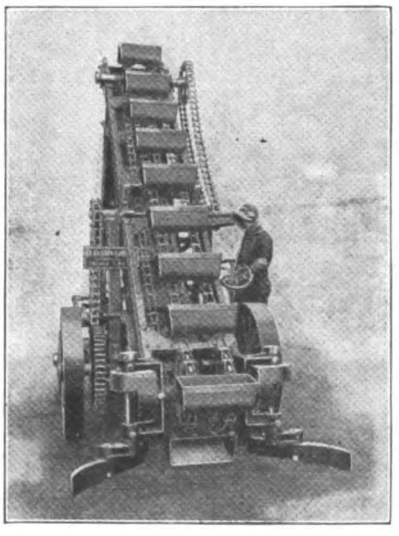
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Lake Washington Ship Canal, Seattle, Wash.

By

A. W. Sargent

U. S. Assistant Engineer

History and location of the project

THE project for a canal to connect Puget Sound with Lakes Union and Washington is practically as old as the City of Seattle, the first federal recognition being contained in a report of a board of engineers for the Pacific Coast made December 9, 1867, recommending the lakes as sites for a naval station on Puget Sound. (See page 323.)

Seattle, the largest city of the State of Washington, has a magnificent harbor, perfectly protected from storms, and always accessible to the largest vessels afloat at all stages of the tide. In the immediate vicinity of Seattle are two lakes, Union and Washington, and also Salmon Bay, an estuary connecting through Shilshole Bay with Puget Sound.

Lake Union, the smaller of the two lakes, situated in the heart of Seattle, has an area of nearly 1,000 acres of which 500 acres has a depth exceeding 40 feet. The general elevation of Lake Union was originally 25.5 feet above extreme low tide in Puget Sound. Between Lake Union and Puget Sound is a high ridge, cut by a low valley at the extreme western end of the lake. Through this valley the natural drainage of the lake found its outlet to Salmon Bay.

To the south of this valley and of Salmon Bay are two high hills between which is a low narrow valley connecting the head of Salmon Bay with Smiths Cove, an indentation in the north end of Elliott Bay on which the City proper is situated, also the greater part of the present docking facilities.

Salmon Bay extends in a westerly direction to Shilshole Bay, an arm of Puget Sound. Salmon and Shilshole bays were originally navigable at high tide, but both bays were practically dry at extreme low tide. In these bays the tide has a mean range of 11 feet and an extreme range of 19 feet.

Lake Washington forms the eastern boundary of the City of Seattle, is 19 miles long, with an average width of 2 miles. The surface of the water in Lake Washington originally fluctuated between 33 feet and 37 feet above extreme low tide in Puget Sound. Lake Washington is separated from Lake Union and from Elliott Bay by a high ridge, extending along the western side of the lake. In this ridge is a low depression at a point where the shores of Lake Union and Lake Washington approach each other to within 2,000 feet. At this point known as "The Portage," a narrow channel was cut for the passage of logs. The natural outlet of Lake Washington was from the southern end through Black and Duwamish rivers to the waters of Puget Sound at the southern end of Elliott Bay. These rivers had sufficient capacity for the transportation of logs. Cedar River, which entered the Black River about ½ mile below the outlet of Lake Washington, is subject to annual floods, due to the melting of snow in the headwaters of the river in the Cascade Mountains. During the height of these floods the direction of the current in Black River between Lake Washington and the mouth of the Cedar River was reversed, and a large quantity of water emptied into the lake, which acted as a storage reservoir preventing excessive flooding of the Duwamish Valley.

The river and harbor act of 1890 contained the first appropriation for the canal, as a commercial waterway, and authorized a survey and selection of the most feasible location, together with an estimate of cost. A board of engineer officers, consisting of Col. G. H. Mendell, Maj. T. H. Handbury, and Capt. T. W. Symons was appointed to make the survey. Five possible routes were considered.

First. From Elliott Bay by way of the Duwamish and Black River valleys to Lake Washington, and across the Portage from Lake Washington to Lake Union.

Second and third. By way of the depressions between the southern end of Lake Union and Elliott Bay (known as the Mercer farm route and the tramway route) thence to Lake Washington by a canal through the Portage.

Fourth. By way of Shilshole Bay, Salmon Bay and the valley of the outlet of Lake Union, thence through Lake Union to the Portage, thence through the Portage and Union Bay to deep water in Lake Washington.

Fifth. By way of Smiths Cove to the upper end of Salmon Bay, thence as in the preceding route.

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All of the routes except the last two were soon eliminated from serious consideration on account of their great cost and other disadvantages. The fourth and fifth routes were entirely feasible, and estimates of both routes were submitted. The two routes coincide in alignment from Lake Washington to Salmon Bay; they differ in that one route makes the connection with Puget Sound through a low valley to Smiths Cove and Elliott Bay, and the other (the present route) through Salmon Bay and Shilshole Bay.

In each of the projects, by Smiths Cove or Shilshole Bay, a masonry lock was to be built near the Sound, the waters of Salmon Bay being raised to the level of Lake Union and another lock was to be built at the Portage between Lake Union and Lake Washington with a lift of about 7½ feet to overcome the difference of level between these two lakes, the elevation of Lake Washington was to be held at approximately its lower water level. The Smiths Cove route required a dam to be placed at the westerly entrance to Salmon Bay to raise its level to the required height. The Shilshole Bay route, being less expensive, having a better alignment, and being more convenient for ships going from the lakes direct to sea and vice versa, was adopted by the Secretary of War in 1899.

The rivers and harbors act of 1894 provided that no money should be expended on the improvement of the waterway until the entire right of way and release from all liability to adjacent property owners had been secured by the United States free of cost, and to the satisfaction of the Secretary of War. These requirements were satisfactorily complied with by King County, in which the canal is located, at a cost of $250,000.

During the following years Shilshole Bay and Salmon Bay were improved by dredging, and a narrow cut was excavated along the canal location between Salmon Bay and Lake Union for control of the water level of Lake Union. The cut between Lake Union and Lake Washington was enlarged to regulate the flow from Lake Washington. The flow of the water through these cuts was regulated by wooden gates.

The rivers and harbors act of March, 1907, ordered a new survey and estimate of cost. All projects prior to this date contemplated two locks, one between Salmon Bay and the Sound and the other between Lake Union and Lake Washington. In this report submitted by Maj. H. M. Chittenden, district engineer, the single lock plan was recommended, locating the lock at the westerly entrance to Salmon Bay, raising Salmon Bay and lowering Lake Washington to the level of Lake Union, with unobstructed channels uniting these bodies of water. Some modifications were made in the channel of the canal, the principal change being at the Portage, where a new route was adopted affording a better alignment. This changed right of way at Lake Washington is through the State University tract and was ceded by the State free of cost to the United States. Under this plan the County of King was required to do the excavating in the waterway above the lock, and to hold the United States free from any claims or damages on account of lowering the level of Lake Washington, raising the level of Salmon Bay or any other alterations of the levels of any part of the waterway. The cost of fulfilling these requirements was to King County $750,000; and to the State of Washington, $250,000.

This report was approved by the Board of Engineers for rivers and harbors, and on June 25, 1910, the rivers and harbors act authorized the project. In September, 1911, construction work was actually begun under the direction of Maj. (now Colonel) James B. Cavanaugh, Corps of Engineers, the district engineer who was in charge of the entire project, both as to the federal and county expenditures, until the completion of the work.

General description of canal and results attained

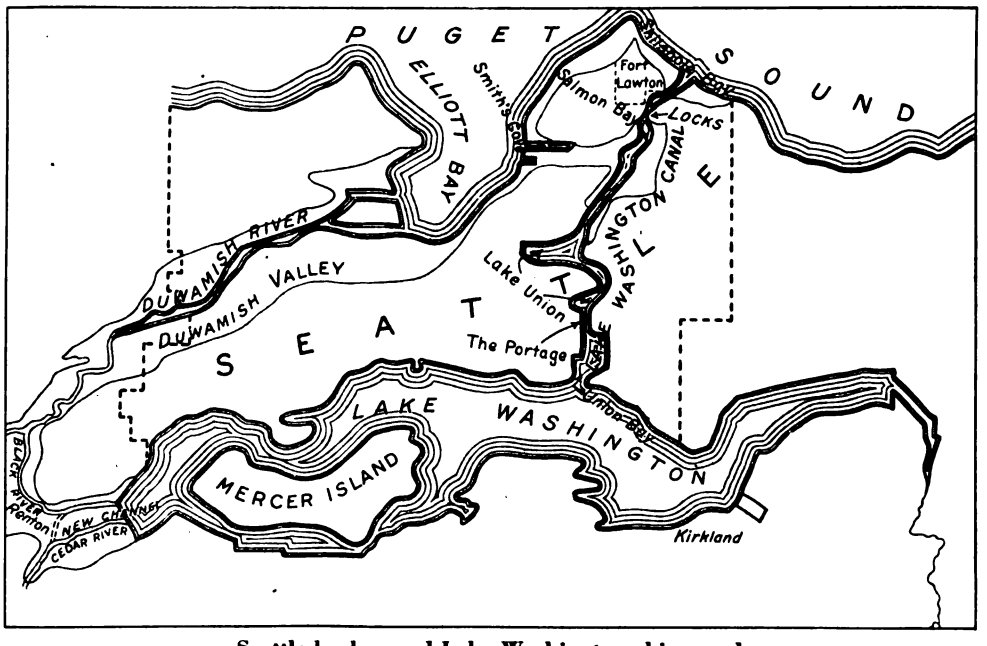
The length of the canal between deep water in Puget Sound and deep water in Lake Washington, is 8 miles. The dredged channel below the locks is 150 feet wide at the bottom and 30 feet deep at low water; from the locks to Lake Union a channel 100 feet wide on the bottom and 36 feet deep has been dredged; from the easterly end of Lake Union to Lake Washington the channel is 75 feet wide and 26 feet deep. These dimensions will be increased to meet the needs of commerce.

The locks and dam are located in the narrows at the westerly entrance to Salmon Bay. The locks and spillway form a dam at this point, holding the waters of Salmon Bay 25 feet above extreme low tide in Puget Sound. They afford access from the Sound to Salmon Bay, and to the fresh-water lakes beyond.

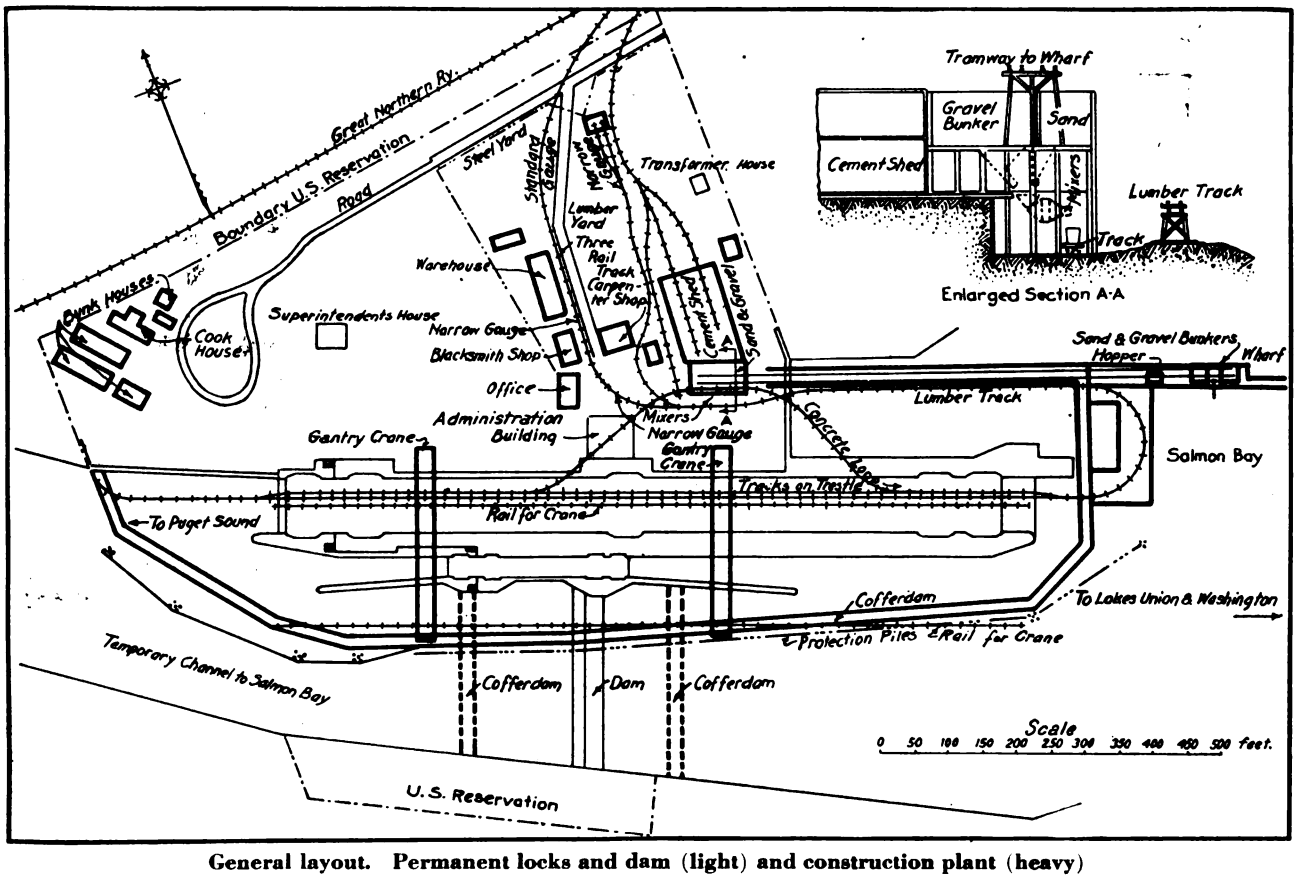
The canal has added many miles to the water-front of Seattle and thus affords unlimited wharfage room as well as unlimited anchorage, perfectly protected from storms, and free from tidal fluctuation and currents. The construction and maintenance of wharves is much less expensive than in Elliott Bay where the depth of water is very great and where the teredo is very destructive. The economy of a fixed water level in loading and unloading vessels and the absence of the teredo is obvious.

The lowering of Lake Washington has helped to reduce the floods in the Duwamish valley, and the problems of the development of the Duwamish waterway have been greatly simplified. Swamps along the shores of Lake Washington have been converted into favorable sites for industries, especially at the north and south ends, where tracts have been made available for commercial purposes, as the shore is flat and

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Seattle harbor and Lake Washington ship canal



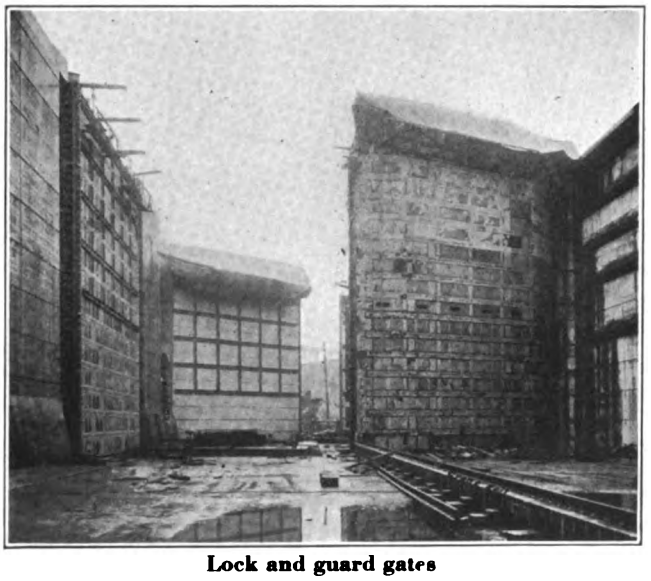
General layout. Permanent locks and dam (light) and construction plant (heavy)

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railroads may meet water transportation on an economical basis. In general there will be improvements of harbor facilities and increase of shipping and industries in an already developed city.

Foundations, excavation, cofferdams, etc.

The locks and dam are constructed by placing concrete directly on a clay foundation. Borings made with a 2-inch auger and carried to a depth of 50 feet below the foundations show the same character of ma-



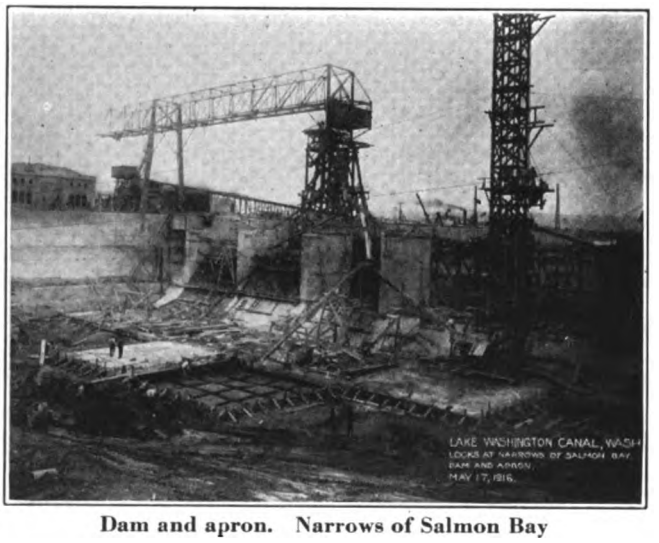
Lock and guard gates

terial throughout. The tests of the bearing capacity of the foundations were made after the excavation within the cofferdam had been practically completed. The apparatus consisted of a 12 by 12-inch post 15 feet long shod at the lower end with a ½-inch steel-plate 12 inches square. A loading platform 4 feet square was built around the post, supported underneath by struts. The post projected about 2 feet below the loading platform and was held vertical by means of independent braces placed in such manner that the post was free to settle in its vertical position. The platform was weighted at first with a few tons of pig iron, and the load gradually increased until a maximum load of twelve tons had been applied. The settlement was carefully checked by levels, and allowed to cease before each increase of load.

The material excavated from the lock-pit and the entire canal except at the Portage between Lake Union and Lake Washington, was removed by suction and dipper dredges, and deposited partly in deep water in the Sound and partly on adjacent lands. Excavation at the Portage was done in the dry by steam shovels and dump cars; the excavated material being used to fill the adjacent low land belonging to the State University. Before the excavation was commenced a cofferdam was constructed around the Lake Union entrance and a wooden dam with gates was constructed across the Lake Washington entrance. These head gates were later used to control the flow of water from Lake Washington during the lowering of that lake to the level of Lake Union.

The cut at the Portage is 96 feet deep at the highest point, the material mostly hard clay with some cemented gravel. The cut is 100 feet wide on the bottom with side slopes of 1½ on 1, up to an elevation 5 feet above the water surface, where there is a berm. Above this elevation the slope flattens to 1 on 1½ with another berm about midway of the slope. The cut is lined with concrete up to the first berm through a greater part of its length.

The cofferdams within which the locks and dam were constructed consisted of two walls of sheet piles, 17 feet apart, driven well into the hard bottom and supported by round piles and wales, the two walls being securely bolted together, the intervening space filled and the outside banked with clay. At high tide the bottom of the excavation in the lock pit was about 58 feet below water level, but very little difficulty was experienced from seepage. The cofferdam area was first unwatered by a pumping plant consisting of two 12-inch and one 8-inch electrically driven centrifugal pumps, after which a single 2-inch centrifugal pump was sufficient. The closure in the cofferdam was made at low tide after the required excavation inside was completed, and the entire cofferdam, except a gap



Dam and apron. Narrows of Salmon Bay

about 6 feet wide, had been completely filled and banked.

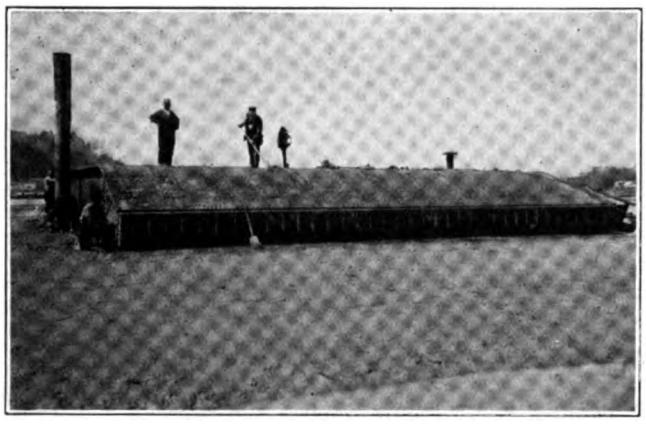
This gap extended down to low tide level and provision was made for sliding gates into recesses provided in each wall. These gates were made of the upper portion of the sheet piles which had been driven and sawed off at low tide. After these gates were placed, this section of the cofferdam was filled and banked as rapidly as possible by clam-shell buckets with material which had been deposited for this purpose in a convenient place near the cofferdam.

The excavation within the cofferdam enclosure was

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carried to a depth of about 2 feet above the completed foundations with dipper dredges; the excavated material not required for filling and banking the cofferdam was placed on barges and dumped in Puget Sound.

Provision was made for filling the coffer, when the work in the enclosure was completed, through three 4-foot diameter wood pipes, which were closed with wooden bulkheads. These were built into the coffer at low tide level. When the construction work on



Lower guard gate beached for painting

the locks was completed these bulkheads were broken and the coffer allowed to fill gradually.

General features of the locks and dam

The large lock is 80 feet wide and 825 feet long between upper and lower service gates; it is divided into two chambers 375 and 450 feet long, by an intermediate gate. Vessels up to 36 feet draft can pass through the large lock.

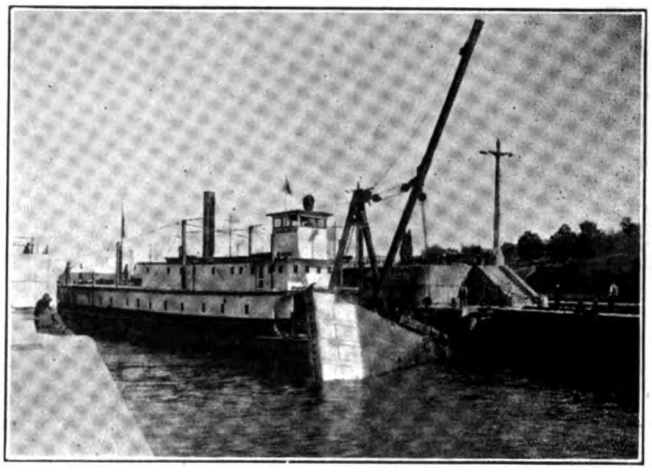
Alongside and south of the large lock is a much smaller one, suited to vessels up to 16 feet draft, its inside dimensions are 30 by 150 feet. The object of the small lock is to handle the great number of launches and small craft continually passing in and out of Salmon Bay. The spillway between the wall of the small lock and the south shore is 225 feet long, with six spillway openings of 32 feet, and a fish-way through which salmon can always find access to the fresh water in the lakes above. The spillway openings are closed by Taintor gates operated by means of a portable electric hoist on a track over the dam.

There are five gates in the larger and four in the smaller lock, all provided with a mitering device consisting of a jaw on one leaf which engages a post on the other as they swing together. The gates of the large lock are double sheathed so as to form an air chamber by means of which the buoyancy is increased and the pull on the anchorage reduced. The lower guard gate, which will be used only when the lock is unwatered for purposes of repair or inspection, will withstand a head of 43 feet. This is the heaviest gate, each leaf being 46 feet high, 47 feet long, and 5 feet thick. The lower service gate and intermediate gate are 56 feet high, to withstand 26-foot head. The upper service gate and upper guard gate are smaller, being 43 feet high, but the guard gate is subjected to a head of about 38 feet when the lock is unwatered.

In addition to the guard gates, emergency dams will be provided at the upper entrances to both locks. These dams will be used to stop the flow of water through the canal and locks in case the lock gates should be accidentally damaged. The dam for the large lock will be of the swing-bridge type, with rolling wickets, cutting off the flow of water in successive horizontal planes. The emergency dam for the small lock will be a series of wickets which drop into vertical recesses in the lock walls.

The large lock is filled and emptied by means of culverts 8½ by 14 feet in cross section, which extend almost the entire length of both walls, communicating with the lock chamber through a number of small openings at the floor level. The flow of water through the culverts is controlled by the Stoney gate valves. Similar culverts 4.3 by 6 feet in section, are provided for the small lock, the flow of water being controlled by cylindrical valves.

The Stoney gates are raised and lowered by means of two vertical screws revolving in fixed nuts in the



Replacing lower guard gate after painting

crosshead which is attached to the valve stem. The valve stem passes through a stuffing box in a watertight bulkhead closing the bottom of the machinery recess, which is about 22 feet below high water level in the lock. Roller trains are provided which are raised and lowered with the valve but at half the speed by means of a chain passing over pulleys, one end of the chain being fastened to the crosshead and the other end to the roller train stem which passes through a stuffing box in the bulkhead. Signal lights installed in the operating house, controlled by contacts with switch, indicate whether the valves are in

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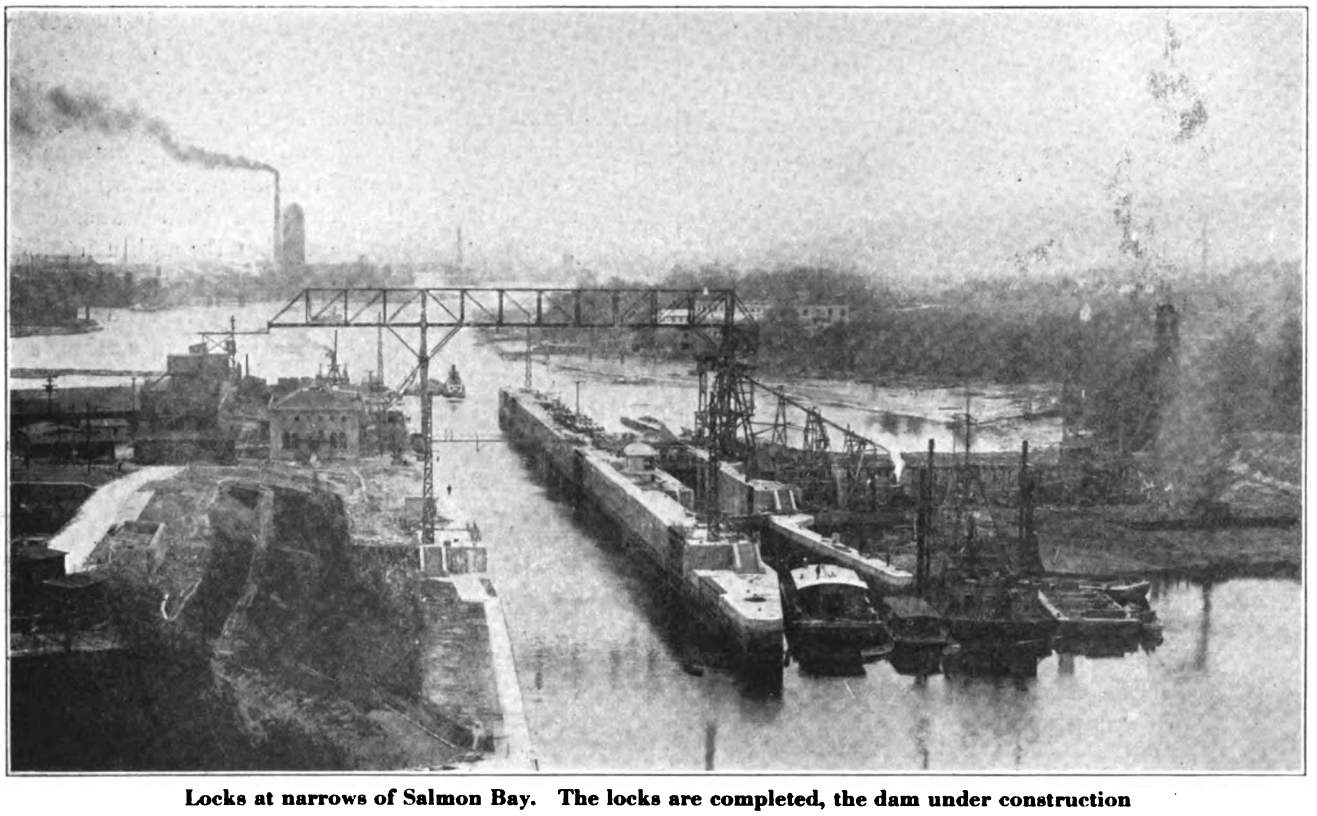
the open or closed position, and switches are provided for limiting the travel of the valves.

The cylindrical valves are raised and lowered by means of a screw passing through a stationary nut at the upper end of the shaft through which the stem passes. The travel of the valve is controlled by a limit switch, and signal lights indicate the open and closed positions.

Electric power purchased locally and delivered at the transformer station at the locks, at 13,000 volts, is used for the operation of the locks. The service gates and valves are controlled from operating stations on the lock walls. Three of these stations for the large lock are on the north wall, while a single station between the two serves the small lock. All operating machinery is placed in covered recesses in the tops of the lock walls. The gates are actuated by two cables attached near the outer edge of each leaf, the other end of the cables being attached to the spiral drum on the gate-operating machine. The drum spiral is so proportioned as to take up the slack due to change in cable lengths as the gate swings through its arc of revolution. The life of the steel cables used in the operation of the gates is from six months to one year. To replace broken cables and do other necessary repair work that can be accomplished without unwatering the lock, a diver is ordinarily employed as an operator or lineman on the lock force.

All of the gates and machinery in both locks except the bottom and back of the guard gates, are accessible when the locks are unwatered. To do necessary painting of these surfaces the guard gates of the small lock are hoisted onto the lock wall; and guard gates of the large lock are floated away and beached after the valves admitting water to the water chamber have been closed and the interior of the gate pumped out.

When the lower guard gate was removed for painting during July, 1919, it was found that the greenheart timber sill attached to the lower edge of the gate was completely honeycombed in places by the teredo. The sill was removed and replaced with iron bark.



Locks at narrows of Salmon Bay. The locks are completed, the dam under construction

A pumping plant of two 30-inch pumps, with a capacity of 4,000 gallons per minute, one 10-inch pump and a 3-inch sump pump, all electrically operated, has been provided for unwatering the locks when necessary for inspection and general repairs. The pumps are located in a well under the administration building, the intake being through the lock wall at the intermediate gate, while the discharge is carried in a concrete pipe supported on the back of the lock wall, and empties just below the guard gate of the large lock.

For the purpose of providing means of repairs, a combined machine shop, blacksmith and carpenter shop, has been constructed adjacent to the locks. There is also provided a concrete warehouse, administration building, and quarters for the superintendent.

The locks are well lighted by electricity.

The lock walls are mass concrete, approximately

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62 feet high, and are constructed with stepped back and vertical face, except near the top and bottom, where the face is sloping. The top edge is rounded and the reinforced toe extends ten feet beyond the face of the wall, its top being at the floor level. Concrete cut-off walls were built under the heel of both walls, across the lock under the miter sill at both ends, and at the intermediate gate, and across under the entire length of the dam to the south bank.

Lead stopwaters were placed between all wall sections, a channel between Shilshole and Salmon Bays being always kept open for the passage of vessels; between the toe of the wall and the floor, across all floor sections and between the sections of dam. To relieve the pressure on the clay foundation a toe block 10 feet wide was built, on which the toe of the wall rested, the outer end of the toe being at the center of the block.

The bearing capacity, and the imperviousness of the material in the foundations, at the upper end of the large lock, beyond the guard gates, were less than over the rest of the lock area and cellular walls were built here, and the under side of the floor over this area was constructed in the form of a flat arch.

The walls, for the most part, were built up in sections thirty feet long, concrete being deposited in layers five feet thick. The top layers in adjoining sections were kept at approximately the same level and numerous key blocks were made projecting upward into the next layer formed. Key blocks were also built into the ends of each section, extending the full height.

The floor of the large lock is three feet thick and is constructed without valves of any kind to relieve the hydrostatic pressure, reliance being placed upon the cut-off walls to prevent leakage.



Locks and dam at narrows of Salmon Bay, after completion

The locks and dam were constructed as two separate units, a channel between Shilshole and Salmon Bays being always kept open for the passage of vessels. The cofferdam for the lock was 1,320 feet long, the two ends being tied into the high bank along the north side of the site, leaving a temporary channel between the cofferdam and the south shore. During the construction of the dam vessels passed to and from Salmon Bay through the large lock chamber, all of the lock gates being left open, providing an unobstructed channel.

Operation of the locks

The locks are operated 24 hours a day, 31 men being employed. Records of all lockages are kept and a statement as to the amount and kind of cargo car-

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ried must be submitted by the masters of all boats. The information furnished is used for compiling commercial statistics of the canal.

The time of lockage varies with the stage of water and the vessel passing through. Tug-boats pass through the small lock in five minutes, but large vessels and barge traffic in the large lock require from 15 to 30 minutes and log rafts from 30 to 45 minutes.

During the three and one-half years of operation the traffic through the canal shows considerable increase, the principal traffic being logs, lumber and miscellaneous freight carried on barges.

During the calendar year 1919, 24,676 vessels, with total net registered tonnage of 1,104,688 and carrying 1,020,710 tons of freight with a value of $9,520,311, passed through the locks.

Since there was no navigable channel into either of the lakes prior to the completion of the canal, it will no doubt require several years before industrial and commercial lines of any great magnitude are established; although the opening of the canal has created a fresh water harbor absolutely beyond comparison and ample for the needs of the greatest commercial city in the world.

Salinity

When the lock has been filled, the water in the chamber is a mixture of fresh and salt water, the greatest salinity being always found at the bottom. The lower pool has practically full salinity and the upper pool contains mostly fresh water.

Since the water above is lighter than that in the lock, and the culverts through which the pressures on both sides of the gates are equalized, are at the floor level, the flow through the culverts ceases before the water in the lock has reached the same level as the water above. This difference in head is usually about 3 inches but sometimes is as high as 6 inches. When the difference in head is excessive the water in the lock is lowered by discharging into the pool below; and filled again with fresh water before the upper gates are opened.

At the lower end of the lock the outlets to the culverts were raised above the floor level and no difficulty has been experienced in opening the lower gates.

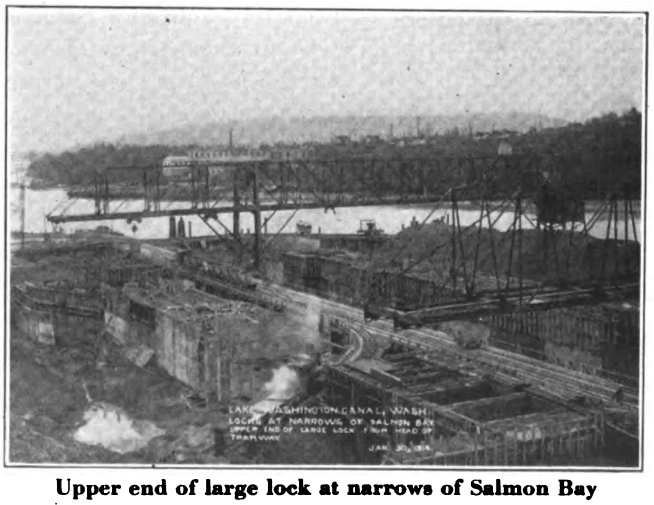
The difference in density of water in the lock when the gates are opened produces currents caused by the fresh water in the chamber flowing out on top of the salt water into the channel below; when the upper gates are opened the salt water in the lock rushes out into the upper pool, the fresh water flowing in on the surface. This flow of salt water into the upper pool would in time cause the water above the locks to become salt, but provision has been made for drawing the salt water back into the pool below the locks. A large sump or settling basin has been dredged in the channel above the locks, from which a concrete pipe with its intake near the bottom of this sump and its outlet over the spillway dam, is carrying a continuous flow of water from the bottom of the sump to the pool below. In addition to the salt water remaining in Salmon Bay when the water was raised by the closing of the dam and lock, the bottom of Lake Union contains large quantities of salt. In 1903 and again in 1914 the dam and gates controlling the outlet of Lake Union broke and the outflow lowered the lake to level of tide water and allowed salt water to enter the lake. It is not anticipated that all of the salt in the lake will be removed but it is hoped that all of the salt entering the upper pool due to the operation of the locks will find its way to the settling basin and be carried back through the pipe to the pool below. Salinity tests made during February, 1920, show that the salt remaining in the upper pool is confined principally in Lake Union at a depth greater than 32 feet, which is the controlling depth in the channel between Lake Union and the locks.

General

After completion of the locks and dam the lock gates were closed at low tide and Salmon Bay was filled with fresh water from Lake Union through the Lake Union outlet gates, after which the gates and dam were removed. The locks were then put in operation and the canal completed into Lake Union.

The lowering of the level of Lake Washington was accomplished through the head gates before mentioned. The lowering of this lake made a dry channel of the Black River and necessitates the conveyance of the entire run-off from the watershed of Lake Washington and Cedar River, 580 square miles, through the Canal to Puget Sound. The maximum known run-off from this drainage area is nearly 12,000 cubic feet per second for a period of 24 hours.

Owing to the fact that the waters of Salmon Bay were raised considerably above high tide elevation, a large proportion of the wharves, lumber and shingle mills in the bay had to be reconstructed. The same



Upper end of large lock at narrows of Salmon Bay

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is true on Lake Washington where the water was lowered some 8 to 11 feet or to the level of Lake Union. The railroads and city bridges crossing the canal were all rebuilt with lift spans of the bascule type. The change by the Great Northern Railway required an entire relocation of its main line for several miles on either side of the canal, with heavy grading both north and south of Salmon Bay. There have been five new bridges erected, none of which has a horizontal clearance less than 150 feet.

The building of the locks was conducted entirely by hired labor and government plant. The gates and machinery were manufactured under contract from designs prepared by the Engineer Department.

The entire work was conducted under the direction of Major (now Colonel) James B. Cavanaugh, Corps of Engineers, the author being in local charge, and Mr. C. A. D. Young, Assistant Engineer, in charge of design of gates and machinery.

Questionnaire on battle experiences

With a view to profiting by the experiences of the war in our future training, the War Department is sending the following questionnaire to officers and N. C. officers who commanded troops in battle.

As this questionnaire has an instructive value in itself as indicating the things a commander will encounter, and what he should know and do, we reprint it in full.

1. Were you ever engaged in an active operation in a front-line organization and in immediate contact with the enemy? 2. In what major offensive, defensive, or local operation? 3. In what locality? 4. Date and time? 5. In what regiment and division?

6. What was your rank at the time and what command were you exercising? 7. What kind of orders did you receive governing the attack or defense? Written or verbal? Standing or special? Divisional, brigade, regimental, battalion, company or platoon? 8. At what time did you receive such orders, with reference to hour or other period of engagement? Where did you receive them? 9. Were your orders accompanied by a map? Kind of map? How marked? 10. Did you have a map, or the opportunity to consult one? What kind of map?

11. On receipt of orders, was your command in position for attack or defense? If so, where? 12. If not, did you have any opportunity to reconnoiter the ground? Were any guides furnished you? What reconnaissance, if any, was made? 13. If your command was not in position, where was it when orders were received? In what formation was it brought up? Under whose command? What were its relations on movement up to other units of the superior unit? What were the conditions of light or darkness, weather, roads, etc?

14. What was the physical condition of your command at the time orders were received? When had it last slept? Last eaten? Last eaten hot food? How far had it marched in the preceding twenty-four hours? 15. What was its mental condition, as to morale, briefly? 16. What was the condition of its clothing, equipment? What ammunition did it have? Where were packs left? 17. What was the strength of your command at this time? Officers? Men? 18. What, in brief, were the orders received?

19. In approach to attack or defense position, what changes in formation were made due to terrain or other conditions? 20. When and where did your command come under artillery fire? What changes were made, due to terrain or other conditions? 21. The same for small arms fire? 22. Once in position, when did your command start to fire? 23. At what time did Infantry attack or defense start? What was the condition of light and weather?

24. Who gave the order that actually started your command, if attacking? How was it given? Barrage, watches, word of mouth? 25. What was the conduct of your command? was it silent? Was there shouting? Singing? Grumbling? Swearing? Nervousness? Confusion? 26. What was the rate of advance? Did men halt to fire? Did men so doing resume the advance? 27. Was your command under your personal control? Were you in touch with your immediate superior? With units to your flank? How?

28. When and where did your command halt? What halted it? The barrage, orders, exhaustion, enemy fire, enemy hand to hand resistance, enemy counter-attack? 29. What was the strength of your command at the halt? Was there any check made of those present? Can you account for the absent? 30. What was the physical condition of your men at the halt? The mental condition? Were they silent? Noisy? Did they fire? 31. What was the formation of your command at the halt? Of the superior command? Were you in touch with adjoining commands? 32. Did you reorganize at the halt? How?

33. Was your command supported by artillery fire during the advance? At the halt? Were you in liaison with artillery? Was there any complaint of short firing? Was such complaint justified? 34. Same for fire of small arms and auxiliary weapons, including tanks. 35. When was the advance resumed? On whose orders? How given? 36. What was the strength of your command on resumption of advance? What was its formation? Was it in liaison to the flanks? With superior command?

37. Where was your command at nightfall? Did it remain there? What was its strength? Its formation? Did you reorganize it? Did you receive orders? When? What were they? Were you in liaison with any other command? 38. Did you receive reinforcements from the rear? Hot food? Ammunition? Did you have water? 39. What was the physical condition of your men? Mental condition?

40. What constituted the enemy's resistance? Artillery fire? Small arms fire? A hand to hand stand? Attack? Counter-attack? 41. Did the enemy die fighting? Did he surrender? Retreat? Stand to engage in bayonet fighting? Did an actual bayonet contest take place? 42. What constituted the most serious opposition of the enemy?

43. Was the advance of your command assisted by accompanying guns? By other artillery support? By auxiliary Infantry weapons? By machine guns attached? By overhead machine gun fire? By tanks? 44. Did you see your immediate commanding officer during advance or at a halt? Any other superior officer?

45. What were the losses of your command? Dead? Wounded? Gassed? Exhausted? Missing? Separated from the command but returned to it after the operation? Can you account for the absence of men so separated? 46. What kind of wounds were received? Shell? Bullet? Bayonet? Did you actually see bayonet wounds inflicted? 47. When did your command get to their packs after battle?

48. Who was your immediate commanding officer? 49. What other officers do you know with sufficient experience to speak authoritatively on front-line battle and with sufficient coolness to have observed in battle?

50. Submit a chronological report of the engagement. A sketch will be of value, and statements need not be restricted to cover only the points mentioned herein.

Plank surfacing for secondary highways.—A writer in *Eng. News-Record* suggests plank highways for the temporary relief of communities unable to invest in permanent construction. Generally the plank could be laid upon a well compacted sub-grade. A telford base should be used where the sub-grade is soft or badly drained. Sleepers should be laid on top of small trenches cut in the sub-grade and filled with crushed stone. The spaces between the sleepers should be brought to the level of their tops with crushed stone, and the whole thoroughly rolled. Two-inch plank are recommended for the wearing surface.

Counties constructing such roads should have their own portable sawmills and creosoting plants.

The writer estimates that such a road (exclusive of excavation, culverts, etc.) should be built for $12,500 per mile, on an 18-foot width. Seven years of good service may be expected.

Such a road would be specially applicable to military operations, except that the planking proposed (2 inches) is too thin. Three inches would be the minimum that would be satisfactory for the heavy motor traffic of an army, and 4 inches would be better. For military purposes creosoting of the timber would be unnecessary.

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The Port of Seattle

(See plan with article on Lake Washington Ship Canal, page 321.)

Seattle is the only major port in the United States in which no dredging has to be done for ship channels. The ample depth in Puget Sound, minimum 156 feet, makes it possible for ships of the greatest draft to enter the port and berth, without the aid of a pilot.

The commerce of the Washington Customs District, of which Seattle is the chief port, has increased nearly 1,000 per cent in the last 10 years, and has risen from 22nd place in 1910 to 2nd place in 1918, amongst United States Ports of Entry.

The Port of Seattle Commission, an elective body, directly operates six terminal units. No exclusive leases are made, nor preferential assignments of an exclusive nature. The Commission is free to give berthage to all vessels and all lines, upon equal terms, and to keep every pier working.

The six terminals represent an investment of about $9,000,000 and a present value of $18,000,000. They include piers, transit sheds, warehouses, open storage, a grain elevator, oil storage tanks, and cold storage plants, and are equipped with mechanical handling devices with a range of capacity from a case of salmon, weighing 70 pounds, to a locomotive weighing 100 tons. The investment this equip- locomotive weighing 100 tons. The investment in this equipment amounts to three-fourths of a million dollars, more than any other port in the United States.

Seattle has led all other ports of the U. S. in the size and capacity of its ocean piers. It now owns and operates two piers, each over half a mile in length, one 310 feet and the other 365 feet wide, and representing the last word in terminal efficiency.

The six municipal terminals are equipped with about 15 miles of trackage, for loading and unloading cars: of this about 23,000 feet, with a capacity of 560 cars, are on the ship side of the piers, and 51,000 feet with a capacity of 1,280 cars, are on the land side. The berthing space is 16,700 linear feet.

The storage facilities in warehouse and transit sheds have a total net floor area of 1,635,000 square feet, of which 680,000 is covered.

The private commercial wharves have a total berthing space of 26,750 linear feet, a car capacity of 480, and a warehouse capacity of 290,000 tons. The private industrial wharves have a total berthing capacity of 10,000 linear feet; a car capacity of 270, and a warehouse capacity of 23,500 tons. The total grain storage amounts to 4,240,000 bushels.—*Port of Seattle Year Book, 1919-20.*

Metric System not to be perpetuated in the U. S. Army.—During the World War the U. S. Army, serving in France and largely equipped with French *materiel,* made much use of the metric system.

A recent order of the War Department prescribes that hereafter the customary British units of weight and measure will be used, as they were before the war.

All materiel and equipment graduated in metric units will, as soon as worn out, be replaced with articles graduated in British units.

Terminology for areas of military activity.—1. Hereafter the following terms will be used exclusively in describing the indicated areas of military activity:

Theater of operations.—The territory prescribed by the War Department as that within which military activities are controlled by the commander of the field forces.

Zone of the interior.—The territory within which military activities are controlled by the War Department acting through agencies other than the commanders of field forces.

Combat zone.—That portion of a theater of operations designated as such by the commander of the field forces operating in that theater. It includes division areas, corps areas, and army areas as hereinafter defined.

Communications zone.—That portion of a theater of operations designated as such by the commander of the field forces operating in that theater.

It includes all territory from and including the base to the rear line of the combat zone.

Supply zone.—A subdivision of the zone of the interior with boundaries prescribed by the War Department.

Army area.—That portion of the combat zone allotted to an army by the commander of the field forces or the commander of a group of armies. If but one army is operating, the combat zone and the army area are one and the same; hence in this case the use of the latter term is unnecessary.

Corps area.—That portion of an army area allotted to an army corps by the army commander or higher authority.

Division area.—That portion of a corps area allotted to a division by the corps commander or higher authority.

Advance section, communications zone—Intermediate section, communications zone—Base section, communications zone.—Subdivisions of the communications zone corresponding to similarly designated sections of the line of communications, as described in paragraph 369, Field Service Regulations.

Application of the cement gun.—Due to the pressure under which it is applied the strength of the mortar placed by the cement gun is much greater than by any other method, and accordingly very thin sections may be employed.

It is too slow and expensive for heavy mass work and should be used only in its proper field.

For coating steel structures to prevent deterioration it is ideal. No forms are required, and the very thin sections possible greatly reduce the dead load where this is important. The initial cost of the coating is greater than painting, but also far more effective and durable. Steel structures coated with gunite can be erected much more rapidly than reinforced concrete. For warehouses, etc., "mill construction" gunite coated may be quite as durable and much cheaper than reinforced concrete. While gunite coated structures are not strictly fire-proof, they are practically ignition proof, and thus greatly reduce fire risk. The reduction in insurance premiums more than offsets the cost of gunite coating.

Wherever steel must be protected from chemical action or wear, gunite is the most effective and economical covering.

For roof coverings and reservoir linings gunite is particularly useful because of its density and watertightness. It is equally applicable to tunnel and mine shaft linings, where it is easily applied and forms a fire-proof covering.

The application of gunite requires skilled operators, and usually a wire mesh reinforcement should be placed around the structure to be coated.—*Proceed. Eng. Soc. of W. Pa.*

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Experiences of an Engineer Battalion Commander with the 2nd Division, A.E.F.

At the Second Battle of the Marne

By

M. P. Fox

Major, 2nd Engineers, A. E. F.

[*Note.*—Personal experiences of observant people are the most valuable and the most interesting source of information. There was no American division which saw more active front-line service than the 2nd Division. The author of this story commanded a battalion of the 2nd Engineers during that period of intense activity known as the 2nd Battle of the Marne. The account, enlivened by Major Fox's sharp perception and entertaining humor, is a word-picture of the experiences that fall to the lot of combat engineer troops during battle. In a highly entertaining fashion it presents a vast amount of information as to the difficulties that must be met and how things should and should not be done. Every engineer should read this entertaining and instructive account.—ED.]

I SHALL describe briefly the experiences of the 2nd Engineers near Chateau-Thierry and Soissons during the period from the last of May until their relief from the line in the latter part of July. The subject is taken up more from the standpoint of a battalion commander than from that of a divisional engineer, because my opportunities for observing at close range that portion of the work were much better. Attempt will be made to point out mistakes made during this period; show if possible how they may be avoided, and to explain in some detail the actual conditions under which the regiment worked and what it accomplished.

About the middle of May the 2nd Division was concentrated in a rest area about 50 K. N. W. of Paris. The division had previously served in a quiet sector near Verdun, American battalions being sandwiched in between French. In this rest area maneuvers were held, under French corps orders to fit the division for taking over a sector of their own, functioning as a division. The general understanding was that the first of June the division should be placed in line alongside the first division near Montdidier.

On the 27th of May, however, the Germans started their third big offensive of the year, over-running the Chemin des Dames ridge, crossing the Aisne and Vesle, and reaching the Marne. Accordingly, orders were received May 28th to be ready to move by truck at 10 that night. Movement by truck always means separation for an indefinite period from all animal-drawn transportation, including of course rolling kitchens and tool wagons. Consequently, all the available time between the receipt of orders to move, and the arrival of the trucks is usually employed in cooking up available rations. It is a pretty good idea to get rations into such shape that each man can carry his own rations on his person, since there is usually a march of several miles both to the embussing point, and from the debussing point. In this case the trucks were 12 hours late in arrival, about the usual amount. The entire regiment was loaded at 10:00 a. m. May 29th and unloaded at 3:00 a. m. May 30th at a point 35 kilometers approximately N.W. of Chateau-Thierry, about 10 kilometers in rear of the line and opposite a point half way between Soissons and Chateau-Thierry. From there the regiment was marched to Montreuil, about 10 kilometers west of Chateau-Thierry. Practically all the officers in one company and a large number of men were missing, due to several trucks having broken down on the way. It is like putting all your eggs in one basket to put only officers in a truck, for French trucks are uncertain to say the least.

At this time the front line was lightly held by French cavalry, about 150 men per kilometer of front. The divisional infantry had taken up a position in rear of the French outpost line, one regiment from each brigade being in line. Orders were issued that evening for assigning the engineers, one battalion to each brigade of infantry, an order which did not have the happiest possible results. The brigade commander to which my battalion was assigned in turn assigned two companies to the 9th Infantry in line, and one to the 23rd in reserve. At this time the engineers were in a far worse condition than the infantry for tools, since of course the wagons had not arrived, and the engineers had no intrenching tools. The division engineer was able, however, to secure from the French corps engineer enough shovels, picks, and axes to provide about 40 tools per company.

In leaving Montreuil to join the stations assigned,

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the companies took up formations designed to avoid loss in case of being shelled en route, and moved across fields instead of on the roads. This lost much time and proved entirely unnecessary, since the Germans had so far outrun their artillery that they did not have a single piece available. Upon reporting the two companies to the regimental commander, 9th infantry, he assigned one company to each of his two battalions in line. The result was that the battalion commander had no command and the only thing possible was to attempt to advise the infantry battalion commanders as to the choice of positions and the methods of preparing them for defense. With the limited number of tools very little work could be done, so one of the first steps necessary was to organize foraging parties, and collect all the tools in abandoned villages near the front. By these foraging methods, enough tools to equip all the men were secured, and enough kettles, pots and pans to provide each platoon with sufficient kitchen utensils to start a mess for each platoon. This made a very mobile organization.

Platoons could be sent anywhere, each man carrying in addition to his regular pack either some tools or a cooking utensil. The general distribution of engineers was, however, very unsatisfactory and no good results could be secured.

These arrangements lasted for about a week, until June 6. Life was very pleasant at first, due to the absence of German artillery, but about the third or fourth day their artillery started to arrive and by June 6th was practically all on hand. By June 3rd, the French had been driven through the American lines in some parts of the sector and on the balance the Americans had moved forward and taken over the front lines from the French.

On the 6th of June, about 3 p. m., the Americans started local counter-attacks with the idea of securing more advantageous positions. That company which had been with the brigade reserve was designated to take part in the attack. Two platoons were detailed with one infantry battalion. They were sandwiched in between the first wave and the support, given three tools per man and instructed to assist the infantry in entrenching as soon as the objective was reached.

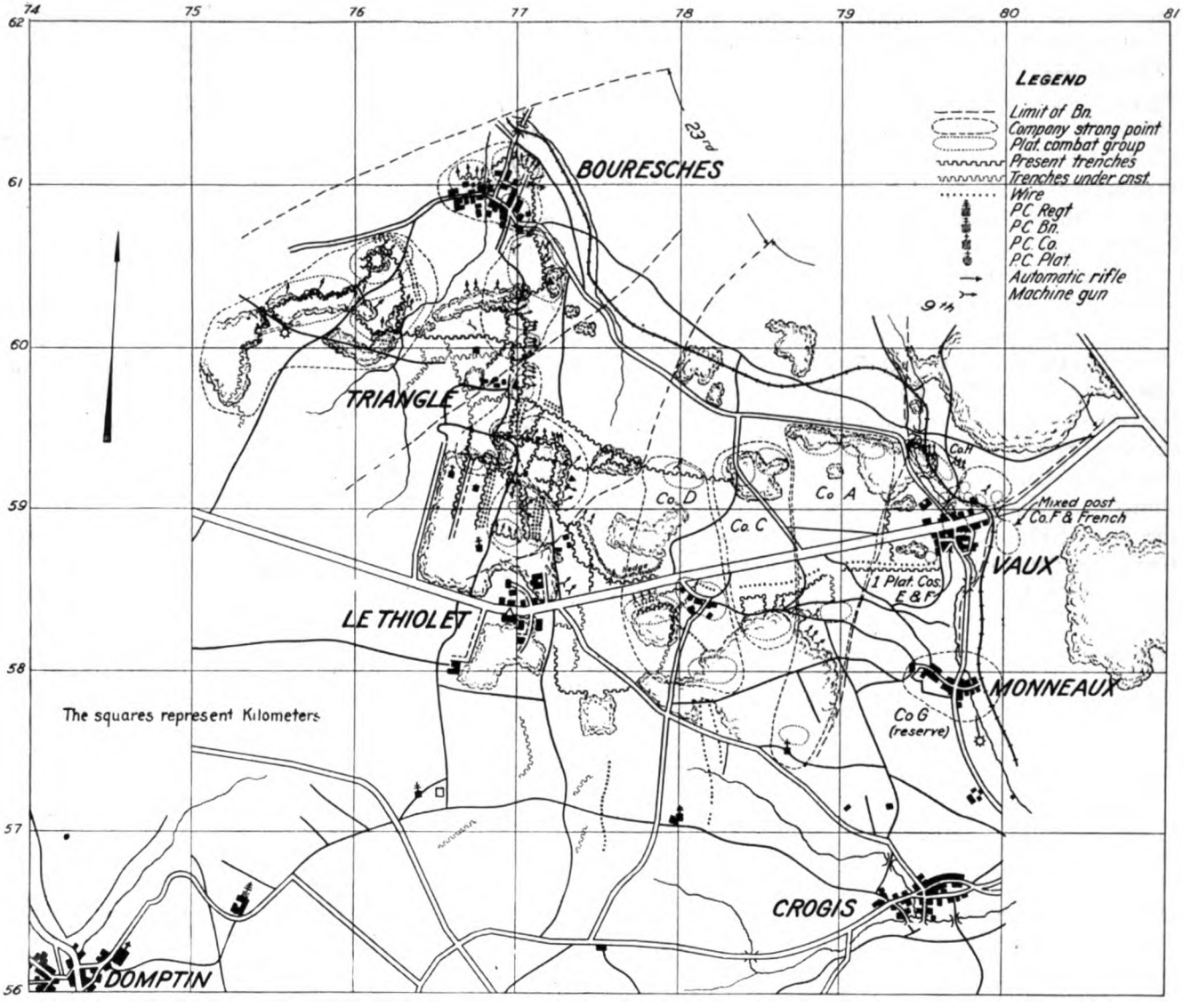
The attack failed, with very heavy casualties, and the objective was never reached. The engineers were able to render valuable assistance to the infantry, both as engineers and infantry. But it was rather an unfortunate location for one of the two platoons especially, since it came out with one officer and four men. It is believed that in a small local attack of this kind the best place for engineers is at some distance in rear of the support, and it is usually preferable to wait until the objective is secured before moving out to consolidate it.

That evening about 9 p. m. orders were sent from Brigade Headquarters for the two companies attached to the 9th infantry to proceed to Lucy le Bocage. The two companies carrying tools and kitchens arrived there about midnight and found a dark, deserted town, under shell fire. The companies were halted outside and eventually a marine private was found who could give instructions on how to find the P. C. of one marine major. Two battalions of marines had attacked that afternoon, one succeeding in capturing the village of Bouresches, and the other securing a lodgment in Belleau woods. The engineers had apparently been sent to consolidate these two positions, and accordingly one company was sent into the village, the other two into the woods. The company in the woods could do very little. The woods were very thick, all fighting was very close and the engineers were valuable principally as so many infantry reinforcements. The company in the village had a better opportunity for engineer work. They fitted up all the cellars in town as secure dugouts. They prepared buildings and walls for machine gun and rifle fire, and laid out a few trenches near the town. Rations and supplies during this time were delivered at night principally, although during the second attack, which took place on the 8th, ammunition was delivered by truck.

The repulse of the second attack on the woods the 8th of June was the signal for the relief of all the units engaged in it. One day's rest was allowed, and then the engineers were ordered to resume work.

This time arrangements were made that proved more satisfactory. The orders governing the work were issued by the French corps to which the division was assigned. The outpost line or sector was placed entirely under the charge of the infantry occupying it. The main defense line was placed entirely under charge of the engineers, the corps engineer indicating where this line should run. It was, as a rule, placed about 2,000 m. in rear of the outpost line, the reason being of course that the French have a very healthy respect for the German *minenwerfer*. The conditions then existing demanded that the line selected be put in a defensible condition as rapidly as possible. The division engineer therefore decided to organize first a series of strong points on this line, capable of obstinate resistance, and at 400-800 meters in rear of these a similar system of supporting points. Each of these two lines was to hold four companies and numerous machine gun replacements. The strongpoints were to be dug to a depth of 3 feet with a 1-foot embankment. They were to be wired in, and the space between the strongpoints was covered with wire only, the wire to be swept with machine gun fire. After completion of this, fire and communicating trenches for a continuous system were to be dug to a depth of about 6 inches. This was done so that any infantry assigned to the positions would have a definite plan laid out, and the

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works resulting from anything they might do would be part of a harmonious plan.

The construction of the works was divided evenly between the two battalions. One battalion was camped at La Croisette, the other about 2 k. east of Montreuil, or about 6 k. from the line. The battalion at Croisette was camped in a fairly large woods about 1 or 2 k. from the front, one large enough to make it too expensive for the Boche to try to cover the entire woods with artillery fire. Therefore so long as he was kept in ignorance of the exact location of the camp there was no danger from his shells. It made it very convenient to go to work making a long march to and from positions unnecessary. There were, however, several disadvantages. There was a more or less constant strain, since shells were continually passing overhead, and since the Boche used a cross road about 150 yards distant for a registration point. In case of an *alerte* this battalion was always assigned to a certain sector of trenches, and this of course interfered with work. There was also constant liability of a gas attack, always to be feared in camps located in woods.

The battalion camped further in rear, had a really more desirable camp site and selection of a position at this distance to the rear is to be recommended. They had, of course, to start to work earlier in the evening. But as they came nearer the front, it grew darker and they found they could just about march, so that the falling darkness would be sufficient to hide their movements from hostile observation. They lived, of course, under no strain and could have a much more comfortable camp than the battalion nearer the front.

In choosing camp sites it is of course necessary to secure concealment from aerial observation, which makes it necessary to choose either a woods or a village. While villages offer more protection due to their cellars, which can easily be gas-proofed, woods are less liable to shelling and to aerial bombardment, and in the summer are, in my opinion, more desirable.

The camp at Croisette consisted of a number of shallow pits, about 2 to 3 feet deep, laid out accurately in platoon streets. It is essential to have an accurate layout, since in case of gas men cannot be trusted to awaken by noise, but the gas sentinel must awaken

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each man individually. Over each dugout was put about 1 to 2 feet of cover, dirt laid on short poles. This is a good plan in woods. The majority of shells landing in a wood are air bursts and even this slight protection will keep out fragments. Kitchens were placed about 300 yards from camp and so screened that cooking could be done at night, without light showing through. The location selected was on the road, to facilitate the delivery of rations.

Rations were delivered of course at night. Each battalion has a supply officer detailed with the regimental supply officer, whose duty was to look after supplying the battalion with rations and clothes. He was charged with distributing rations equally among the companies; a very serious proposition because of the extreme shortness of rations at that time. Food was brought up to the camp from the kitchen, and when there was any artillery fire going on served to the men at the entrances of their dugouts. One infantry company near by permitted their chow carriers to appear in the open one day, and this brought a salvo from the Boche about 15 seconds later that caused upwards of 30 casualties. Water was brought in at night. Water carriers had to work all night to supply enough for the kitchens and drinking purposes, so cleanliness was out of question. Hence cooties, the most constant companions of the soldier.

After the arrival of tool wagons, they were kept in camps near the kitchens, and intact as far as possible. Battalion engineer dumps were run by each battalion, these were located about 1 or 2 kilometers in rear of the outpost line. The material for these dumps came from the French and American corps engineers largely, since the division engineer tried to keep the supplies in the engineer train intact also, in case of emergency. The infantry could draw supplies and tools from the battalion dumps, or upon request, the division engineer would deliver engineer supplies to any spot desired. For this purpose an engineer supply officer was appointed who made deliveries nightly as requested, using trucks from the engineer train. Supplies consisted principally of barbed wire, intrenching tools, wire cutters, axes and mauls. There was little demand for dugout material, since the occupation of the sector was almost certain to be of short duration. During the period June 1 to July 8, there were lost by the division upward of 1,500 tools, mostly shovels. The only way to prevent this needless loss is to impress the infantry with the fact that tools cannot be replaced, for the principal loss was due to pure carelessness.

Work was of course done entirely at night, except in woods. Due to the shortness of the nights, hours were fixed from 10 to 4. It was found desirable in the battalion at Croisette to have each man keep his entrenching tools at his own dugout. This obviated getting a mass of men together for issuing tools and saved time; but from my observations of the infantry I doubt if the same rule could be successfully applied to them. Work in woods was done daytime, it was found impossible to work there at night. In isolated cases where it was necessary to go across open ground, working parties would be moved into the woods under cover of darkness and brought back the following night. Staking out was ordinarily done in the day. The size of the party was kept to the minimum, ordinarily the battalion commanders, the commander of the company which was to do the work, and one man to act later as guide for the working party. A party of this size usually failed to draw artillery fire. Care had to be taken to prevent the Germans learning where work was to be done. This could be accomplished by a staking out a few days ahead, or by staking out additional localities where no work was to be done at all.

Considerable difficulty was experienced in securing any infantry working parties. Eventually when it was seen how slow the work was going, the division engineer was given one battalion of the division reserve. The rules for working parties are well known, but too much stress cannot be laid on having them strictly followed. It is amazing how little work 1,000 infantry-men can do in one night on a poorly laid out job. An officer from each battalion of engineers was assigned to brigade headquarters as liaison agent. The importance of this officer's duty is very great. He must keep the brigade commander familiar with everything that the engineers do, since in an *alerte* the brigade commander is responsible for the defense of that sector. Also he is the division engineer's principal source of information as to what work the infantry is doing on the outpost line.

Lots of trouble was experienced in making reports of work done. Maps were so inaccurate, especially as regards woods, that considerable difficulty was found in showing accurately on a map the real location of work done.

During this period, instruction in wiring entanglements was given to some of the battalions of infantry in reserve. Excellent results were obtained and it is believed that considerable extension of this instruction in engineer work is possible and desirable.

Between June 8 and June 30 fighting continued in the famous Bois de Belleau, and the engineers were used to very large extent.

Serving with infantry as infantry, has two very considerable advantages. It gives the engineers more prestige than anything else they can do. After the infantry discovers that engineers can fight, they are usually much more willing to coöperate on engineer work, and line and staff officers are usually more willing to recognize the value of an engineer regiment. Furthermore, the effect on the morale of the men is excellent, it makes them easier to handle on any work

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that has to be done under fire. But the practice must not be carried to such an extreme as to seriously interfere with the work the engineers must do.

On the evening of July 1st an attack was made by one battalion of the 23rd, one of the 9th, and one French, with the objectives of Bois de la Roche, Vaux, and Hill 204. This was an elaborately planned attack, very much on the order of trench warfare attacks. There was considerable time for reconnaissance, and for arrangements of details. Aeroplane maps were made, elaborate barrage charts, and tables worked out, and practice held over ground staked out to resemble the terrain to be attacked. One company of engineers was assigned to the 23rd infantry, and one to the 9th. The task of the first company was comparatively simple. They were to help the infantry dig in, and to wire the position when captured. The company with the 9th infantry going into Vaux was assigned the following duties by the infantry battalion commander:

To follow the support into Vaux at 400 meters.
To help mop up the town.
To spring tank traps on Monneaux-Vaux road and repair the road.
To examine all dugouts, box traps and label for use.
To inspect and label all water supply, whether fit for use or not.
To organize Vaux for resistance, loopholing walls and buildings and strengthening cellars.

Engineer dumps for these two companies were placed, one at Bourbelin and one at Monnieaux. The jumping off place was the north edge of Bois de la Marette, and both companies were moved into this wood before daylight of the first. The artillery preparation for this attack was very heavy, lasting over 12 hours. Naturally the Germans replied, firing back on the brigade sector, according to intelligence bulletin that day 21,000 shells, of which 12,000 were 105's or heavier. By keeping troops back 500 to 1,000 meters from the edge of the Bois de la Marette, however, very few casualties resulted, although most of the infantry and half of the engineers had no shelter whatever. Practically all the German shells fell within 100 meters of the edge of the woods, or in the village of Monnieaux. The attack was successful as far as the American end of it went. The company detailed to consolidate the woods waited until the German barrage placed on the north edge of the Bois de la Marette lifted, and then proceeded to their work. Two or three platoons finished their work and came out the same night. The third platoon was under a sergeant who became interested in teaching the infantry to operate German machine guns, and two nights later it was necessary to send back a platoon under an officer to finish up this work. The total casualties in this company were only four.

The other company moving into Vaux had more troubles. The artillery preparation had been so complete that it was in places hard to tell what had been street and what buildings. Careful examination of maps and distant reconnaissance of the ground had failed to show the relative heights of walls, buildings, etc. Therefore elaborately detailed plans for the consolidation of the town had to be abandoned, and new arrangements made on the spot. No tank traps nor booby traps were discovered. The company here remained in Vaux for several days, doing combined engineer and infantry work. This was necessitated by the failure of the French to capture Hill 204, leaving Vaux in a very uncomfortable position.

The Germans had been in these positions for a month, so they had made considerable preparations for defense. Their preparations as usually found were done in about this order: Preparing just trenches enough for the garrison assigned and wiring them in; preparing shelters, deep shelters for the men, and very fine ones for PC; making arrangements for obstructing roads to the rear. At this time the Germans seemed to have, and to be able to get to the front, all material including engineer supplies, they could use. This was probably due in large measure to their captures since March 21st.

Beginning the 8th of July, the division was relieved, and started for a rest area. Due to the discovery about this time of a heavy German attack impending, the division was held in reserve, about 8-12 km. in rear of their former position, and were engaged in working on the corps line, a position about 6 to 8 kilometers from the front.

On the morning of the 15th of July the German attack was delivered, the extreme western edge of the attack coming a few kilometers east of the divisions' position. That evening, as I learned considerably later, decision was made to counter-attack near Soissons. Work was called off on the 16th, and everyone held in readiness for movement. At 6 o'clock that evening orders were received to entruck at a point 6 kilometers away at 4 p. m. The trucks, however, did not show up until midnight, so the orders arrived early enough. As usual the engineers all carried tools in addition to their regular equipment. This has a certain advantage, since you can pick out your men at quite a distance. The trucks arrived at *their* destination (not *ours*) about 3 p. m., July 17th. For some reason French trucks never land you very near where you want to go. The entire country was filled with troops all marching east, both French and Americans. The division engineer had kept with division headquarters, and at this point issued maps and directions for the march to position. The greater part of the march was made at night and in the rain. Roads were badly crowded, four organizations of foot troops, and two columns of wheeled transportation abreast. Unfortunately, one of the engineer captains had not

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been furnished with a map and in attempting to take a short cut lost his way. He had the 2nd company, so five companies did not reach their destination until nearly 7 the next morning. At that they did better than a large part of the infantry. The attack was scheduled for 4:35 a. m. of the 18th, and started off very successfully. The lateness of the engineers did not cut any figure, since they were in division reserve. As the attack progressed, the engineers moved forward, repairing the roads as they went. The main artery of traffic consisted of a road paved in the middle with Belgian block, and with a wide earth berm on each side. The Germans had ruined the road in several places, and had felled numerous trees across it. The work of removing these was very valuable, since the road in about four hours was made to carry three columns of traffic in place of one. One obstruction requiring much labor was a tank trap. Pits 8 feet deep and 15 feet long had been dug out on each side of the paving, and the paved sections ruined.

The first phase of the attack was completed by 8 p. m. the evening of the 18th, and the 2nd phase started immediately, with about 1,000 to 1,500 meters advance. This phase of the attack met with very severe opposition, and was stopped almost immediately.

The engineer regiment received orders to move out shortly after this phase of the attack had started, and consolidate the position to be taken that night. It was assumed, owing to the success of the previous attacks that this one would be successful, and assignments of sectors were made on the assumption that the objective would be reached. The attack, however, was stopped after about a 1,500 meter advance, and the lines were rather badly mixed and lacked some half a kilometer of connecting with the French on the right. The necessity for getting work done rapidly, the mingling of units, the difficulty of finding battalion and company commanders, and of trying to stake out positions at night made any satisfactory layout impossible. Lines were straightened as well as possible, and then the engineers dug in as supports and to fill gaps in the line. Carrying of tools was absolutely essential in this case. Practically all division maneuvers had been almost solely for testing out liaison agencies. But at 1 p. m. not a report had been sent back to brigade headquarters as to the location of the line, and so far as could be determined the only ones that ever did come back were sent by the engineers.

The value of insisting on prompt reports is of course evident.

Furthermore, it is believed that if engineers are to be used in consolidating positions in attacks of this kind, some liaison agents must be kept in touch with the infantry and be given every opportunity to make reconnaissance during daylight.

The next day the attack was scheduled for 7, but did not take place until 9. It was stopped completely by 11, partly due to the failure of the French to keep up, but principally because of a determined German resistance.

Orders were given for consolidating the ground gained that night. Arrangements were made by the division engineer for the delivery of wire, and additional tools at the front. By this time the engineer train was available, but most of the material had been secured from captured dumps. In this case it was possible to get a view of the ground by daylight and to find the location of troops and infantry unit commanders, and it is believed that work could have been done in a very advantageous and thorough fashion, lines rectified, and units properly placed. But by evening orders had come for the relief of the division, which took place that night.

Here endeth the first lesson.

Blasting a ditch when digging is impracticable.—A ditch 530 ft. long, 30 ft. deep and 6 ft. wide, through a tangle of underbrush in a soil of clay and quicksand, where digging was impossible, was successfully blasted.

Holes were bored in the soft sticky clay and dynamite cartridges pushed into them with a tamping stick. No tamping was necessary, as the water filled the holes.

In the quicksand the sticks of dynamite were encased in pointed tin tubes and then pushed down into the quicksand to the required depth.

The charges were spaced about 2 feet apart both in the quicksand and in the clay, at a depth of about 2½ feet. The charges were 1 or 1½ sticks of dynamite.—*The Excav. Engr.*

Gin pole aids in unloading trucks from open top cars.—A gin pole with block and tackle solved the problem of unloading a train load of trucks for the Iowa Highway Commission. The trucks were shipped by the War Department in open cars, of which neither ends nor sides could be lowered or removed.—*Eng. and Cont.*

Enemy planes brought down by anti-aircraft artillery and machine guns.—American anti-aircraft units, operating in France, brought down 59 enemy airplanes. The first plane was brought down by the 2nd A. A. Battery east of Verdun, May 18, 1918. This battery also fired the first shot against hostile aircraft, April 18, 1918. The other 58 enemy planes were brought down in the four months prior to the signing of the armistice; 17 by five batteries of anti-aircraft artillery and 41, which were low-flying planes, by two anti-aircraft machine-gun battalions of four companies each.—*War Dept. News Bureau.*

Winter work on Alaskan Railway.—The temperature in Alaska ranges from —70 to +100 degrees Fahrenheit. Construction is done during the short season of warm weather, but distribution of materials is accomplished during cold weather. Transportation by sled over the ice is easier than building corduroy roads over soft ground.

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Peace-time and War-time Economics

By

P. S. Bond

Major, Corps of Engineers; M. Am. Soc. C. E.

[*Note.*—Economic principles are as applicable to war as to peace. The only difference is in the conditions to which these principles are applied. A knowledge of the fundamental economic principles which should govern the conduct of war is even more important to the military engineer than a knowledge of technical methods—which are simple in wartime. These economic principles are the basis of good practice, which is our excuse for presenting the arguments herein.—ED.]

IN the minds of many who are uninitiated the term "economics" finds no application whatever to warfare. War, they tell us, is unmitigated waste.

Now it is true that war is destructive, but it does not follow necessarily that it is uneconomical. The building of an empire by war was a fundamental economic principle of German politics, and Germany is by no means the only nation that has recognized the principle. When we look into the history of these things we find that all empires have been built up by war, including our own. To be sure the German empire was built up largely at the expense of other nations. But this was justified economically by the German publicists on the ground that, looking at the results as a whole, the economic progress of Germany more than compensated certain incidental temporary embarrassments to less worthy neighbors Germany's early successes in the practice of this particular form of economy ran away with her good judgment, and caused her to violate another fundamental economic principle, which is that anything, however wise in moderation, becomes bad when carried to excess. Germany carried her war economics to excess, and came to grief in consequence.

Those who have observed the processes of nature will have noted that she is prodigal in her expenditures. And if they have not thought deeply on the subject they may have come to the conclusion that she is inexcusably wasteful of matter, energy and life. But the scientists tell us that no atom of matter nor ounce of energy is, or can be, destroyed. They are not so positive as to life, but we may safely reason by analogy that life, in common with the matter and energy by means of which it manifests itself, is indestructible. Those who hope for a future existence *in propria persona*, if there really be anybody who desires eternally to combat the H. C. of L., can draw only a little comfort from the principle of the conservation of life. For while there is good evidence that life is indestructible, the same is not quite so true of conscious individuality.

But we are wandering from our proper domain into the dreamland of spiritualism and metaphysics. What we wish to point out is that prodigal expenditure is not necessarily the antithesis of economy. Nature is prodigal in her expenditure yet perfect in her economy. And in war a prodigal expenditure of money and life at the right time may be, and usually is, the means to victory, and the highest form of economy. The highest economy of war is victory, and the greatest waste is defeat. Assuming that we do not enter war for trivial purposes in a moment of inflamed passions, or without good and sufficient reasons of an economic nature, the value of victory is so great that it almost invariably justifies the expenditures *necessary* to win it, however great they be. Before entering the war we should carefully weigh the issues at stake, and consider all the probabilities. For it would manifestly be the height of folly to allow our passions to lead us into a war in which defeat was certain, and the end of which would find us worse off than if we had acceded to the demands of our opponents without resort to war. A settlement out of this court of last resort, whose charges are very high, may be and usually is the wisest and most economical procedure. And most cases are usually thus settled "out of court" by compromise. But if the compromise involves the sacrifice of national honor it may only lead to worse difficulties and greater sacrifices in the future, and even defeat may be preferable to this. There is a limit beyond which patience and compromise cease to be virtuous, wise and economical—especially economical. An example of this is afforded by our too pacific neighbor, China, whose history proves the economical principle heretofore referred to—to-wit, that anything carried to excess is bad, even the highly commendable desire to remain at peace with one's neighbors. Moreover, the fortunes of war are always uncertain, and we must reckon with the inclination to take "the fighting chance," which is characteristic of virile nations as it is of virile men though, fortunately for the peace of the world, to a much lesser degree.

All these are amongst the conditions that should be weighed by those in control of the destinies of the state before pitching the national hat into the ring. But having carefully estimated the situation and decided in sober judgment that war is the best solution, the highest economy usually demands that it be prosecuted as surely and rapidly as possible to decisive victory, freely paying the cost thereof. At least this is the wisest procedure for a nation so powerful as America. It might not be so in the case of a smaller nation, forced to hold a larger one at bay, while hopefully awaiting the intervention of allies. But even in this case, and when there is no hope of actual victory, expenditures should be made as freely as the resources of the state permit, to insure a strong defense. If a nation cannot win decisive victory it may at least evade crushing defeat, and that is worth much.

Accordingly a free and rapid expenditure, within proper limits and not reckless, is good economy in war. This is so because time is one of the important elements, probably the most important element of victory. And an expenditure which saves valuable time is always justifiable, even if it involves considerable incidental waste. War consumes our accumulated resources at an appalling rate, not only by reason of the direct expenditures, but in many incidental ways. When the war is over these expenditures cease, after a greater or less interval, depending chiefly upon the efficiency of the government administration at the time. Accordingly, if by doubling our direct expenditures of lives and money we can bring the war to a victorious conclusion

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in one year, when otherwise we would spend two and, of course, run greater risks of defeat, economy invariably dictates such a procedure.

Another fundamental economic principle, not of war alone but of national policy, undoubtedly the most important principle of all, was enunciated by the Father of Our Country, the great Washington, when he pronounced that wise maxim: "In time of peace prepare for war." This maxim his people have never heeded, and perhaps it is useless to again call their attention to wise advice so persistently disregarded. This is sound economy, first because preparation in advance will frequently induce our neighbors to accede to our wishes or leave us alone, when otherwise they might have defied or attacked us; and second because preparation insures victory should war be forced upon us.

Important economic considerations are thus involved in the decision to make use of war as a means to our ends, and also in the manner of conducting the conflict itself. War is not always merely a necessary or unavoidable evil. It is usually a recognized means to an end. But in estimating the economics of the situation in order to decide whether we shall make use of war, we should, of course, consider *all* of them. And the decision will be made as in any other affair of life. If the probable profits are reasonably in excess of the probable costs, the war is wise and economical. But of course we must weigh *all* the profits and *all* the costs. These will include not merely the money outlay in prosecuting the war, and the territory and indemnity which victory will bring us, but matters of national honor, the effects on the spirit of our people and our future growth and prosperity in a multitude of direct and indirect ways. And we may go farther, and in an altruistic spirit consider also the effects of war or abstention from war on humanity generally, including even our enemy. As a wise and just people, we should use war as an economic instrument to accomplish a necessary purpose (when other instruments will not serve), and not at all as a means of revenge and destruction. The destruction is merely incidental to the purpose.

Of course extraneous conditions will have less weight with us than those which apparently touch our own welfare more closely. But it would be quite wrong to totally disregard them.

We may find it necessary during the war to cultivate in our people a spirit of hatred for the enemy. But this is solely for the purpose of insuring a vigorous and therefore economical prosecution of the war. Hatred of the enemy may be a necessary stimulus to our national effort, but should not be regarded as an end or purpose in itself.

It will certainly be quite apparent upon taking thought that the economic principles of which our industrial leaders tell us are quite as applicable, in fact more applicable to the affairs of nations and to war, than they are to the affairs of individuals and to peace. And serious mistakes in economic judgment are far more expensive and disastrous in war than they can possibly be in peace, because they involve the whole nation. And while there is usually opportunity at leisure to correct the mistakes of peace, those of war are generally irreparable.

All of the great nations, except China and the United States, are well versed in the economics of war. Especially do they realize the truth of the Washington maxim. The commanders of the armies of a nation, in fact all the officers of these armies, must appreciate and practice the economics of war. Otherwise they are not qualified to meet the great responsibilities placed upon them. A knowledge of these fundamental principles is more necessary in war than in peace. Economic blunders in peace-time may involve the waste of a few lives and a few millions of dollars. But in war they may involve the waste of hundreds of thousands of lives and billions of dollars, and perhaps also the loss of national freedom and independence. So we cannot afford to take chances, either in preparation for war or in the conduct thereof.

The expenditures of our government during two years of the World War were some 33 billions of dollars. This was a sum greater than all its expenditures in the 140 years of our previous history (including the cost of other wars), which were but 27 billions. An economic blunder in the conduct of such a war, a single wrong decision in an important matter, arrived at after a few days or even a few hours thought, by a military commander, a legislative body or an executive official, may involve a waste which could not be offset by a hundred years of the most rigid governmental economy during peace. And such important decisions must be made promptly on the information of the moment. There is never time for long reflection or exhaustive investigation after war is upon us.

It must be apparent then, that there is nothing which concerns our country that is so vitally important as that our army commanders and government executives, who direct the affairs of the nation, should be thoroughly versed by study and training, in the economic principles which find their application in the conduct of war.

The most important decision ever made by any legislative assembly was that of the American Congress in May, 1917, when they enacted the law providing for universal compulsory military service in the conduct of the great war. That fateful decision insured the victory of civilization and the downfall of Prussian militarism. Most of our legislators had but a few days in which to make up their minds in this important matter. Had Congress failed to enact this law they would have committed the most colossal economic blunder in all history. Yet considering the previous attitude of the American people towards compulsory service, it would not have been surprising had Congress committed this awful blunder, which would almost certainly have doubled, even trebled the cost of the war, besides uselessly sacrificing hundreds of thousands of precious lives, and probably bringing disastrous defeat to our armies and those of our allies.

A thorough understanding and a working knowledge of these fundamental economics of war is of the utmost importance to engineers who would fit themselves to perform the highest possible service to their country in times of armed conflict. It is well that they be carefully thought upon. The engineer does not escape from the practice of economics when he enters the war. On the contrary, the opportunities for tremendous profits or ruinous losses are far greater than will ever be presented in times of peace. The engineer must have that correct sense of proportion which will enable him to accurately determine the important matters to which he should devote his energies, and the less important and unimportant affairs to be temporarily neglected or permanently set aside. And having decided upon the really important tasks, he must be able to carry them out with vigor and courage, with the resources at his disposal, and in the manner and under the difficulties which war imposes.

The engineer in war must be constantly guided by his knowledge of the economic principles of warfare. These are easy to state, but their effective application in times of stress requires the highest judgment based on experience and study, and the greatest resourcefulness, determination and courage. The more important of these economic principles are briefly enunciated as follows:

(*a*) In war the principal considerations are *time* and

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results. Cost, while not to be disregarded, is of far less importance than is usual in peace. This means that all works of military engineering must be conducted with feverish rapidity.

(*b*) The work of the engineer must be adapted to military needs. However excellent in themselves, his results are a waste unless they fulfill the tactical requirements of the army. Accordingly the military engineer must be a thorough tactician. It is not sufficient that his works be *technically* well executed.

(*c*) High technical skill will seldom be required of the engineer with the combatant forces, for works of military engineering are invarably simple, but his faculty of getting results will be constantly taxed to the utmost. Explanations or excuses for failure, however plausible or valid, are useless, and will receive no consideration. *Success* is the sole criterion by which the engineer will be judged. This is harsh but inevitable.

(*d*) While it is the duty of the engineer to see that suitable equipment and supplies are assembled for his works, yet results must be obtained with the facilities at hand, however inadequate they be.

(*e*) The works of the military engineer must be in nature and extent sufficient unto their purpose, and *no more* than sufficient. *Bare necessities* are all that *time* will allow. This means that the factors of safety and permanence are generally lower than in civil works. The rough-and-ready structures which serve their purpose are the triumphs of the military engineer's art. Any refinements beyond absolute necessities are evidence of incompetence. The civil engineer builds for posterity, and takes a just pride in the permanence of his work. The military engineer builds for the exigency of the moment, and may temporarily escape criticism if his work is ready when it is needed, or a little sooner.

(*f*) The engineer must be able to immediately perceive the principal requirements of any situation with which he is confronted. He must devote his energies to these, ruthlessly eliminating all but absolute necessities.

(*g*) Military engineering must be of the utmost simplicity both in plan and method. Only the simplest works can be successfully executed under war-time conditions. Complexity invites failure and is proof of incompetence.

(*h*) Ultimate completion and eventual utility of his work are not all that will be expected of the engineer. Work may be interrupted or the partial use of the structures demanded at any time. Accordingly they must be built so that at any instant prior to ultimate completion they will have the maximum utility that it is possible to secure up to that instant. For example, if the work consists of several units, each should be completed in its entirety, or to the point of utility, before the next is started, unless this start will not delay completion of previous units. This requirement is so at variance with that which usually obtains in time of peace that the civil engineer will find it difficult to adapt himself thereto.

(*i*) In military operations the engineer must be able to think in large numbers, and must have the foresight and courage to plan his work on a vast scale, even when the need is not at first apparent. For the demands of war increase at such a rate as to overwhelm us if we have not foreseen them. If, from motives of economy, we hesitate, we are very apt to be lost. This is closely related to (*j*).

(*j*) It is not sufficient that the engineer should promptly execute the works demanded of him. More than this will be expected. He should be so closely in touch with the military situation and the plans of his commander, that he can *foresee* the engineering needs before they arise, and take steps to meet them. Of course in doing this the engineer runs the risk of making mistakes and executing unnecessary works. It is a risk he must assume. If the staff perceive that the engineer is forehanded in his work, does the right thing on his own initiative before he is called in, they will have confidence in him and will be glad to give him a free hand in carrying on his operations. If on the contrary the engineer waits always for orders he will soon find that the staff will take over his proper functions and look upon himself as superfluous. Cordial relations between the engineer and all commanders and staff are essential to the success of engineering operations. These cordial relations depend chiefly upon the judgment, foresight, initiative and capacity of the engineer. If he is competent and universally recognized as such, he will enjoy the confidence of all, and be allowed full scope for the useful exercise of his talents.

To ponder upon these principles, to recognize the truth of them and accurately visualize to himself the effect of their application upon the conduct of his work, is the most important step in the engineer's preparation to efficiently perform his duties in war.

Controversy over concrete block tunnel for Hudson River

Sharply divergent views on subaqueous tunneling practice were brought out during the course of recent public hearings on the Hudson River vehicle tunnel project. Most of the controversy hinged upon the rejection of the 42-foot concrete block design in favor of twin 29-foot cast-iron tunnels. In reply to specific questions by the advocates of the former design, the chief engineer of the joint commissions advanced objections to that project.

(1) The 22-foot 6-inch roadway could accommodate but two instead of three lines of traffic as estimated.

(2) The concrete block tunnel does not provide sufficient strength at cross joints between adjacent segments.

(3) The great number of joints between the blocks makes it impossible to secure water tightness.

(4) The estimated cost of the concrete-block tunnel is too low; viz., (*a*) concrete blocks at $11 per cubic yard in place, instead of $33; (*b*) cost of excavation, estimated at $3,730,000, should be $9,700,000; (*c*) items of water proofing, tunnel ducts, etc., omitted from the estimate and quantities of steel and payment too low; (*d*) the cost of plant, $1,435,000, should be $2,658,000; (*e*) no item in the estimate covers the cost of real estate, about $2,500,000.

(5) The completion of the tunnel in the estimated time of three years would require more rapid progress than that attained in either the Pennsylvania tunnels or the recent rapid transit tunnels under the East River.

Col. W. J. Wilgus presented further objections of the Board of Consulting Engineers to the concrete-block design.

(1) The designer believes the material to be encountered is stiff clay, whereas it is a silt with specific gravity and moisture content classifying it among the softest clays.

(2) The unstable nature of this material would produce maximum stresses of 1,000-pound square inch compression, 400-pound square inch tension, and 1,192-pound square inch shear, in the concrete.

(3) The block tunnel with its many joints would be vulnerable to disintegrating attack by the acid-bearing underground waters encountered on the Jersey side.

(4) The proposed 42-foot shield with four horizontal air compartments, each carrying different air pressures, the face of each compartment three feet back of the one below it, ignores (*a*) the cracking in the material following each shove of the shield; (*b*) the probable obstructions, such as piles, boulders, sunken vessels, offering passage of the air between the compartments thereby raising the pressure of the top compartment to that of the bottom one and causing consequent blowouts in the former; (*c*) the unavoidable rotating of the shield, causing tipping of the floors of the compartments and also equalizing top and bottom air pressures; (*d*) the certainty of breaking many blocks under the enormous jack pressures.

To compare directly the cost of the two types of construction, J. F. O'Rourke presented estimates for a pair of 31-foot concrete-block tunnels and corresponding estimates for the pair of 29-foot cast-iron tunnels of the official plan. The totals of his estimates were:

Total cost of twin cast-iron tunnels	$30,240,000
Total cost of twin concrete-block tunnels	15,540,000
Estimated saving with concrete blocks	$14,700,000

Mr. O'Rourke's estimate of the cost of the twin cast-iron tunnels exceeds the estimate of the chief engineer of the joint commissions by $7,978,000.—*Eng. News-Rec.*

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Ocean pier to be scrapped because of concrete disintegration

The municipal pier at Santa Monica, Cal., was closed to the public as unsafe in November, 1919. This reinforced concrete pier was built in 1908; it carries a large outfall sewer and serves as a public pleasure pier. It is 1,600 feet long, 35 feet 8 inches wide at the deck, with three platform spaces 89 feet wide located at the end and at two intermediate points. The floor is concrete on wooden stringers. It has concrete floor beams, on concrete bents, of posts cast in place, and supported by concrete piles which were jetted into place. The bents are spaced 20 feet center to center and the piles 13 feet 6 inches. The deck is from 21 to 50 feet above the ocean bottom, but the piles are not braced, either transversely or longitudinally, below the floor beam level. The piles are round with bulbs at the bottoms. They were cast on shore in a position inclined about 40° to the vertical.

The pier appeared to suffer no appreciable deterioration for some years; in 1912 it appeared to be in good condition. In 1916 it was again examined and serious deterioration was observed. Some piles near the outboard end had failed, supposedly because of damage inflicted by floating debris. An analysis of some of the disintegrating concrete showed the presence of 2.88 per cent MgO (magnesia), indicating that disintegration had been in progress for some time. Many of the piles, as well as the floor beams, were badly cracked, and some showed evidence of erosion and spalling. No examination was made of the outboard piles below the low water level at that time.

In August, 1919, a settlement of the outer end of the pier, occurring when it was crowded with people, led to an examination by a board of engineers from whose report the following comments are abstracted:

Forty-two bents, originally containing 150 piles, were examined. The following conditions below low-water mark were noted by a driver: 3 piles gone; 3 practically gone; 60 badly rusted, showing oxidation of steel had set in; 30 badly cracked, showing disruption was in an advanced stage; 54 still serviceable. The following conditions were observed above the low-water mark: 3 piles gone; 3 practically gone; 91 cracked in two or more places; 33 cracked in one place; 20 showed no serious deterioration.

The principal cause of the present condition of the pier was found to be permeable concrete permitting the penetration of sea water, producing: (1) chemical disintegration of the concrete, and (2) mechanical fracture of the concrete by expansion of the reinforcing steel due to corrosion. The chemical disintegration took place below the high-water line, while the cracking along the reinforcement was confined almost entirely to caps and struts above that level. Measurements with a milli-voltmeter showed a slight difference of potential between the sewer and the reinforcing steel of the pier. This difference fluctuated with the starting and stopping of electric cars on adjacent tracks. There are no signs of electrolysis at present, and the fact that similar disintegration has been observed in other concrete structures in these waters and even in lamp posts and fences exposed only to the salt air, indicates that electrolysis was not an important factor in producing the conditions under investigation. The life of the pier would have been prolonged had the reinforcement been more deeply embedded. Beach sand and gravel were used in the concrete. The uniform sizes of such materials increase the difficulty of securing impervious concrete, and the salts they contain facilitate the corrosion of the steel.

The Board finally concludes:

(1) The prime cause of this failure was permeable concrete due to poor workmanship and improper selection of materials.

(2) Contributing causes were two severe storms which cracked many members during construction.

(3) Electrolysis accelerated but did not cause disintegration.

(4) Blame does not attach to the designers nor builders, in view of the knowledge regarding the action of sea water on concrete existing when this pier was built, nor to the officials in charge of maintenance, who exercised reasonable care.

(5) Reconstruction of the pier in concrete is not recommended on account of the difficulty of securing concrete, particularly in substructural members, without removal of the deck.

As a consequence of this report, the pier has been closed by the City Commission and a new creosoted pile pier will be built.—*Eng. News-Record.*

Unique flood control project at Erie, Pa.—A mild little stream, called Mill Creek, flows through the city of Erie, Pa. At intervals of about 25 years this quiet stream goes on a rampage, and on the last occasion, in 1915, caused a loss of 34 lives, and millions of dollars of damage. And so Erie joined in the nation-wide movement for flood abatement.

A flood channel of sufficient capacity involved too much real estate, and so the engineers proposed the unique plan of sealing up the little creek in a tight concrete pipe, which it could not get out of. There was to be no more overflowing of banks as banks were to be eliminated, and Mill Creek degraded into a sewer.

The proposed plan included impounding or detaining dams, and a pipe large enough to carry the regulated flow. But having in mind the unfortunate experience of Johnstown in their native state, the good people of Erie decided they wanted no dam to get on their nerves. So an alternative plan of a tube large enough to carry the entire flow was adopted.

The tube is elliptical in cross section, 18 by 22 feet, and about 2 miles long, through the city. Wing walls at the intake and outlet regulate the velocity of flow.

The project was started in May, 1917, but due to the war extraordinary difficulties have been encountered. One contractor has gone bankrupt and the work is not yet completed.

The original contract called for completion at a cost of $812,000. The ultimate cost will be more than double this amount ($1,800,000).—*Eng. News-Rec.*

Growth of American merchant tonnage.—On June 30 the total gross tonnage of all sea-going vessels of 1,000 tons, or over, under the American flag, was 1,647,000. On May 1, 1920, it was 10,451,012. Of this increase 1,000,000 tons was obtained from foreign sources, and the remainder is new construction.—*Statistical Section, General Staff.*

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Animal-Drawn Transport in War

By

A. A. Keesler

Captain, Engineers

[*Introductory note.*—At the entrance of the United States into the World War, A. A. Keesler resigned from the Presidency of the Watson Wagon Works, Canastota, New York, to accept a commission as Captain in the Corps of Engineers, U. S. Army. He was assigned to the General Engineer Depot and placed in charge of the procurement of road machinery. Later he was assigned to the work of developing a tool wagon for combat engineers which would overcome the defects in the type that was then being issued. In the spring of 1919 he was directed to take the wagon which he had developed to France for test and criticism by various engineer organizations that had seen actual service. After returning in the fall of 1919, he was charged with the design and construction of a wagon based on the criticisms he had received. On the completion of this work, he left the Service and resumed his former position as President of the Watson Wagon Works.—ED.]

IN all previous wars armies have placed their chief reliance on animal-drawn transport. The opening of the Great War, however, found motor transportation already well developed, and instant and far reaching use was made of it. Without it no such great armies could have been put in the field, supplied and munitioned, even under the favorable circumstances of fighting in civilized and well-developed countries, well cleared and gridironed with roads. Nor could the great strategic concentrations characteristic of the struggle have been so quickly effected. The splendid road systems of France, Belgium and Germany answered instantly the question as to what kind of transportation to use. The first great thrust of the Germans was parried by the taxicabs and motor busses of Paris. The two vital elements were there—the motor transportation and the roads. They were used most effectively and they won. Much has been and could be said of the miraculous performances of the gasoline motor in every moving machine from airplanes to tanks, and the vivid pictures in the minds of officers and men of the great problems solved and the decisive results accomplished by motor transport, have tended to obscure the still great importance of the slow moving but reliable wagon train.

Could transportation problems have been solved and the war fought and won without the aid of the horse and mule?

Perhaps it could. Given plenty, a great plenty, of all kinds of motor vehicles, it might have been done, and the general result would have been the same. Animals, like men, were resources ready to hand. They needed only to be mobilized. The "hay motors" were ready and prepared to function in the old familiar way, as in previous wars.

A horse and wagon are a simple and effective machine, with few things to get out of order. There is no delicately adjusted engine, with a thousand things to go wrong, no tires to puncture or blow. They are slow, perhaps, but sure. When you set out for a place you usually arrive.

Motor transport, certainly so far as now developed, demands good, or at least reasonably good roads for effective use. Where the roads are not of this class, the horse-drawn vehicle is both more economical and more reliable. For the purposes of the light artillery in battle the horse (not the mule) is still required. Of course the future development of caterpillar traction may change all this—we are speaking of conditions as they actually existed during the late war.

A war might be conducted without the aid of our dumb allies. It might even be done without the rifle, provided *neither* side had it. There is little point in such speculations.

The motor cannot be dispensed with and the horse and wagon must not be abandoned until every country where the army might be called upon to operate has adopted the motor and built the roads it calls for. All wars are life and death struggles for the nations, as for the men engaged, and no thoughtful and efficient staff would fail to use all available resources. So long as the horse and wagon remain a factor in civilian life and commercial transportation, they are bound to remain as a factor in military operations, and possibly that may be their last and final great use. If this is true, then it is obvious that the carrying capacity of the vehicle as a chief means of transportation should receive careful attention.

For a long time prior to our entry into the World War, very little attention had been given by our government to the development of animal-drawn transport and the proper equipment of our army therewith. In fact, except for the efforts of a few individuals, there had been little improvement since the Civil War. To say that we were unprepared in this important particular is only to repeat what has been said, and is so well known, of all our machinery of war. The people through their representatives had provided no money for either development or personnel. Our vehicles were obsolete. Yet we needed vehicles. There was neither time nor skilled personnel to improve and bring them up to the present requirements, or make

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them more efficient. There was no time to study the relation of pay load to dead weight of vehicle and other important questions. There was no time to design, draft and build more suitable vehicles. There was no time to test out the improvements suggested by army officers or patriotic manufacturers. There was no time to study the relation between the loaded vehicle and the tractive power of the animal. Vehicles must be had in undreamed of numbers Everyone was busy, and prodding jaded brains and nerves to do more and still more. The forces "over there" with mountains to move from seaport to battle area, with grim determination moved supplies with whatever equipment they had, from where they were to where they were wanted. *Time* was indeed "the essence of the contract," and none of that precious "essence" could be used for deliberative study of the problems of horse-drawn vehicles. We used what vehicles we had. We won. It is hoped that a kindly recording angel omitted most of our remarks on the lines of communication, and gave us full credit for delivering the goods. May no inquisitive official ever investigate further the wrecks by the roadside, nor attempt to compute the cost in animals and other wastage. It would be useless, for we started at scratch and we crossed the tape a jump ahead, and ultimate success covers as with a blanket a multitude of sins. Had we given as much advance attention to these problems as the Germans, it would not have been so long a race. Give the American inventor a little time, a little money, and back him up with the engineering skill and plant facilities, and his transportation, as well as other war machinery, will have to be copied by any nation that goes to war with us.

One of the most brilliant of our regular army officers, being faced with the necessity of producing tool wagons for a certain number of divisions in a much shorter time than he should properly have taken for design alone, and with nothing to start from save an utterly obsolete model used for another purpose, in another war performed his task with the assistance of a civilian engineer in government employ, in about 5 days. He used an ordnance wheel and a searchlight frame, and concentrated on evolving a compartment body that would hold the tools as specified in the equipment tables. Was it satisfactory? No. Neither would it have been satisfactory to have taken the time for design, drafting, construction of model, testing, specifying, awarding contract, mobilizing material and building. The Kaiser would have been at Brest to prevent his landing with his carefully designed and efficient vehicle. The above is only an instance, but it is typical of America's neglect of all items of preparation for war. It is obvious that this is not the way to equip an army with transportation. Officers in the field will have plenty of handicaps to overcome, even when they are given carefully designed and well balanced vehicles suitable for bringing up their supplies and doing their other work.

It is not enough to have a vehicle that never breaks down. It is easy enough, but it is crude designing, to construct a wagon that cannot be broken, no matter what the loads piled on it or the roads traversed. It is also easy to go to the other extreme and construct your wagon too light, so that it fails shortly under normal load, and lies down utterly under the overload which an emergency will put on it. To overlook in design the factor of effect on animal tractive effort, or the important relation of dead weight to "pay load," is to produce an inefficient vehicle, and a rapidly growing "boneyard." Dead animals and broken-down vehicles are wastage that can be greatly reduced by intelligent design. Animals are like battleships, in that you have so many when you go to war, and every loss is a net decrease. Wars seldom last long enough to grow an animal to working age. Your vehicle and your road may be modified or improved to double and treble his transport capacity, but when you have overloaded and killed him your "horsepower" is decreased by so much for that war. There is no replacement available.

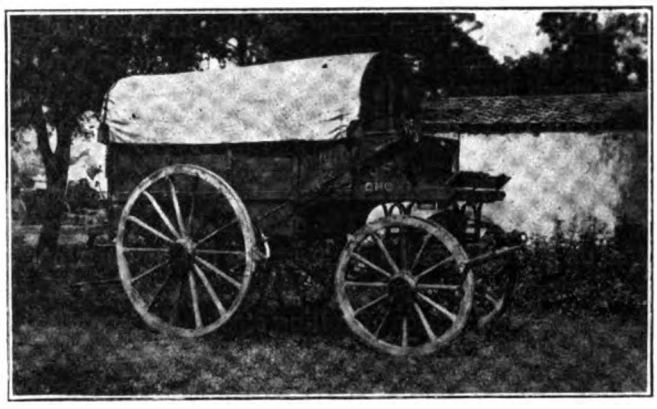
The spectre of broken-down wagons stands at the elbow of every designer of army vehicles, and he is surrounded by unknown factors which (in our country) he has not had time to investigate or funds to test. If he lacks experience as to the effect of road shock and vibration at various speeds, he increases the weight to offset uncertainty. It is easy to gain strength by weight. It is difficult and requires skill to decrease weight and still retain strength. Does a part break, weight is added. Does it need standardization, weight is added to utilize parts of other vehicles. The ideal is minimum weight with maximum strength. To gain it or come near it, it is necessary to have experience both as an army officer and a designer of vehicles. The designer must know the needs—how an army moves and fights and of what and how its vehicles should be constructed. It will make a vital difference whether we are at war with a first or a third-class power; whether we are moving over the paved chaussées of France or the undeveloped trails of Mexico. A wagon must be and can be had and used that will be suitable for both extremes.

Animal-drawn transportation for an army can be divided into three classes of vehicles, the stiff-reach wagon, the limbered wagon, and the two-wheeled cart. The first type was used largely by all armies in the field. It varied much in design, weight, construction and cubic and load capacity, but its function, that of hauling general supplies, was the same. Much might be written on the comparative established efficiencies of the French, British, German and American types.

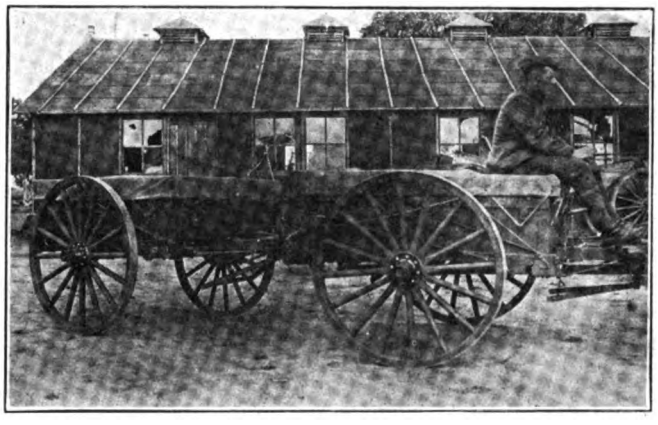
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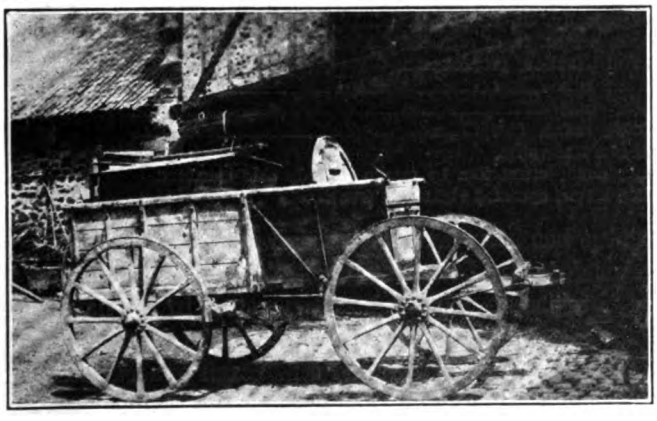
British general service wagon



French Fourgon—general service wagon



Proposed American general service limbered wagon



German general service wagon



British general service limbered wagon

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The American army used them all, but seldom if ever did the same regiment or unit have occasion to compare their respective merits. A discussion of the different models by regimental and company officers who actually had foreign-made vehicles in their trains, would be valuable and illuminating. Our own type of stiff-reach, known as the "escort wagon," is a familiar sight to every officer and man who served in the army. Undoubtedly, it has faults of design and construction which could and should be eliminated before it is called into service for another heroic campaign, but its strength and sturdiness can not be questioned, and it is generally spoken of by officers and men as the one satisfactory piece of rolling stock. The number of its friends fall only a few short of our total personnel. Those who say that it is too heavy and cumbersome, with too large a turning radius, admit at the same time that it came through every time with its load or overload. Its faults weigh more heavily on the animals than on the men, and the general opinion concerning it was that well enough should be let alone. An attempt was made during the war to transform this wagon into a full cut-under type similar to the French Fourgon. The designer, evidently having in mind the disturbance of standardization as little as possible, used as many of the original parts of the escort wagon as he could. The new type was not generally used and it has yet to prove itself. One serious objection to it is the raising of the center of gravity.

Next to the American "escort" the most generally satisfactory wagon was the British general service wagon. This wagon in design and construction is more nearly like the light farm and lumber wagons used in the United States than it is like the escort wagon, which latter has been developed for purely military purposes.

Its essential specifications are as follows:

Wheel-base	6′	10″
Over-all length	11′	10″
Height of wheels (front)	3′	7″
(rear)	4′	7″
Weight, lbs.		1800
Load distribution, proportionate—		
Front axle		35
Rear axle		65
Capacity, cu. ft.		41
Weight, per cubic foot of capacity, lbs.		44
Turning radius, ft.		30

Bed, removable.
Reach, extension.
Brake, operated by screw in rear and lever at right front.

The French Fourgon or general service wagon had undoubtedly received the close and careful attention of competent designers. Such of them as were used in the American Forces did not meet with universal favor, notwithstanding a full cutunder, but the sturdiness and capacity were generally admitted. This wagon has a canvas cover mounted on bows without extension to cover driver's seat. It is the only general service wagon mounted on springs.

Its essential specifications are as follows:

Wheel-base	6′	10″
Over-all length	18′	2″
Height of wheels (front)	3′	5″
(rear)	5′	2″
Height, ground to box bottom	3′	4″
Weight, lbs.		1960
Load capacity, cu. ft.		52.5
Weight, per cu. ft. of capacity, lbs.		37.2
Load distribution, proportionate—		
Front axle		0
Rear axle		100

Turning radius, own length.
Bed, non-removable.
Reach, none; connection by means of body side members.
Brake, screw; operated right side front.

The German general service wagon differs materially from either our own or our allies, but it would be more nearly comparable to the French than to the British or the American. It has quite evidently received careful and thoughtful attention from the designer, and from experienced officers. I believe an attempt has been made to standardize on the same type in several sizes, but this is not certain. It was of such design that use could also be made of it for peace-time purposes, and it is understood that each German farmer who provided himself with one of these wagons received from the government a subsidy in the form of a discount on the purchase price, which is characteristic of German thoroughness in "preparedness." Great attention had been paid to standardization in design, but in construction it was quite evident that much more hand work had been done than is customary in other countries. It is much the lightest in total weight and also in weight per cubic foot of capacity of all the general service wagons.

The essential specifications are as follows:

Wheel-base	6′	9″
Over-all length	12′	1″
Height of wheels (front)	4′	0″
(rear)	4′	0″
Height, ground to box bottom	2′	7″
Weight, lbs.		1210
Load capacity, cu. ft.		46.6
Weight, per cu. ft. of capacity, lbs.		26
Load distribution, proportionate—		
Front axle		23
Rear axle		77
Turning radus, feet		25

Bed, non-removable.
Reach, none; connection by means of body side members.
Brake, screw, operated right side front.

There has been much discussion regarding the relative usefulness of limbered and stiff reach wagons for army purposes. The limbered wagon is in the nature of special equipment. It can be dispensed with, but we cannot do away with the stiff reach general service wagon while animals are used in the tram. Anything that can be handled in a wagon can be transported in such a type as the escort, but undoubtedly there would be a great lack of efficiency. It would be like assigning one size of gun to all artillery.

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There are engineer officers who made brilliant records in the hardest campaigns, who are of the opinion that the escort is a good enough engineer tool wagon, and others who believe it would easily take the place of the ammunition or combat wagon. Are they right? I believe not, and the great weight of opinion is against them. It is generally true that to do a special task most efficiently, you must have a special tool therefor. The task may be done with a general purpose tool, but it can be done quicker, better and with immensely more satisfaction to one's self and one's superiors with the proper tool designed for that particular work. On the other hand there is, of course, danger in having too much "special" equipment or too many different types.

The limbered wagon has one great advantage over any other. On extremely bad roads or if there are no roads, it can be instantly divided. Dividing the load is equivalent to doubling the horsepower. Its turning radius is so short that nothing exceeds it but a cart, and a properly designed and constructed limbered wagon can be put into service as two carts in less than three minutes. It is practically impossible to upset it, as it is swiveled in the middle. Limber and caisson may stand at sharply opposing angles without strain. An ordinary road ditch must be bridged or filled in before you may turn from the road to bivouac in the field with an escort, but the limbered wagon follows easily over the roughest terrain which the animals can negotiate.

The most successful, and practically the only successful, limbered wagon used in the Great War was the British type. Its lightness, its capacity and its mobility made it an immediate and strong favorite with many American officers who served with or near British troops. Some able officers believe that we should adopt it *in toto*. Probably it would be better to naturalize it first; that is, to adapt it to American uses and methods of manufacture. This wagon can be instantly divided, but it cannot be put into service as two carts. There is no way of loading the limber and caisson with different supplies, dividing the four-line team and sending them to serve different platoons. One may not retain the limber with its ammunition or tools, and send the caisson back for subsistence forage or more tools. One of the greatest advantages of this design is its low center of gravity, making it almost impossible to upset the two parts and causing them to ride steadily with the least possible sway. This feature is obtained by the use of a cranked axle, of a very costly and complicated design. The axle alone would cost as much to manufacture as the balance of the cart. The slight lowering of the center of gravity and the consequent steadying effect would not compensate for the cost and delay in procurement in quantities in times of emergency. The unit as a whole is also too light to stand the almost universal practice of overloading in the American army.

A limbered wagon so designed that it may be instantly put into service as carts; with open bodies, both limber and caisson being identical units, will probably come nearest to meeting requirements. It will embody the lessons learned in recent experiences, and will be capable of such a variety of uses that it should find a place in the wagon train in almost as great numbers as the escort wagon. It will be suitable for engineer tools, for small arms ammunition, and for other general and special uses. By substituting a tank for the body it would serve as a water cart. It should be light enough to be handled over the worst roads, and heavy enough to carry a conservative load for the animals. It should undoubtedly be postilion driven, using artillery harness instead of reins as shown in the illustration.

A comparison of steam and electric motive power.—Mr. A. H. Armstrong, of the General Electric Co., recently delivered an address with the above title before the Schenectady section of the American Institute of Electrical Engineers, from which the following is taken:

During the winter of 1917-18 our railways fell down badly when the need was the greatest in their history. It is true that the cold weather conditions were unprecedented and the volume of traffic abnormal, but the weakness of steam engine haulage was disclosed in a startling manner.

In marked contrast to adjoining steam-engine divisions, the 440 miles of electrified section of the Chicago, Milwaukee and St. Paul R. R. continued to do business as usual throughout the trying winter of 1917-18. Freight and passenger trains were brought over the electrified tracks on schedule time or better; in fact, it was quite customary to make up on the 440-mile electric run fully two hours of the time lost by passenger trains on adjoining steam engine divisions.

The author, in discussing other advantages of electrification, points out that a large reduction in non-revenue producing ton mileage would be made by eliminating locomotive tenders and locomotive coal, and also in the reduction of railway coal, by reason of the great savings that could be made in burning fuel in large modern power stations under the most efficient conditions possible, rather than under the boilers of 63,000 locomotives now in service throughout the country.

Without considering water power as a means for generating electricity, he estimates that the electrification of our railroads would in 1918 have saved more than two-thirds of the fuel consumed by the railroads that year.—*Eng. & Cont.*

Progress of the National Guard.—During April the National Guard of the U. S. a little more than held its own. Forty-three additional units (companies) were extended Federal recognition, and there was a gain of 2,666 in enlisted strength. The total authorized enlisted strength of the Guard is 178,920, and its actual strength May 1 was 45,272, or a little over 25 per cent. The individual states show great variation, from 2 per cent in Pennsylvania to 69 in Maine.—*War Dept. News Bureau.*

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The Military Engineer

Dedicated to the National Defense

Maj. P. S. Bond
Corps of Engineers; M. Am. Soc. C. E.
Managing Editor

Maj. H. R. Richards
Engineers
Business Manager

Col. G. A. Youngberg
Engineers
Consulting Editor

VOL. XII JULY-AUGUST, 1920 NO. 64

Formal organization of Society completed

THE temporary Board of Directors of the Society of American Military Engineers consisting of nine Engineer officers, which was appointed on November 1, 1919, to effect the preliminary organization, decided to fill the vacancies on the Temporary Board in accordance with Art. II, Par. 1 of the By-Laws, and accordingly called a meeting for June 2, 1920, which a number of representative members of the Society resident in the east were invited to attend.

At this meeting, the temporary organization was perfected, and, due to the lateness of the season, and to the fact that it requires at least 60 days to call a meeting of the Society, it was decided, upon motion by Colonel F. A. Molitor, to continue to function until after the first annual meeting, which is scheduled for the Friday preceding the third Wednesday in January.

The following officers and directors of the Society were elected and committees appointed; all to serve until the 1st Annual Meeting. The names are a sufficient indication of the calibre of the men who are directing the affairs of our Society.

Maj. Gen. William M. Black, *President*
Col. William Barclay Parsons, *1st Vice-President*
Col. Charles Keller, *2nd Vice-President*
Capt. D. L. Weart, *Secretary*
Maj. William O. Tufts, *Treasurer*

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Col. F. V. Abbot	Lieut. Col. Glenn Smith
Col. F. A. Molitor	Lieut. Col. Evarts Tracy
Col. George D. Snyder	Lieut. Col. G. A. Youngberg
Lieut. Col. C. H. Birdseye	Maj. Percy E. Barbour
Lieut. Col. A. H. Brooks	Maj. P. S. Bond
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Lieut. Col. H. S. Graves	Maj. Max C Tyler
Lieut. Col. W. W. Kirby	Maj. William O. Tufts
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EXECUTIVE COMMITTEE

Maj. Gen. William M. Black	Lieut. Col. A. H. Brooks
Col. William Barclay Parsons	Lieut. Col. H. S. Graves
Col. Charles Keller	Maj. William O. Tufts
Col. F. A. Molitor	Capt. D. L. Weart

COMMITTEE ON DEVELOPMENT

Maj. P. S. Bond, *Chairman*	Lieut. Col. J. H. Finney
Col. F. A. Molitor	Maj. Percy E. Barbour
Col. George D. Snyder	

COMMITTEE ON DESIGN OF EMBLEM

Lieut. Col. G. A. Youngberg	Lieut. Col. Evarts Tracy

COMMITTEE ON MEMBERSHIP

Lieut. Col. G. A. Youngberg	Maj. William J. Shea
Maj. Edwin H. Marks	Capt. Thomas H. Messer.

Let us get together

IT is a most natural human trait to distrust, or perhaps we should say to lack confidence in people and things we do not know. We are apt to mistrust the most honest man, if he is a stranger to us, and on the other hand, to have a considerable amount of confidence in one with whom we are well acquainted, even while knowing that he is more or less of a knave.

One cannot learn to play a game by reading the rules, nor to practice a trade by studying text-books. If one wishes to become a blacksmith, for example, he must go in amongst the blacksmiths. He might read all that was ever written on the subject of horseshoeing, yet he would have an awkward time of it on the first occasion when he attempted to shoe a mule. All trades and professions have developed efficient working methods which can be learned only by association with the trade. On the other hand, the professional man or artisan who never "rubs against" men of other trades becomes so narrow and one-sided in his development that he does not attain high proficiency even in his own calling.

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These facts, which we think none will deny, have their application to the principal function of the Society of American Military Engineers, and this journal, which is the promotion of the practical efficiency of the engineering profession in the service of the nation in time of war.

The engineer in civil life can learn the practical side of military engineering only by contact and association with those engineers, both civil and military, who have learned the game by actual practice in war or peace. And the engineer in the regular service can avoid the narrow development, which so greatly restricts his usefulness, only by contact with engineers in civil life. Mutual confidence and efficient coöperation are possible only if we are all well acquainted. Therefore let us make an effort, a continuous effort, to "get together."

It was this "get together" idea that gave birth to our Society, and the next logical step was the formation of local posts in the larger communities. This was undertaken during the month of June in most of the important cities of the U. S., and everywhere the response was most enthusiastic. These posts will furnish the medium for personal contact and association between our members, without which our Society cannot be a virile, living organization. You will want to meet your fellow patriots—they are the best of good fellows—and so you should join the local post, if there is one in your locality.

THE MILITARY ENGINEER is a professional journal. And the usefulness of a professional journal lies in the fact that it brings the members of the profession in contact with the ideas, aims and experiences of a larger number of their professional brethren than is possible by personal acquaintance alone. Our columns include contributions from both military and civilian engineers.

When the next war is upon us, and it will surely come, the American engineering profession must work together with a friendliness, a mutual confidence and a practical knowledge of the game, which will achieve even greater results than we attained in the late conflict.

To insure such efficient service is the purpose of the Engineer Officers' Reserve Corps, the Society of American Military Engineers, its local posts, and its journal, THE MILITARY ENGINEER. But to these should be added the continuous personal effort of every member of the profession, both in and out of the regular service. The record of the profession in the late war is second to none. But we must not rest on our laurels. That record should be regarded as merely the point of departure for still better service in the future.

1st Division to erect memorial

THE following letter, which we are glad to present to our readers, has been received from the commanding general of the First Division:

The First Division will erect a monument in Washington or Arlington in memory of the 209 officers and 4,690 soldiers who were killed or died of wounds on the battlefields of France. We feel that the officers of the army would like to help us in honoring the sacrifices of the brave men who made the success of our arms possible and in preserving to our country, the inspiration of their spirit and their example.

The First Division endeavored to uphold before the world the standards of the Regular Army. You know its story. If it has earned your sympathy and approval, will you not join in this worthy task? Twenty dollars will make it possible to place one name in perpetual memory.

Should you be unable to contribute at once, will you not subscribe to a series of payments? If you have already contributed, please disregard this appeal.

It is requested that all contributions and subscriptions be sent to Major General C. P. Summerall, Camp Zachary Taylor, Ky.

C. P. SUMMERALL,
Major General, U. S. Army.

Emblem of the Society of American Military Engineers

FROM the earliest times and in all parts of the world it has been the custom for individuals and organizations to display distinguishing symbols. Ancient literature—both secular and sacred—describes the devices worn on the shields of heroes and antique sculptures and ceramics depict these badges of identification. In the Old World the Egyptian and the Greek, the Phœnician and the Roman, the Chinese and the Hindu, all had their emblems; and when the European first saw America he found the Aztec chiefs with shields and banners bearing their personal devices. Even the Alaskan tribes had their totems.

In the days of chivalry, the design of armorial bearings and coats of arms became a veritable science circumscribed by many meticulous conventions. Though "days of old when knights were bold" have faded into the background of medieval history, the value of the badge has in no sense diminished. The late war demonstrated its value and the idea blossomed forth to an extent never before exceeded from the standpoint of mere numbers. The divisional "shoulder patch," in its various forms, took its place in the military sign manual, and succeeded in a measure to the post of honor not long since occupied by the regimental insignia or the special uniform of various organizations. After much serious consideration certain of these insignia have been authorized by the War Department as part of the peace-time uniform.

Throughout the ages the effort has been to embody in these signs some manifestation of the wearer's individuality, some indication of his qualities of heart and mind. In conformity with this world-old practice, the Society of American Military Engineers has adopted an emblem which seeks to visualize the under-

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lying principles of the organization. Formed in the interests of military preparedness as a rational measure of national defense, the Society has taken the national shield as symbolic of its reason for existence and as a token that the scope of the Society is nation-wide and that it serves no party or clique. On this shield is the figure which has been adopted for the World War medal. Its presence serves to indicate that the Society is an outgrowth of this greatest war of mankind, in which the engineering profession played so important a rôle. This winged being represents primarily the spirit of Victory, and it is an easy step to conceive it as "Liberty Victorious," which, in spite of the victory achieved, has not been lulled into a false sense of security and has not laid aside its armor or its weapons; it stands as the incarnation of Military Preparedness, equipped and ready to fight again,



if need be, that "government by the people may not perish from the earth." At its feet is the cogged wheel — the symbol of mechanical engineering, which has its application in war in a myriad of forms ranging from the production of the bombing plane to the manufacture of shoe-pegs for the footwear of the doughboy. Electrical engineering, too, plays its part and is represented by its characteristic symbol—the thunderbolt of Jove grasped in the talons of the eagle, which has ever been likewise the symbol of independent Americanism.

Beneath and underlying all is a bastioned fort—the strong point in military defense, representing the constructive skill of the civil engineer applied to military purposes. These three great branches of engineering — civil, electrical and mechanical — coupled with a sound knowledge of military history, strategy and tactics, are the fundamentals of military engineering. Though they by no means cover the entire field of military science and though the ranks of the Society are open to all engineers of suitable military qualifications, it is entirely appropriate that these three great divisions of engineering should be represented in the emblem of this Society, and their presence carries no implication of the exclusion of the miner or the metallurgist, the chemist or the physicist or other technicians, for war diverts to its own purposes all the arts of peace, with an intensity far exceeding their usual industrial application. Surrounding all is a laurel wreath indicative of achievement and representative not merely of past successes, but emblematic as well of aspirations and determination for the future.

The device as a whole is believed to be a fitting emblem of the Society and to present in dignified symbolic form a concept of the obligations and the responsibilities which rest upon every loyal American engineer to hold himself at all times efficient and ready to aid in his country's defense.

The Society is indebted to Mr. C. A. Houston of the Bureau of Engraving and Printing of the United States Treasury Department for the development in a well-balanced and artistic form of the ideas which we have attempted to present. Arrangements are under way for the production of this emblem to be worn as a lapel button, as a pin or as a charm, and announcement will be made at a future date as to prices and conditions under which this badge of the Society may be made available to its members.

We must "dig in" and hold our gains

One of our members writes:

A democracy is proof against the lessons of war. It nevers learns. The only way we can hold our gains in military experience is by means of such a Society as you have organized. I trust the censor may be conspicuous by his absence. Nothing can be accomplished if the *status quo* is considered perfect. We must not conceal our mistakes if we are to profit by them. There must be no camouflage. Good men learn more from their failures than from the successes.

Capitalize your "callings-down"—build on your "bawlings-out."—The resourceful man will turn any circumstance, however discouraging it may appear, to advantage. Such a man, in applying for membership in our Society, writes as below. We need more such men, and we recommend his methods to the attention of all. His desire to join us is further convincing proof of his initiative and resource.

I owe a large measure of my present success to a "balling out" administered by a Colonel of Engineers, while I was serving on the border in 1917. That deserved rebuke has resulted in an increase of 1,000 per cent in my income, and the further satisfaction that results from successful effort. I feel kindly towards the Engineers. Please send me information concerning the Society.

General officers serving in the World War.—During the World War there were 489 general officers, i. e., generals, lieutenant generals, major generals, and brigadier generals, who served in the American Army. Pennsylvania furnished the largest number, 51, with New York a close second with 46, 31 joined from the state of Ohio, 29 from Illinois, 25 from Missouri, 21 from Michigan, and 20 from Massachusetts. Colorado and Delaware furnished one each, while there were none from Nevada, Montana, Idaho and Wyoming.

The average age of the general officers was 49 years. 52 were born in New York, 45 in Pennsysvania, 35 in Illinois, and 29 in Ohio; the remainder being natives of the other states except 7, who were foreign born.

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Congress Investigates Army Construction

By

H. A. Finch

Colonel, Engineers

BUILDING contractors and engineers generally throughout our country's civil and military circles, who are concerned with construction work will find very interesting, if curious, reading in the government document listed as No. 190 on the House calendar (Report No. 816, H. of R.). The document includes the majority and minority reports of the House Investigating Committee on the cost and construction methods of our army cantonments erected to meet the needs of the war.

As the document itself is rather long, containing some 175 pages devoted to a compilation of the voluble testimony of many witnesses, as well as the widely divergent conclusions of the two factions of the Committee itself, this digest may save the busy man some valuable time. The subject is of such importance to the engineering profession and to the country generally that every citizen should know of it.

At the outset it may be said that the report suffers from the handicap that afflicts nearly all such Congressional documents in that the conclusion of both the majority and minority sections are too highly flavored with politics to serve as a reliable guide in the formation of an opinion on the real merits of the question investigated. In the matter of the cost of the cantonments the majority report brands the entire proceedings, as was done also in the investigation of the Air Service program, as, "a riot of waste and extravagance," whereas the minority in both of these instances, as in many others, refers to the criticized operations as a record of brilliant achievement. One side is strongly anti-administration and the other is as decidedly pro.

Such complete divergence of opinion hurts confidence in the practical usefulness of Congressional investigations, for the unbiased reader has only the two extreme statements as guides for his conclusions. As he is left to choose between recommendations, either for a prison sentence or for a Distinguished Service Medal for the government agents involved, the distracted seeker after exact truth may as well omit reading the report altogether—and it appears that this is what most of them do! This decision is all the more reasonable when it is remembered that neither side publishes any of the evidence except that which appears to support its own findings. Non-partisanship in a partisan political body is of course difficult to attain, and there are some pessimists who will insist that the reader of a Congressional Committee Report gets no better than he deserves, that is to say, he gets only what he goes after, which is evidence to sustain his own preconceived opinions, and that he discards everything contrary thereto. He accepts as gospel truth one or the other of the antipodal versions presented, and that is the end of the matter so far as that particular individual is concerned. This theory certainly has some support in the fact that nothing ever happens after such a report is published. So much for the most pessimistic view of this matter. But there are in existence unbiased men who want unbiased information. Let them seek it in what follows, and good luck to them.

The majority report charges that in the construction of the 32 camps and cantonments erected for our troops, a civilian sub-committee of the Emergency Construction Committee, headed by an architect from New York City, arrogated to themselves the powers legally vested in the army officer nominally in charge of the Construction Division of the War Department, and that this group of civilians, some of whom were interested parties in the proposed construction work, were guilty of the actions set forth below:

(*a*) That they wilfully ignored the provisions of law which required that detailed estimates be furnished for the work to be done.

(*b*) That they far exceeded their powers granted under the Act creating the Council of National Defense, by doing away with the necessity for advertising for bids, and by letting contracts illegally and arbitrarily.

(*c*) That the sub-committee secured the adoption of the cost-plus percentage form of contract, an indefensible proceeding even after considering the emergency conditions, which resulted in the waste of millions of dollars of government money. To be exact, the waste charged amounts to an average of $5,000,000 on each of the 16 National Army cantonments built, or between 40 per cent and 60 per cent of the amount of the individual contracts.

(*d*) That even after adopting the cost-plus form of contract, the sub-committee failed to provide adequate safeguards for the interests of the United States. Two safeguards were incorporated in the contract: (1) Supervision of the contractor's audits and accounts by the army quartermaster, and (2) a limitation of the total fee for the contractor to the sum of $250,000 (6 per cent on $4,166,000), but these are branded as being entirely inadequate, too easily evaded, and, in the case of (2), largely inoperative because the maximum was not reached in 315 out of 500 emergency contracts.

(*e*) That an excessive scale of rentals for contractor's equipment was authorized; that the selection and rejection of contractors indicated favoritism; and that even after reputable contractors had offered to do the work in some cases for as low as "cost plus 3 and one half per cent," the scale of remuneration was fixed at "cost plus 6 per cent" and upward.

(*f*) That the cost-plus form of contract had a ruinous effect upon labor in that it encouraged the men to loaf and malinger "on the job," and that this led to delay in the completion of the cantonments instead of expediting their

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construction as has so often been urged in justification of the adoption of this form of contract.

In brief, the indictment framed in the majority report charges that the War Department, through its agents, was responsible for inefficient methods, scandalous waste, outrageous delay in obtaining results, collusion between government representatives and interested contractors—in fact, about every form of culpability possible in the contracting game, short of "sticking up" the Treasury itself from behind a mask and a Colt automatic!

Turning to the minority report we find the other side of the picture is presented. Here we are advised:

(*a*) That there can be no doubt from the testimony that the unanimous indorsement of the cost-plus contract and its subsequent approval by the Secretary of War, was in harmony with the judgment of the leading builders, architects and civil engineers of the country.

(*b*) That the cost-plus system was not only justifiable, but inevitable and unavoidable, since no reputable contractor could be expected to run the risk of financial ruin, even for the sake of patriotic service, by bidding on construction work involving not only buildings but also the installation of light, water and sewerage systems—all of this without a careful preliminary examination which lack of time did not permit, and also with the certain knowledge that the operation of the draft law would upset labor conditions to such an extent that no accurate estimate could possibly be made as to his pay-roll.

(*c*) That the framers of the cost-plus contract recognized the opportunities that would exist for waste of materials and for loafing by laborers, and employed every safeguard to protect the Government's interests in these respects. They proceeded on the theory that it was far better to waste lumber and nails than to waste American lives in France.

(*d*) That there is no testimony in the record that any contractor participated in the recommendations as to the assignments of contracts.

(*e*) That there was of course a certain amount of loafing going on, among the laborers employed on the different projects, but there is not a shred of evidence that proves, or tends to prove, that the contractors encouraged loafing. The testimony is quite to the contrary.

(*f*) That there was petty grafting on these great building projects is undoubtedly true, but the charge that the contractors for the 16 cantonments deliberately sought to increase the cost of the work in order to swell their fees is not supported by the record. On all of the 16 original projects the cost of the work was more than twice $4,166,000, the limit upon which the contractor could earn his percentage, and since all parties in the beginning recognized that the cost would far exceed the maximum figure of $4,166,000, there was no incentive for the contractor to increase the cost since his maximum fee was assured at the outset. [It might perhaps be added that there was also, apparently, no incentive for him to *decrease* it, except pure patriotism.—ED.]

It is for the reader to decide who has it—the yeas or the nays. As reflection is given to the matter it is believed that it will become clearer that neither report hits the nail squarely on the head. The truth appears to be that our cantonments were built by "profiteers"; that is, by the American people generally. This applies both to the contractor and to the laborer, for while it is not established that any actual large scale graft was put through by the contractors, there was certainly no concerted systematic effort made by them to prevent loafing and "shooting craps" on government time. The spirit was not right; the motto, "Service, not Profit," may have animated many of the head men of the contracting firms, but they did not see to it that this word went down the line to their foremen, time-keepers and laborers.

Perhaps the demoralizing effect of the cost-plus system upon the laborer was too pronounced to be controlled effectively, but the contractors might at least have tried to exercise control—and there is little evidence to show that they did this. For the subordinates themselves—the laborers and their foremen—there is even less to be said of credit. They were frankly out "to get while the getting was good," without any thought for the welfare of their country at war. For every case cited of a superintendent's urging his men to "take it easy and drag out the job," there are also a dozen instances testified of the laborers' passing around the word that the thing to do was "to keep an eye out for the boss and pretend to be busy when he is around." The workers in many cases came to the camps expecting to do a fair day's work for a fair daily wage, but found that this was not required. The spirit was not right; the thousands employed made strict supervision impracticable, and the men did not hesitate to take advantage of the situation. This condition was undoubtedly encouraged by the form of contract, and the result was that too great a percentage of the workers soon learned to loaf, to malinger, to lay off on week days and to demand the higher-paid work on Sundays.

Of course patriotism should have prevented this, but the fact remains that it did not, hence the conclusion that the cantonments were built by "profiteers"—which classification may be not unjustly extended to include the loafing laborer, the tricky time-keeper as well as the too complaisant contractor.

However, when we come down to the general conclusions to be drawn, can we say that the construction of those cantonments stands in a class by itself? Is not the majority report, insofar as it is correct, in fact an indictment of the American people? Are we not in our country to-day witnessing "hold-ups" that aggregate monthly in unjust profits far more than the $80,000,000 alleged to have been wasted on all 16 of these projects during a period of over one year? It is a regrettable thing to be compelled to say, but it does seem that profiteering is a business not limited to a small and greedy class. "Everybody's doin' it now" that can—certainly those who are not are in the great minority. Only the other day the writer heard a friend damning the profiteers, and in the next breath bewailing the fact that he had been "stuck" by renting out a house of his just before the war for $50.00 a month on a lease that stood in the way of his getting the $150.00 per month that the house would now bring.

In the *Congressional Record* for May 18th it is shown in a speech by Senator Walsh of Massachusetts that in the four great classes of products which affect the life of the average American citizen, fuel, food, clothing, and steel, in hundreds of cases corporation annual profits for the past three years have ranged from 100 per cent to 300 per cent, and that in thousands of instances these annual profits have exceeded 50 per cent—and this largely on well-watered stock holdings! According to Mr. Basil M. Manly, at one time with the War Labor Board, "In the last three years the American people have paid in net profits every dollar's worth of stock of the coal companies and all corporations in the essential lines of industry and trade," which, as further explained by Mr. Manly means that, "If the national Government at the beginning of the war had taken over the essential lines of industry, and the American people had

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been required to pay the prices which private manufacturers and merchants have charged them, there would have been sufficient profit to pay for every dollar's worth of capital stock, and leave the nation to-day in possession and control of practically all its manufacturing plants."

It is safe to say that the recipients of these swollen dividends do not consider themselves profiteers at all, but only as persons gifted with remarkably far-sighted judgment in placing their investments. It may be that this vexed question is so closely intermingled with the fundamental impulses of human nature—not to mention the operation of that grand old law of supply and demand—that it would be literally impossible to separate the sheep from the goats. Just at present there is no doubt as to the identity of the "lambs," but if the sheep represent those of us who are morally incapable of stooping to benefit by the opportunity of obtaining high prices for our products, it is feared that the vast majority of us Americans are covered with hair instead of wool.

Before recommending that active profiteers be hanged without benefit of clergy, it might be well for the remainder of us—would-be profiteers—to search our souls on this question. In that case it is likely that we who are in no position to profit by high prices will rest content with saying that if such opportunity should present itself, we beg leave, as did the boy when faced with the problem of whether or not he would return a lost twenty-dollar bill to the owner, to await the event before announcing the course of action we should follow.

It has often been said that the great mistakes the administration made was in failing to draft laborers as it did soldiers, paying them as the soldiers were paid and granting like allowances to their families. The only reasonable explanation for this failure that has so far come to the writer's notice is that our government realized that the war must be won, and could not afford to bring about internal dissension in the face of this imperative need. As we look back on those days we believe that it *could* have been done without undue friction, but at that time we did not have the whole-hearted response to the draft law to act as an incentive to the necessary legislation. We were not so sure of our ground as we now are.

Our country is a great one, but as the *Brooklyn Eagle* has it, "A civilization that has advanced from head-hunting to rent-gouging and profiteering has still *some* distance to travel."

[*Note.*—Colonel Finch's review of the "findings" of the committee of Congress with reference to the efficiency of army construction gives the impression that the report makes upon an unprejudiced observer, and will be of great interest to all our readers.

As the jury has so positively failed to agree, we refrain from delivering a verdict in the case. Morcover, the guilt or innocence of the individuals in responsible charge of army construction in the United States is not the chief issue raised by this investigation. The matter goes farther and deeper than that. Colonel Finch asks if the majority finding is not an indictment of the American people. It is.

Where there is so much smoke there must, of course, be some fire. This report, following the similar one concerning aircraft production, and preceding a "washing of dirty linen" in the Navy Department, is further convincing and painful evidence of how our utter unpreparedness for war pervaded every phase of our activities. Such investigations are the characteristic aftermath of such lack of adequate preparation. It is hoped that the significance of all this may not be lost upon the American people. Probably a vain hope. The very bitterness of this report proves that we are not a united people even in defense.

We were unprepared as to the training of our men and the effective utilization of our material resources. But at the bottom of all this is the basic fact that we were unprepared spiritually. The nation was not *morally organized* for defense—as this report too plainly shows. Of little use for a President to proclaim that to our cause we pledge our lives, our fortunes and our sacred honor, unless that noble sentiment resounds in the heart of every citizen of the Republic.

As a nation we are certainly hysterically and temporarily susceptible to patriotic influences, as we are to all other less holy emotions. But patriotism, like other beautiful flowers, does not thrive and endure in the wild. It must be assiduously cultivated to attain its highest perfection and beauty. What we need in this country is less emotional, and more practical patriotism. The American people have really had too little training in practical patriotism, so it is perhaps not remarkable that they exhibit certain deficiencies when put to the test. This was revealed in the construction of the cantonments, but that was only one of many revelations.

The only sure basis of an effective national defense is the *moral organization* of the people, the sedulous cultivation of the spirit of patriotism in the heart of every citizen. This strikes at the root of the malady, of which profiteering at the cantonments is merely one of the symptoms. As General Wood has said: "Manhood suffrage implies manhood obligation of service to the country." By suffrage he means the privileges of citizenship in America, and in manhood he includes womanhood.

What do we need to prevent a recurrence of such unfortunate conditions in the future? We need moral organization, a higher appreciation on the part of all our people of their obligations to their country. We need citizens who would cut off their right hands sooner than turn the agony of their country and of mankind to their own sordid profits.

These are high sounding ideals, but can they be practically, effectively and promptly realized? They *can*. Universal training in good citizenship and practical patriotism is the evident means of accomplishing these much to be desired results, and they can be secured in no other way.

And this is the moral of our fable.—ED]

The "cost-plus" system once more

The committees of Congress investigating war expenditures have done one good thing. They have brought before the engineering and contracting professions the inherent difficulties of the cost-plus contract as applied to public work. There has been much propaganda lately favoring this system, largely based on some real advantages it has. This report shows only too clearly that the possibilities of public scandal, the ease with which proper performances can be given improper appearance, far outweigh such real advantages. In normal times, competition, based on financial outlay and assumed risk, must remain the foundation of public contracts.—*Eng. News-Rec.*

Why house-building must increase.—Mr. Wharton Clay, Commissioner, Associated Metal Lath Manufacturers, furnishes the following as to the stability of the building industry. In 1918 only 20,000 new homes were built instead of 20 times that many, as required; 70,000 were completed in 1919, with the increase of population still outstripping the building program. In 1890 there were 110.5 families and to-day there are 121 families for each 100 homes. Estimating 27,900,000 families in 1925, the housing shortage will continue unless building is increased. If but the average are constructed for the next 5 years, 409,500 homes must be built and the congestion will reach 129.6 families for 100 homes.—*Eng. & Cont.*

Adherence of cement to gypsum.—For some months past, the Bureau of Standards has been conducting researches to discover a means for causing gypsum to adhere to concrete, and also a means for causing cement plaster to adhere to gypsum. These researches have been practically completed and the Director reports that the findings may be summarized as follows:

1. There seems to be no detrimental reaction between the two materials; the tensile strength of the mixture of gypsum and cement is very nearly equal to their combined tensile strengths, dependent upon the proportions of the two ingredients used;
2. The suction of the surface to which the plaster is applied is an extremely important factor; for example, if gypsum plaster is applied to a dry concrete surface, the suction of the concrete will take so much water out of the gypsum that it will prevent its proper hardening;
3. The expansion of neat cement, when wet, is of an entirely different order from the expansion of neat gypsum, and a bond between the two materials can be permanently maintained only when enough sand is added to both materials to reduce the expansion for both. The above mentioned research work has been supported by the Gypsum Industries Association, and a report covering it has recently been made to them.

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Freight Traffic and Federal Expenditures on the Great Lakes

By

Edward H. Schulz

Lieutenant Colonel, Corps of Engineers; M. Am. Soc. C. E.

THE table following gives in simple form a general comparison of the tonnage and value of commerce and the relative cost of improvement works of the United States harbors on the Great Lakes. The data have been obtained from the annual reports of the Chief of Engineers. The districts considered are those of Duluth, Milwaukee (including the Grand Rapids sub-district), Chicago, Detroit, Cleveland and Buffalo. The information given is generally for the calendar year 1917, for all districts except Milwaukee which is, in some cases, for 1918. To avoid the introduction of a mass of figures and tables, the comparison is made generally by district, or involves only the more important harbors. A sketch map of the Great Lakes and a table or resume of traffic are printed herein.

Among the Great Lakes harbors under improvement or maintenance by the United States, there are 41 that had in 1917 (1918 for Milwaukee), a total tonnage of over 250,000 tons. Of these there are in the Duluth district, 6; in the Milwaukee district, 8 (not including Gladstone and Escanaba, private harbors); in the Grand Rapids sub-district, 3; in the Chicago district, 3 (not including Gary, a private harbor); in Detroit, 4 (of which three are principally all through-freight, and not including two others, Calcite and Alpena, private harbors); Cleveland, 8; and Buffalo, 7.

Of the Great Lakes harbors of over a million tons total commerce in 1917, Duluth district has 6, viz: Duluth, Superior, Agate Bay, Ashland, Keewenaw Waterway, Marquette Bay and Marquette; Milwaukee, including Grand Rapids sub-district, has 5, viz: Green Bay, Manitowoc, Milwaukee, Ludington and Frankfort, also Escanaba (private); Chicago has 3, viz: Chicago, Calumet and Indiana Harbor, also Gary (private); Detroit has 3, viz: St. Marys Falls, Detroit River, Rogue River, also two private harbors, Alpena and Calcite; Cleveland has 8, viz: Toledo, Sandusky, Huron, Lorain, Cleveland, Fairport, Ashtabula and Conneaut; and Buffalo has 4, viz: Erie, Buffalo, Charlotte and Ogdensburg. The total commerce of these harbors by district and its value for 1917 is as follows: Duluth district, 78,388,025 tons, at a value of $628,563,780; Milwaukee, 16,114,122 tons, at a value of $92,837,224; Chicago, 14,393,599 tons, at $445,117,147; Detroit, 97,695,569 tons, at $1,284,090,190; Cleveland, 75,817,185 tons at $449,912,528; and Buffalo, 27,539,313 tons, at $725,383,170. Of these harbors, in the Duluth district, the principal receipts are hard and soft coal and stone and the principal shipments are iron ore, grain, flour, lumber, and copper. In the Milwaukee district there is no one outstanding item of shipment, but the principal shipments are grain, manufactured goods, lumber, chemicals and leather. The receipts are principally hard and soft coal, lumber and grain. In Chicago the principal receipts are iron ore and coal, and the principal shipment is oil. Detroit's principal traffic is coal, ore, grain, flour, lumber, stone, and copper. In Cleveland the receipts are almost entirely iron ore, sand and stone, and the shipments are practically all of soft coal. The Buffalo district has a predominant receipt of iron ore with a considerable quantity of grain, stone and lumber, while the shipments are mostly of hard and soft coal.

On the Great Lakes there are twelve harbors or traffic ways, having an annual commerce of over five million tons. Of these there are three in the Duluth district; one in the Milwaukee district; one in the Chicago district; four in the Cleveland district; two in the Detroit district; and one in the Buffalo district. They are as follows:

Harbors	*Order of tonnage*	*Harbors*	*Order of value*
Detroit River	95,243,110	Detroit River	$1,269,690,776
St. Marys Falls	89,813,896	St. Marys Falls	1,196,922,183
Duluth-Superior	52,611,824	Buffalo	564,134,005
Buffalo	18,925,179	Duluth-Superior	471,309,736
Ashtabula	15,992,388	Milwaukee	362,564,868
Cleveland	14,282,687	Calumet	225,122,383
Toledo	13,710,238	Cleveland	128,239,054
Conneaut	12,956,398	Ashtabula	87,876,962
Agate Bay	10,773,241	Toledo	80,318,986
Calumet	10,269,304	Conneaut	62,501,557
Ashland	9,580,085	Agate Bay	43,020,032
Milwaukee	7,066,550	Ashland	36,137,511

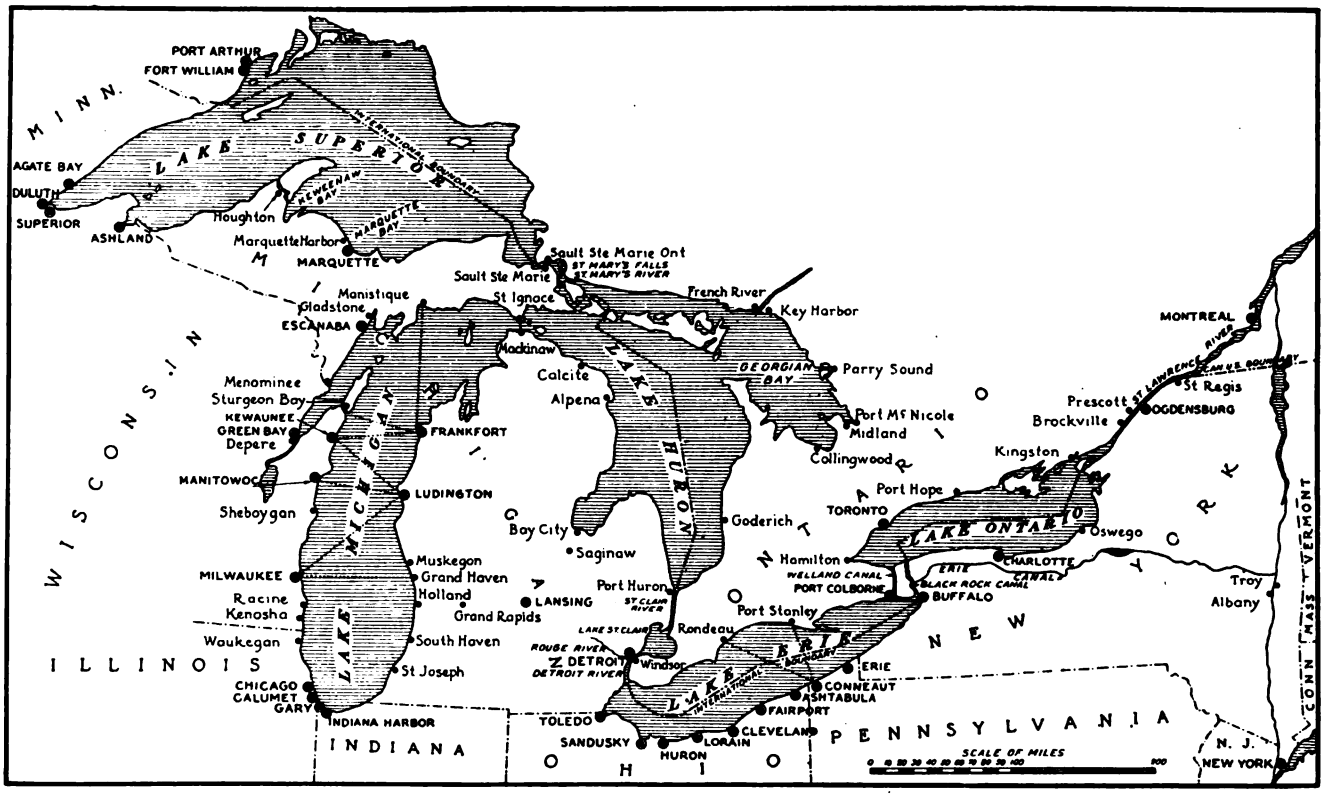
The commerce at Detroit River and St. Marys Falls is practically all through-freight.

The Milwaukee district, including the Grand Rapids sub-district, had a total commerce for the calendar year 1918 of over 18,000,000 tons, valued at over $875,000,000. Of this total, Milwaukee Harbor furnished something over 7,000,000 tons at a valuation of over $362,000,000. In the combined district there is a large translake car-ferry business, amounting to about 45 per cent of the total in tons, and to about 84 per cent in value.

In 1917, the total shipments and receipts in all the districts on the Great Lakes amounted to approximately 310,000,000 tons, and was valued at over four and a quarter billions of dollars. This represents a movement of 155,000,000 tons of freight, or allowing 50 tons to the 50-foot car, an annual movement of 3,100,000 cars of freight. Taking 31 cars to a train, this would amount to 100,000 trains, having an aggregate length of nearly 30,000 miles. The amount of 310,000,000 tons is more than three times the total annual tonnage of Chicago, rail and water combined. The Detroit district had a greater tonnage for that year than any other, having a commerce of approximately 98 million tons valued at over a billion and a quarter dollars. The value of the traffic for 1917 ranges from $44.45 per ton, in the Grand Rapids sub-district, to $5.93 per ton in the Cleveland district.

The accompanying table shows a comparison of the freight tonnage and the cost of harbors on the Great Lakes with percentage of receipts and shipments, value per ton and costs per ton. This tabulation is made by district. The Detroit district is divided into two groups and the Grand Rapids sub-district is shown separately. The cost

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per ton (F) is the average annual cost of Government works per ton of traffic based on the total expenditures for the five years, 1914 to 1918, and the total tonnage for the five years, 1913 to 1917. By reference to the table it is seen that this cost varies from $.0043 per ton for the Duluth district, to $.057 per ton for the Grand Rapids sub-district. The cost per ton (G), based on the investment expense of harbor improvements, is derived from the total tonnage for 1917, and 4 per cent interest on the total expenditures to 1918. This cost varies from $.0066 per ton for the Duluth district to $.0951 per ton for the Grand Rapids sub-district. It will be seen by reference to the table that the average expenditures by district, per ton, under the two methods, (F) and (G), bear a close relationship to each other.

The general conclusion is that the cost of Federal improvement works of the Great Lakes harbors has been well justified by the commerce. This is true not only of the present traffic, but also of the great traffic in lumber, grain, ore and coal of former years, when many of these improvements were begun to foster the very tonnage now grown to such enormous proportions.

NO. OF HARBORS	DISTRICT	TONNAGE IN MILLIONS YEAR 1917	VALUE IN MILLIONS OF DOLLARS YEAR 1917	PER CENT OF FREIGHT	
				RECEIPTS	SHIPMENTS
1-6	GROUP "A"	95,243,119	1,269,590,776	24	76
16	DETROIT (1)				
7-16	GROUP "B"	2,452,450	14,499,414	96	4
10	DULUTH	78,388,025	628,563,780	19	81
10	CLEVELAND	75,817,185	449,912,528	61	39
14	BUFFALO	27,539,313	725,383,170	69	31
8	CHICAGO	14,393,599	445,117,147	93	7
16	MILWAUKEE	12,106,280	514,660,663	78	22
17	GR. RAPIDS	4,007,842	178,176,561	53	47

NO. OF HARBORS	DISTRICT	TOTAL EXPENDITURE IMPROVEMENTS AND MAINTENANCE TO JUNE 30, 1918	TOTAL APPROPRIATION TO JUNE 30, 1918	VALUE PER TON YEAR 1917 R. & S.	VALUE PER TON YEAR 1917		ANNUAL IMPROVEMENT COST PER TON	
					RECEIPTS	SHIPMENTS	F	G
1-6	GROUP "A"	40,569,940	42,024,922	$ 13.33	$ 10.26 ¢	$ 14.19 ¢	.0172	.0173
16	DETROIT (1)							
7-16	GROUP "B"	4,867,492	5,753,279	5.81	5.45	34.83	.049	.053
10	DULUTH	13,027,094	13,658,081	8.02	10.96	6.64	.0043	.0066
10	CLEVELAND	19,574,239	20,152,681	5.93	5.38	6.80	.0068	.0103
14	BUFFALO	20,289,764 (2)	21,607,627	26.34	30.71	16.78	.0157	.0294
8	CHICAGO	10,430,010 (3)	14,925,494	30.91	21.28	90.81	.0279	.0288
16	MILWAUKEE	9,492,208 (4)	16,350,244	42.51	33.64	73.17	.0171	.0313
17	GR. RAPIDS	9,541,620 (5)	10,539,842	44.45	46.44	42.18	.057	.0951

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Retirement of Engineer Officers

Colonel F. V. Abbot

WITH the retirement May 11, 1920, of Col. F. V. Abbot, there is stricken from the active list of the Corps of Engineers, a name which has been distinguished in its annals for nearly three-quarters of a century. The name of Abbot epitomizes the traditions and ideals of the Corps.

Frederic Vaughn Abbot was born in Cambridge, Mass., on March 4, 1858, the son of Gen. Henry L. Abbot, a brilliant and distinguished officer of the Corps, still living at the age of 89 years. He graduated from West Point in 1879 at the head of his class. Among his classmates were Thos. L. Casey, T. A. Bingham, and C. McD. Townsend, all engineers of note. Young Abbot and Casey were the sons of classmates who had graduated Nos. 1 and 2 in their class, and a spirited competition developed between them. Like their fathers, they graduated 1 and 2, but the sons reversed the previously established order.

Colonel Abbot's entire service was in the Corps of Engineers, in which he rose to the rank of Brigadier General during the World War. His first important undertaking, after leaving the Engineer School at Willets Point, was the establishment of the boundary line between Virginia and Maryland. In 1885 he was placed in charge of the harbor development at Charleston, S. C. This consisted of the formation of a deep channel through the harbor bar by means of converging jetties. Colonel Abbot remained on this work for over 12 years, and guided it to a successful completion. His next duty was on the Upper Mississippi at St. Paul, where in connection with the building of a lock he made valuable contributions to the art of concrete construction. Amongst many boards of engineers on which he served may be mentioned one which studied the project for the regulation of the Missouri River and added greatly to our knowledge of river regulation.

In later years Colonel Abbot was in charge of the important engineer districts of New York and Boston, including river, harbor and fortification work. He was for many years assistant to the Chief of Engineers in Washington. During the war he was charged with supervision of the organization of the vast force of 300,000 engineer soldiers, who contributed so powerfully to the victory over Germany. In recognition of the importance of this task he was elevated to the rank of Brigadier General.

In his retirement the Army loses an efficient, industrious and loyal worker, and the younger officers of the Corps of Engineers, in particular, will miss his ever kindly and sympathetic helpfulness and genial companionship.

Colonel W. C. Langfitt

Colonel W. C. Langfitt, Corps of Engineers, whose portrait appears as the frontispiece of this issue, former Major General and Chief Engineer of the A. E. F., was retired from active service on May 31, 1920, on his own request after more than 40 years' service. The Corps has lost one of its biggest men, a man of wide experience and ripe judgment, yet still possessed of the vigor, enthusiasm and resourcefulness of youth.

William Campbell Langfitt was born in Wellsburg, Va. (now W. Va.), August 10, 1860. He graduated from West Point in 1883, No. 2 in his class. All his service has been with the Corps of Engineers, in which he rose through all grades to that of Colonel in 1913. During the late war Colonel Langfitt was Chief Engineer of the American Expeditionary Forces with the rank of Major General.

The most striking feature of Colonel Langfitt's distinguished career was the astonishingly wide range of his activities. He was engaged in a wide variety of engineering duties at Galveston, Cincinnati, Portland (Ore.), Washington, D. C., Savannah, and New York. While in Washington he made the investigations and formulated the great project for water power development at the Great Falls of the Potomac River. He has been a member of many important boards, including the Board of Engineers for Rivers and Harbors.

General Langfitt is, however, first of all a soldier, and his thorough military training and aptitude in military affairs, eminently fitted him for the high position which crowned his military career—Chief Engineer of the greatest army that ever took the field.

He served with the engineer battalion at Willets Point, and graduated from the Engineer School at that place; was Engineer Officer of the Department of Columbia; commanded Co. B, Engineers (old battalion), and was instructor at the Engineer School. During the Spanish War he commanded a battalion of volunteer engineers. He was later instructor and commandant of the Engineer School, the post and Engineer Depot at Washington Barracks, where, as chairman of the Board on Engineer Equipment, he was primarily responsible for the successful development of the engineer organization and equipment so thoroughly tested and proven during the Great War. As Chief Engineer of the Army of Cuban Pacification he carried out the famous "reconnaissance survey" of Cuba, mapping the whole island in less than 8 months. In 1916-17 he was Department Engineer of the Southern Department, at San Antonio, Tex., and in charge of railway operations in connection with the mobilization of the American Forces on the Mexican border. He was relieved from this duty to organize one of the railway engineer regiments demanded by the British Government as America's first contribution to the war. He organized the 13th Engineers (Ry.), and conducted them to France.

Arriving in France thus early in the war, General Langfitt at once entered actively into the engineering preparation for the operations of the Great American Army that was even then streaming across the Atlantic. His first assignment was as Chief of Staff of the Line of Communications (later the S. O. S.). While serving as Commander of all American troops with the British Army and as Director of Light Railways in the A. E. F. he took advantage of the opportunity thus afforded to familiarize himself with British methods of supply and transport. On March 12, 1918, he was appointed to the new office of "Director of Utilities," in control of all transportation, roads, railroads, construction and forestry. This was virtually the position of Chief Engineer, and on July 11 he was so named, and all engineering activities of the A. E. F. were combined under his direct control. The enormous and seemingly impossible engineering projects so successfully carried out by the A. E. F., under General Langfitt's direction, are a sufficient commentary upon the nature of his services to his country in the Great War.

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Colonel F. V. Abbot



Colonel M. J. McDonough

In recognition of these services, he was loaded with honors and decorations by three governments; the Distinguished Service Medal, Commander of the Legion of Honor and Companion of the Order of the Bath.

Returning to the United States at the close of the war, General Langfitt was assigned to duty as District Engineer of the 2nd N. Y. District, and Division Engineer of the Northeastern Division—his last assignment on active duty. He retires from the service to enter business life

Colonel Langfitt's high professional attainments, the force and directness of his character, combined with a genial and tactful disposition, earned for him a host of friends in all branches of the army and in civil life, all of whom will regret the loss of his services to the government.

Colonel M. J. McDonough

In the retirement from active service (for physical disability) on May 11, 1920, of Lt. Col. Michael J. McDonough, the Corps of Engineers and the Army lose one of the most brilliant and popular of the younger officers.

Colonel McDonough was well and very favorably known throughout the Army as a soldier intensely active in all matters affecting the better training and greater efficiency of our military forces, as one of the "shining lights" of the Service Schools at Leavenworth, and an author of recognized authority on tactical subjects.

He was born in Massachusetts, January 27, 1877, graduated from West Point in 1899, and was assigned to the Coast Artillery. In 1902 he transferred to the Corps of Engineers, in which he reached the grade of Lt. Col. in 1920. He served in Cuba, and in the Philippines as Director of the Military Survey of Luzon, as instructor at West Point, and on river and harbor work at Albany and Memphis. He was selected as senior engineer instructor for the experimental Citizens Training Camps at Plattsburgh, the forerunner of the Officers Training Camp for the A. E. F. He was a graduate of the Army Engineer School, and honor graduate of the Service Schools at Leavenworth.

At the outbreak of the war in 1917, Colonel McDonough organized and trained the 114th Engineers, 39th Division, at Camp Beauregard, La. This arduous duty brought on a physical breakdown which prevented his accompanying the division overseas, and ultimately resulted in his retirement from active service.

Use of heavy tractors for hauling elevating graders and wagon trains from steam shovel

The artillery type tractors designed by the War Department for military use were employed last year by the U. S. Reclamation Service in the construction of the Salmon Lake dam and Conconully dam enlargement of the Okanogan Project, Washington.

The tractors are the caterpillar type, known as "10-Ton Artillery Tractor, Model 1917." The weight of the machine, with full equipment, is 21,500 pounds.

One tractor was used for 3 months for pulling a standard elevating grader, operating in a borrow pit of fine sand and silt. This grader was loading 1½ cubic yard dump wagons hauled by 3-up teams to embankment. The other tractors were used for 4 months hauling wagon trains from the steam-shovel borrow pit to the embankment. As the length of the haul was short (1,000 feet), and turning space limited, it was considered essential to have tractor train equipment that could turn in narrow spaces. The tractors can turn completely around within their own length; the wagons used as trailers were of the common cut-under dump-wagon type having a capacity, level full, of 3 cubic yards.

Under usual conditions, the tractors easily handled three of these wagons, but under adverse conditions of wet ground, and on grades they could handle only two.

When clearing the dam site the tractors were found to be excellent stump and brush pullers. A ¾-inch steel cable was used for this work, experience showing that a ⅝-inch steel cable would not hold the machines.

On account of the lack of traction in the loose dry silt and fine sand in the elevating grader pit the use of a wheel-type tractor for pulling that machine would have been impossible, while the artillery tractor did excellent service.

The hauling by teams cost 20.1 cents per cubic yard, while the hauling by the tractors cost 19.5 cents per cubic yard. The conditions of the two hauls did not vary greatly; considering the entire period, the teams had the poorer roads

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and slightly more of adverse grades, but the advantage of 200 feet shorter haul.

Based on the experience of the past season under the conditions existing on this work, it is believed that these tractors, when used for transporting earth, will show greater economy, as compared to hauling with teams, when the length of haul is greater than the average haul of 700 feet and on poor roads and steep grades where teams must be given frequent rest periods. As the length of haul gets shorter and the roads and grades improve the teams will prove cheaper, because they can be kept moving more steadily than the larger tractor units and they can make quicker turns at the end of the trip.

The above has taken no account of the question of maintaining an organization. The operation of the tractor requires the service of an operator and about half time of a repair man, both men of considerable reliability. The tractor, when working, replaced six 3-horse teams requiring the services of six teamsters who were hard to secure and much harder to keep on the job.—*Eng. and Cont.*

Should Coast Defenses be Designed like Battleships?

By

C. O. Sherrill

Colonel, Engineers

IN a recent number of the *Journal of United States Artillery,* Capt. J. K. Christmas, Coast Artillery, in an article entitled "Some principles of Naval Design applied to Coast Defense," presents certain arguments intended to show that, since the natural enemy of the fort is the dreadnaught, the former should be designed on the same principle as the latter. He says, "The principles of armament applied in battleship design suggest their application in a modified form to forts of the Coast Artillery."

It is believed that this hypothesis is fundamentally unsound and reactionary. It is contrary to the lessons of the late war and all the experiences of history.

The chief element of invulnerability of defenses, as plainly shown in the late war, is dispersion of the elements constituting the defense, so far as this is practicable without unfavorably affecting control and co-ordination of the defense. The fire of very large calibre guns, for reasons of economy and the limitations thus imposed, is practicable only against defenses concentrated in relatively small areas. Accordingly, to enjoy immunity from such fire the elements of the defense should be distributed both laterally and in depth, while still able to concentrate their own fire, which modern methods of communication render possible.

The isolated fort, bristling with guns of all calibre, the "concrete battleship" concentrated in a small space, is the most favorable possible target for big guns, whether those of an army or a fleet of battleships. It is also the most unfavorable arrangement for the delivery of fire, since guns of different range and calibre should not be concentrated in one place. In designing seacoast defenses in this way we deliberately impose upon them the limitations which the battleship cannot evade, suffering the additional disadvantage of lack of mobility, which the battleship fleet does evade.

For coast defenses to adopt Captain Christmas' suggestions would be too much like a fighter "keeping one hand behind his back" in order to give his opponent a chance to win.

The question of available space and limitations of weight are controlling and limiting considerations in the design of armament for battleships. These considerations are of minor importance in the development of coast defense fortifications. Surely no one would advocate that coast-defense guns should be equipped with the turrets used in the Navy, simply to follow naval design, for if the Navy had unlimited space available it certainly would not hamper itself by the use of the cramped space allowed in naval turrets.

The "big-gun" principle enunciated by Captain Christmas has been long in effect in the design of seacoast defenses, and the major calibre armament is, at the present time, the controlling consideration in all fortification designs. It suggests, moreover, that the armament in coast defenses be limited to 14-inch or 16-inch guns and one type of small or intermediate guns; this is being generally followed today. All new projects under consideration for the coast defenses contemplate only 16-inch guns and howitzers and nothing on fixed mounts of smaller calibre than 6-inch rifles. In fact, the present tendency is to depend on wheel and tractor artillery for all intermediate and minor calibre armament. One could safely go even further than does the author in advocating that no major calibre armament of less than 16-inch be provided for the coast defenses; nor is it agreed that the 14-inch guns mounted on railroad carriages have been practically demonstrated to be an effective type of coast-defense weapon, as stated by him.

Captain Christmas states that mortars in the coast defenses, in view of the fact that they cannot be mounted on board ship, must be considered as a special case. If his idea of following the naval design is carried out, it would naturally follow that mortars and howitzers should be eliminated from our coast defenses. The considerations making necessary the use of howitzers and mortars are based on their tactical efficiency having reference to the relative vulnerability of the side and deck of the ship, and not to any relation that naval guns have to these weapons.

The article makes the statement that major calibre guns of new battleships such as the *New Mexico* can be fired up to 30°, and, further, "if this can be accomplished on board ship, it can be more readily done with the coast guns." In reality, the present mounts under construction by the Ordnance Department of the Army will provide for 65° elevation with an effective range of 45,000 yards.

The author, in carrying out his somewhat forced comparison between naval and coast-defense design, advocates fire control command and spotting centralized in one station. This appears to be in direct violation of the present tendency of fortification design, which is more and more relying on dispersion, concealment and duplication of essential units to provide against hits rather than by concentration and excessive concrete protection. It is undoubtedly true that there is great advantage in having a simple range-finding system which will enable the location of vessels to be promptly indicated to all armament firing on any particular target, but to do this by physical concentration in one station of all the agencies necessary seems to be of doubtful utility. There is nothing in the system of coast defenses that requires a more careful study, how-

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ever, than does this entire matter of range-finding, in view of the great distance at which combat between the coast defenses and battleships may take place. The most promising development along this line at present has been found to be in the system of sub-aqueous range-finding which is now under consideration by the Office of the Chief of Coast Artillery. The great advantage promised by this system is that not only will it be possible to determine ranges as far out as 25,000 to 30,000 yards, but these determinations will be entirely independent of fog, hazy atmosphere, rain and storm conditions, which have such a controlling influence on other methods of spotting and range-finding, whether from shore stations or aircraft.

As mentioned above, practically all of the conclusions of this article are erroneous, due to the fundamental error in the assumption that coast defense design must develop along the lines of naval design. It should not be forgotten that forts which, in the past, were designed with limited areas so as to contain all the elements of defense, as exemplified by the Vauban bastioned system, have in recent years developed more and more along the lines of dispersion, with a view to making each element of the defense less vulnerable to attacks made on other parts, and it appears that the development of coast-defense design in the future will be based on the construction of simple gun blocks with limited auxiliaries for fire control, practically no shelter for personnel and dispersion of all accessories, including ammunition, in small units, so that no two units will be destroyed by a single shell. All works and accessories should then be carefully camouflaged in time of war.

It is believed that such a system will have an even greater advantage over the battleship than has heretofore been the case, besides being simpler and much less costly to construct and maintain.

Death of Colonel E. R. Stuart

The MILITARY ENGINEER performs the saddest duty of its career in announcing to its readers the untimely death, on March 6, 1920, of Lt. Col. E. R. Stuart, Professor of Drawing, at the U. S. Military Academy.

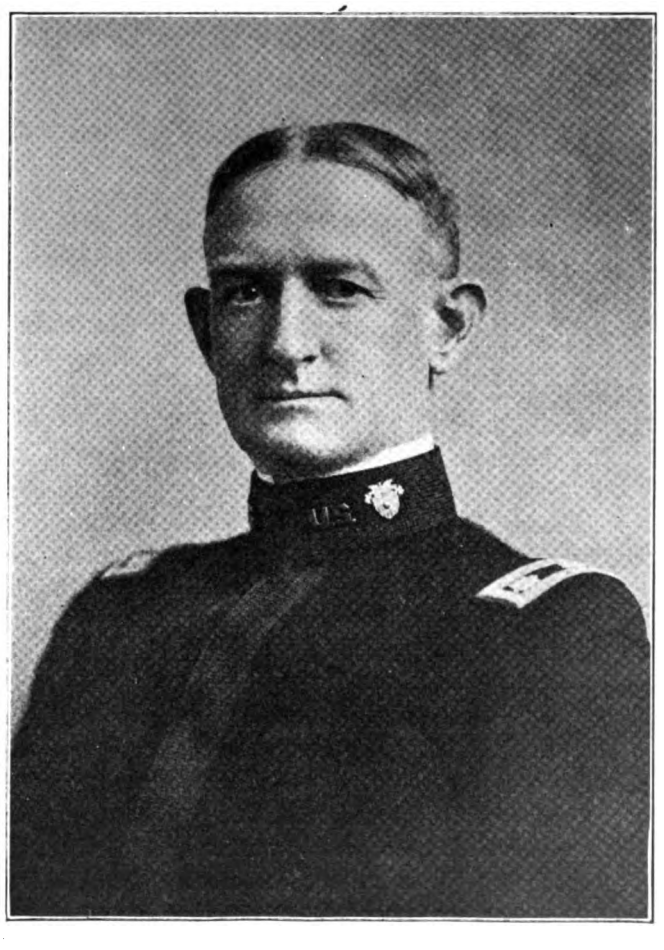
Edwin Roy Stuart was born in Arnettsville, W. Va., Aug. 19, 1874. He graduated from West Point in 1896, No. 1 in his class, and attained the grade of Major in the Corps of Engineers in 1909. In 1911 he was appointed Professor at West Point, with the rank of Lt. Col., which position he held at his death, at the early age of 45.

Colonel Stuart has served on River and Harbor Work in Charleston, S. C. (3 tours), as instructor at West Point, and the Service Schools at Fort Leavenworth, and a number of tours of duty with engineer troops. His special interest was military topography. He was chiefly instrumental in the development of the topographical methods in vogue in the U. S. Army prior to the war, and in organizing and placing on a working basis the largest precise military survey ever undertaken by the U. S., that of the Island of Luzon, in the Philippines.

"Reddy" Stuart was widely and favorably known in the army. There was none more generally respected for his abilities and beloved for his personality by those who knew him. As an officer he represented all the best traditions and ideals of the Corps of Engineers; as a man "none knew him but to love him, nor named him but to praise."

His death was due to a grave tropical disease from which he had suffered ever since his return from the Philippines in 1910. During the war he went to France, but was compelled by ill-health to return to America.

A gentleman of the highest and best type by nature and breeding, a man of sterling worth, a staunch friend, a delightful companion, a mighty intellect, a strong, chivalrous and sunny character—in short, a power for good in the world, is gone out of our lives, and many hearts are left to ache.



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The Tri-Lens Camera in Aerial Photography and Photographic Mapping

By

J. W. Bagley

Major, Engineers.

[*Note.*—This interesting article shows many of the difficulties attendant upon the adaptation of aerial photography to map work, which although a practical thing is treated lightly in many quarters. The so-called Bagley tri-lens camera was developed primarily with a view to covering a maximum area of ground at a single exposure, thus lessening the cost of our photographic work as well as the expensive and tedious restitution process.

Major Bagley is chiefly responsible for the development of the tri-lens camera. The transforming camera was largely developed by Mr. F. H. Moffit of the Geological Survey, with the assistance of Mr. J. B. Mertie of the Geological Survey.

The fundamental principles of multiple lens cameras, and transforming cameras were probably first enunciated by Capt. Theodore Scheimpflug, an Austrian Army Engineer, who studied the problem in connection with captive balloons.—Ed.]

THE use of aerial photographs in the construction of topographic maps is engaging the attention of a great many people in this country, and it is still so incompletely understood that it seems timely to try to give the topographic engineer's point of view of the subject. In attempting to do this it is my wish to emphasize a firm belief in the tremendous value that aerial photography, rightly understood and properly employed, is bound to have in topographic mapping. There have, however, been a great many extravagant claims set forth for aerial photographs as maps, in the form of mosaics, which indicate that the writers had not stopped to inform themselves sufficiently. To those who have fallen into the erroneous belief that in the aerial photograph we have an accurate and complete substitute for the topographic map, it is sufficient to say merely that there is no known way in which the displacements caused by hills and valleys can be eliminated from the photograph itself, and it seems unlikely that this can ever be done.

The accuracy demanded in maps which are to be used to measure distances can not be attained in mosaics, except of flat or nearly flat terrain. In making this statement it is not intended to argue that mosaics of flat country are the only photographic mosaics of value. A mosaic of quite rough country made from aerial photographs, though its pieces match unevenly, may be useful for many purposes; it might conceivably be even more valuable for some purposes than a good topographic map. Let us first, however, get clearly in mind the unavoidable limitation of mosaics as compared with topographic maps.

There has been an attempt to escape this limitation in mosaics by the argument that if the photographs are taken from a very high elevation the displacements will be reduced sufficiently to allow them to be neglected. This is true up to a certain limit, and if we could only have the photographs taken from whatever heights it suited us we could choose the elevation of the flight to accord with the amount of relief we are to deal with. But unfortunately we are quite definitely limited as to the heights of flights by the capacity of the aeroplanes used, by the cost of climbing to those high levels and by increased difficulties of work at extreme altitudes. To state the case more concretely, suppose a photographic mosaic is to be made of a terrain 15 miles square, approximately the area of a standard topographic map, which has a relief of 500 feet. The displacement caused by a relief of 500 feet will be 230 feet at the limits of the photograph, whatever the height at which the flight is made. (Fig. 1, page 362. It is assumed that the angular field of the camera is 50°.) Suppose the flight is to be made at an elevation of 10,000 feet. Each photograph will then embrace an area about 9,000 feet across. If the photographs overlap 50 per cent it will not be necessary to use the entire photograph, but only half, or about 13° each side of the center in the direction of the flight. But the part of each photograph employed will then span only 4,500 feet instead of 9,000 feet. So really, instead of one we shall be using two photographs, and on each there is a displacement equal to half that given at the outer limits of the full size photographs. However the distance from A to B (Fig. 2, page 362) is spanned, the sum of the displacements is about the same. Suppose though instead of making the flight at 10,000 feet it is decided to fly at 20,000 feet above the datum plane, or average elevation of the ground. Each photograph will then span 18,000 feet instead of only 9,000 feet, and in using them to

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obtain the distance A-B, the error of displacement has been reduced to one-half that of the elevation of 10,000 feet. In order to do this, however, we have had to employ a more powerful and more expensive aeroplane, have had to use more fuel and fly a much longer time, and still the error in the distance A-B may be as great as 700 feet. And this is only one of several possible errors. If we add to this the errors arising from inclination of the camera, unequal changes in dimensions of photographic papers by development, the difficulties of joining the photographs together and the several other errors of lesser magnitude, it will be seen that mosaics are barred from consideration for use as accurate scale maps.

It is therefore plain that as corrections for displacements and errors in aerial photographs must be made, it is not very material whether they are large or small, provided they *can* be made, and the photographs which permit us to make them the more readily, economically and with sufficient accuracy, are the ones that will be of the most value.

The tri-lens camera was designed and constructed for the purpose of making maps as rapidly as possible. It was intended primarily to supply photographs which should be suitable for making aeronautical maps. At the time construction of the camera was commenced there seemed to be an urgent need for aeronautical maps which could not be prepared in full from existing maps, because the majority of the latter did not show woodlands, cultivated fields and other features needed to prepare maps to conform to those which our aviators would have to use in France. There was great need to have such maps as soon as they could be produced. In deciding to make a tri-lens camera to meet the above-mentioned need there were other possible uses which it was believed could be made of this instrument, if used in conjunction with a suitable transformer. There are still thousands of square miles of our coastal plains, of slight relief, which are covered only by general maps of scant detail. There are large areas of swamp lands which will have to be mapped before we can satisfactorily undertake to drain and develop them. There are many miles of our outlying coast lines about which we need accurate information, and there are vast areas of our frontiers, such as the valleys and plains of Alaska, of small relief, which probably would remain for a century almost as little known as at present, unless a more rapid and economical method of mapping them than those in general use can be devised. These were some of the reasons why it seemed that the tri-lens camera was needed. Moreover, to the topographer, experienced in the work of making maps from the ground, the question was: To what extent can aerial photographs be used in this work, what improvement will they bring about and how much will their use reduce the cost of making topographic maps? These were the important matters on which we should be informed.

In general there are three elemental steps in making topographic maps; namely,

(1) Establishing the initial control (geodetic positions and elevations);
(2) Locating the positions of all features to be shown on the map;
(3) Finding elevations to draw the contours.

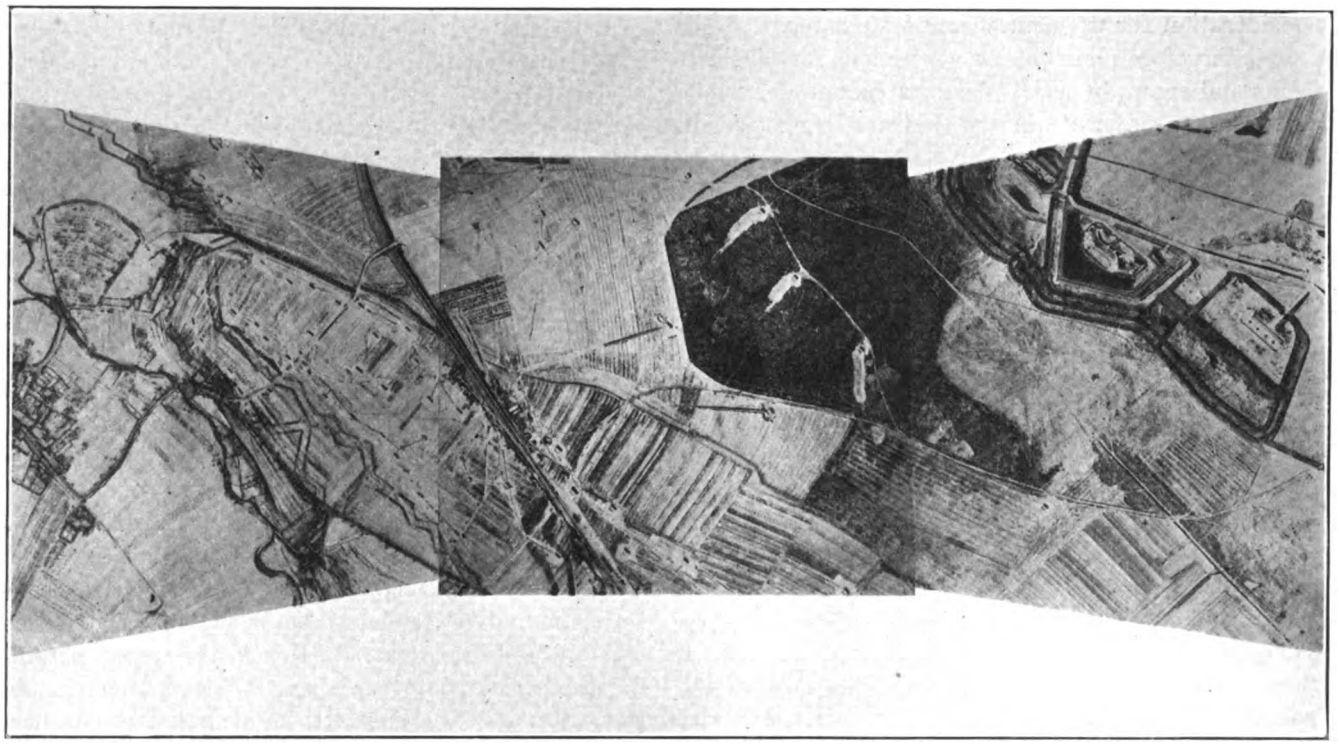
The prospects were good that aerial photographs could be used to supply the second of these three requirements and that they would materially aid in improving the work of the third step, by making possible a better representation of the relief. No aid could be expected from them in the work of the first step, but on the contrary, it seemed probable that a greater amount of control would be necessary before the photographs could be made to take the place of the ground work in the second step. It was believed, however, that the aid given in the construction of contours would balance the increase necessary in control. The net result to be expected was that of supplying the locations of the great number of features to be shown on the maps, and in this would come the decided advantage of obtaining all, or a very high percentage, of the topographical features, whatever their character might be. In the matter of cost, which after all must necessarily be the deciding factor, there did not seem to be the possibility of the great reduction a first consideration might suggest. It was plain, therefore, that advantage must be taken of every means which would lead to a reduction in the cost of obtaining the aerial photographs and of using them in the preparation of the map. It seemed that a considerable reduction in cost could be obtained only by increasing the scope of the aerial cameras employed. The corollaries of an increased camera scope are:

(1) Reduction in cost of obtaining the photographs;
(2) Greater facility in using the photographs for mapping;
(3) Reduction in amount of initial ground control necessary as compared with the amount necessary for photographs of less scope.

The photographs of the tri-lens camera could not be advantageously employed in mapping unless a suitable transformer could be devised to project the side (inclined) photographs into the plane of the central one to give an assembled photograph, made up of the three parts, which would be equivalent to a photograph obtained with a wide-angle single-lens camera. Mr. F. H. Moffit of the U. S. Geological Survey made a careful study of photographic projections and satisfied himself of the possibility and accuracy of making transformations from negatives through considerable angles. Having proved the mathematical principles of this possibility of optics, he set about designing

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and superintending the construction of a transformer to supplement the tri-lens camera. He produced an instrument of great precision which makes it possible to project the inclined photographs of the tri-lens camera into the plane of the center photograph, and when the necessary control is available, to transform inclined photographs to the horizontal plane. Such horizontalized photographs can be readily used to eliminate from the positions of points on maps (not the photographs themselves) displacements caused by relief. The degree of accuracy possible with the transformer is limited only by the character of the lenses employed, those in the aerial camera and that in the transformer.



Transformed tri-lens photograph—Hindenburg line and outer forts of Metz

Note.—A portion of the oblique views has been cut off to limit the width of the illustration

The photographs obtained with the tri-lens camera have been found suitable for use in making maps of country of low relief (200 feet or less) on scales as large as 1:20,000, especially for those of the 1:62,500 scale (employed by the Geological Survey) and for revising maps whatever the amount of relief. Several thousand square miles of country in several states have already been photographed with tri-lens cameras. The rate at which this work was done indicates that by following a systematic procedure each camera will yield from 50 to 100 square miles of country covered per hour of photography. Each exposure will embrace from 3 to 9 square miles, depending on the elevation of the flight. Costs of mapping with the tri-lens camera have not been sufficiently well determined for the purpose of making estimates for future work, but it appears that in making standard 1:62,500 scale maps the reduction in costs below those by ground methods can not be great unless individual photographs are made to embrace large areas, the aerial photographic work done as systematically and economically as possible, and comparatively large areas (1,000 square miles or more) are undertaken as units.

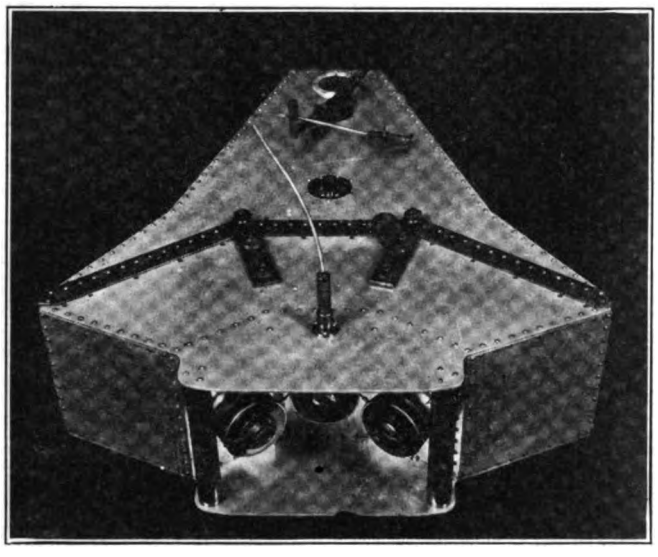
By contrast there is a greater chance to reduce costs of mapping on larger scales, because the cost of these made by ground methods is very much greater than the cost of smaller scale maps. A topographic map of a given area at the scale 1:20,000 costs several times more than a topographic map at a scale 1:62,500. Work at the larger scale requires not only more control and greater accuracy in the location of details, but many more such details must be located and a larger sheet has to be drafted, reproduced and printed. On account of this condition it is to be expected that single lens aerial camera photographs will not only have place in mapping at large scales to bring about reduction in costs, but they will supply the greater amount of details required in maps of this class more satisfactorily than will photographs of the tri-lens cameras.

Before aerial photographs can be largely useful in making topographic maps they must in themselves supply the means of readily establishing secondary control nets over comparatively large meshes of primary control nets—meshes 10 to 20 miles across, such

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as are customarily laid out for standard topographic maps. A measure of this requirement in accuracy is the width of lines drawn on the map. An ordinary line is about one-tenth of a millimeter wide. Its width will represent 1 meter on a 1 : 10,000 scale map and 6 meters on a 1 : 62,500 scale map.

In order to be clear it is well to treat these two cases separately. Because of the possibility of obtaining in the near future means to hold the inclination of the camera to within 1 degree of the vertical, the assumption in both cases will be of photographs inclined from the vertical no more than 1 degree. Furthermore, it is essential in both cases that we avoid the use of photographic papers which change dimensions unequally with considerable difference in differing directions in the process of development, and that we avoid derangements of the perspective properties of the original negatives liable to arise from long exposure. (It is believed that many focal plane shutters are not suitable for aerial photographic mapping.)

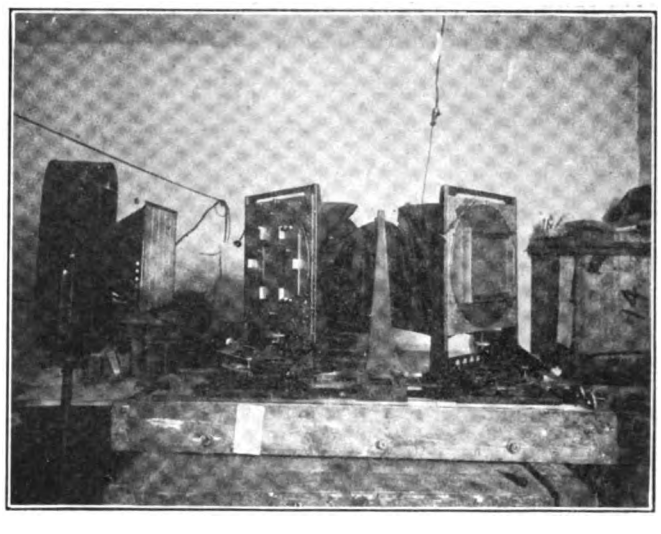


Bagley tri-lens camera

Let us examine first the requirements of aerial photographs to be used for 1 : 10,000 scale maps. We will consider them as having been taken with single lens cameras, and that each one embraces an area 1½ miles wide. Radial lines drawn from the center to the limits of the photographs will represent a map distance of about ¾ of a mile. We can allow an error of 1 in 1200 (about 4 minutes of arc) in the direction of these radial lines and keep within the 1 meter line width mentioned above. It can be shown (the demonstration is too lengthy to be given here) that if the inclination of the photographs is no greater than 1 degree and the relief between successive photographs is not more than 250 feet, the map errors can be kept within the 1 in 1200 limit, provided for control purposes we make use only of points falling within a few millimeters of the center or lying well out towards the borders of the photographs. For the purpose of control it is necessary to avoid the use of points affected by relief which lie in the zone 2°-15° from the centers of photographs, for they are liable to give angular errors to radial lines too large to allow.

In the second case, namely, the requirements of aerial photographs to be used in making 1 : 62,500 scale maps, tri-lens camera photographs embracing a width of 5 miles will be considered. Here we can allow an error of 1 in 600 and keep within the 6-meter line width. As in the case given above, it can be shown that if the inclination of the photograph is no greater than 1 degree and the relief between successive photographs is not more than 500 feet the map errors can be kept within the 1 in 600 limit, provided, as in the case above, for control purposes, use of points lying in the zone 2°-15° and affected by relief, be avoided.

Mention should be made of the greater limitation on the use of tri-lens cameras as compared to single lens cameras because of atmospheric haze. This has been found troublesome for the tri-lens camera during certain seasons, particularly in seaboard regions, and it has made it necessary to take the photographs at somewhat lower levels than would have been the case with better atmospheric conditions. In the plains regions, as in parts of Texas, much less difficulty has been experienced from this cause. When it is understood that the scope of the tri-lens cameras is about three times that of single lens cameras, it will be seen that the advantage, in spite of flights at lower levels, remains with the tri-lens camera.



Moffit photo transformer

Another phase of the problem of using aerial photographs for mapping demands consideration. We are apt to be always limited to the uses indicated above unless a more accurate determination of the amount of inclination of the photographs can be

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made. To do this greatly complicates the task, for it does not seem probable that aerial photographs can be brought accurately to horizontal positions except by working from an accurate and elaborate net of control points on the ground. The practical solution of de-

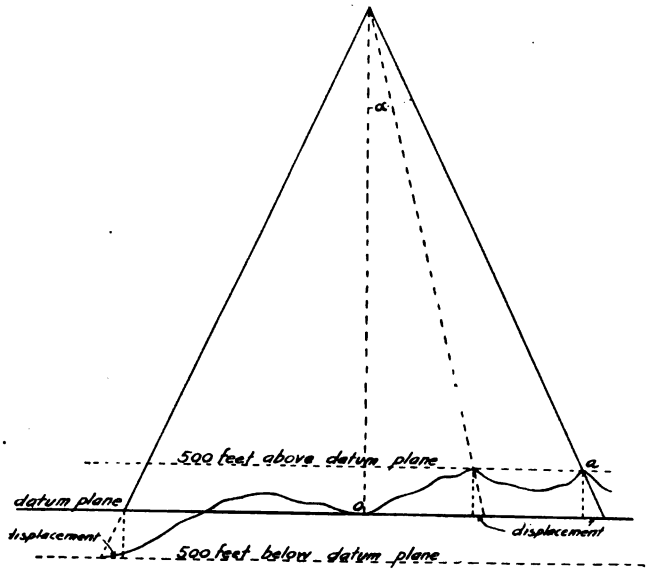


Fig. 1

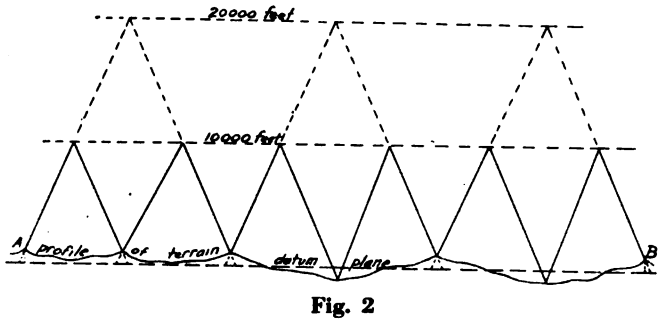


Fig. 2

termining the amount of inclination of aerial photographs with the necessary refinement, promises to give the tremendous advantage of using them to determine elevations as well as positions, and hence to make it possible to accurately draw contours on maps. Every effort should be made to work this possibility out to a practical conclusion. It is believed that the tri-lens camera may possess the essentials required for this undertaking.

Discussion

J. H. Wheat; U. S. Geological Survey

Major, Engineer Reserve Corps

Major Bagley has emphasized many important points relative to the co-ordination of air photos and topographic mapping in his extremely interesting article on the "Tri-lens Camera in Aerial Photography and Photographic Mapping."

The real value of air photos in mapping has been somewhat lessened in the opinion of many engineers, I am sure, through articles by writers, who, knowing little of the technique of the subject, have made the most extraordinary claims for the use of these photographs.

The matter of the limitations of the aerial photograph in topographic mapping is very important to consider, and Major Bagley has well brought out this phase of the subject.

Aerial photography appears to have aroused many writers to flights of fancy. A few months ago a certain mining journal published a bit of interesting news about air photos and maps. It may be stated briefly that the writer of this article claimed that in an area 10 miles square, of practically inaccessible country for men and domestic animals, five men equipped with every device known to science might explore and make a rough map of it in two years at an approximate cost of $60,000, and this for preliminary work only (?), but the airplane in one day would cover it thoroughly in a prospective flight and in three weeks' time the entire 100 square miles would be completed in mosaic maps and detailed engineers' maps (?) at a cost of $3,000. Granted the mosaic photograph; but what are the data for the engineers' map? Further on, he states "It is merely necessary for an airplane to fly swiftly over an area, and, with a camera attachment, make a record so perfect that it could not be duplicated by land survey"; and then from the photographs taken the mosaic is made and from the mosaic the completed engineers' map. Very simple, isn't it?

Perhaps this was written by one of those to whom Major Bagley refers: "That they have not stopped to inform themselves sufficiently." Let us hope so.

In reference to the tri-lens camera, I have experienced considerable difficulty in interpreting features photographed. The lack of definition after transformation is objectionable; also the oblique view of objects in relief remains the same after the inclined photograph has been reduced to the plane; the elevation of buildings and not the ground plan is shown, and the width of city streets between building lines is screened by the tall structures.

The particular field of work for this camera, therefore, appears to be marsh areas of our coast lines and open country with little relief.

The tri-lens camera has a distinct advantage over one which takes a single vertical photograph in-so-far as width of area is concerned, but the technical requirements for transforming the photographs is a factor to be considered. A map draftsman can be taught in a short time to restitute the vertical photograph graphically. It is tedious in many cases, but the only tools required are pencil and ruler. Each print requires four control points for this method, and here again the limitations of the use of air photos for mapping are shown by the amount of control required for adjustment to map form, but this does not destroy their undoubted value for use in giving all necessary detail on mapping projects.

It is hoped that more information on aerial photographs for mapping may soon be given us, especially on results of tests of various cameras and equipment worked out recently at Dayton, Ohio. Practical work was done by photographic flights carried over this part of the country for comparison with the U. S. Geological maps, and the report of the undertaking will undoubtedly prove to be of great interest to engineers.

W. E. Parker

Chief, Division of Hydrography and Topography, U. S. Coast and Geodetic Survey (formerly Captain, Engineers)

Due, undoubtedly, to the remarkable results that have been accomplished during the war, through aerial photography many persons, including some engineers, seem to have the idea that, by means of such photographs, topographic maps, suitable for all purposes, can be constructed with little if any ground control; that, in fact, a royal road

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to rapid mapping at small cost has been discovered. Even among those who frequently use maps and should have better knowledge of their fundamental requirements there appears to be a belief that a mosaic of carefully matched photographs is not appreciably inaccurate as to scale.

Such articles as Major Bagley's will, I believe, do much toward correcting erroneous ideas of the present possibilities of aerial photo-topography. His clear statements of what we can and what we can not do now with such photographs, together with his conservative estimate of what we may expect from aerial photographs in the near future, deserve wide publicity.

One phase of the subject has, I believe, received less consideration than it merits. I refer to what seems to me the great possibilities offered by aerial photography for correcting and bringing up-to-date old maps and charts. The forces of nature and the activities of man are continually causing changes on the face of the earth and particularly along the banks of streams and the shores of tidal waters. To keep maps and charts corrected for such changes, it is necessary to make careful examinations and revision surveys, from time to time, unless some more expeditious method is available. From such information as we now have it appears that we can resort to aerial photography to get a record of such changes and either dispense entirely with ground surveys or at most limit the ground work to providing control for the photographs. As such changes are usually local and of small extent, unless covering a considerable period of years, it seems probable that there will be enough unaltered, recognizable features to fully control the photographs, but, if not, they probably would be of great assistance in quickly laying out the most economical control and would supply much, if not all data necessary to fill in the topography after the control had been established.

Mechanical Equipment as a Method of Curtailing the Increased Labor Costs of Handling Freight*

By

G. F. Nicholson

Chief Engineer, Port of Seattle

IN the September issue of *Freight Handling and Terminal Engineering,* Mr. James A. Shepard, Vice-President and Chief Engineer, of the Shepard Electric Crane and Hoist Company, in his article on "Modern Marine Terminals" made the following assertion, "With our present extreme costs for every kind of labor, and with no prospect for the future, except a more acute stage of the difficulty, but one resource remains: We must requisition at once every mechanical expedient which will enable us to apply our high priced labor more scientifically and thus produce for each dollar expended as much or more than was produced under pre-war conditions."

A terminal may have splendid, modern up-to-date buildings, properly located, but unless it offers all the mechanical appliances and facilities of the up-to-date port, it has failed then in the most essential point in terminal construction.

A survey of the leading ports in the United States would show very little progress in the matter of providing mechanical handling equipment for marine terminals.

It is true that some of the Great Lake ports are well equipped with mechanical equipment on their docks for the handling of such commodities as coal and ore, but the latter are bulk commodities handled in cargo lots and do not present the difficulties that we have with miscellaneous freight.

The most essential requirements of modern handling appliances are as follows:—

1. The location of the terminal warehouses used for long term storage to be as close as possible to the transit shed. Only two or three railroad tracks, serving these facilities, should separate the shed and warehouse instead of placing the latter across a wide, busy street, as has been done in so many of our ports.

2. The construction of transit sheds of timber instead of structural steel and concrete. It is the writer's opinion that there is a tendency at the present time to slight the advantages of timber construction for wharves and sheds and to overestimate those of reinforced concrete. Most probably, new mechanical devices will be introduced in the future that will require a radical change in shed construction. Timber sheds can be altered or even rebuilt at a reasonable expense, while the cost of wrecking and rebuilding the permanent sheds would be almost prohibitive.

There has been a great deal said about the vast amount of mechanical handling equipment of ports in the European countries.

Mr. Carleton Greene, in discussing cargo handling machinery, in his book on "Wharves and Piers" gives several good reasons why the European Ports have supplied numerous cranes in connection with their terminal facilities.

1. When ships arrive at home ports in Europe it has been the custom to discharge the crews and draw the fires, while at our ports crews are retained and the boilers, winches, etc., are available to work cargo.
2. The tidal variation in some of the European ports is so great that the ships' tackle cannot be used to advantage when the tide is low.
3. The cranes are supplied by the municipality which not only owns the dock but has large appropriations for such purposes while the steamship company would not in many instances install them at their own expense.
4. In nearly all European ports they use the deep-hulled barges which have no cargo gear at all, and most of the steamships are more or less deficient in the equipment of booms and winches, so that revolving cranes have a greater range of usefulness in Europe than any other form of cargo handling machinery.

It is very interesting to note that many vessels which handle cargo in European ports use the ship's gear, although the wharf is supplied with numerous cranes. Before the war the Hamburg-American Line, which had almost unlimited capital, rebuilt its piers at Hoboken, New

*Digest of a paper read before the Pacific Coast Port Authorities Annual Convention, San Diego, Cal., Dec., 1919.

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York harbor, and equipped them with the New York pattern of cargo masts, when piers of the same company in Germany were equipped with over one hundred revolving cranes.

The general practice along the Atlantic Coast and in some of the pier installations on the Pacific Coast is to provide what is known as cargo masts along the sides of the pier, which are nothing more than a structural steel or wooden frame high above the roof of the shed, to which may be attached pulleys or blocks over each door opening practically at any point alongside of the pier. This is an exceedingly simple and effective method of handling freight. It is very positive in its action, and there is no swinging of booms to be carefully gauged, and although it does not serve so large an area as the revolving type of crane, its load does not have to follow as long a path. A few years ago Mr. B. F. Cresson, Jr., now Chief Engineer of the New York and New Jersey Port and Harbor Development Commission, and Mr. Charles W. Staniford, at that time Chief Engineer of the Department of Docks and Ferries, New York City, made a thorough investigation of mechanical equipment in the New York harbor and submitted a report regarding this matter to Mr. Calvin Tompkins, who was then Commissioner of Docks. Messrs. Cresson and Staniford, after an exhaustive study, stated in their conclusions that the great movable derricks or cranes installed along the docks and quays in Europe were not adapted to economical handling of American package freight under the present system of pier construction in New York harbor, and recommended a continued use of the cargo masts.

The most efficient method of handling different classes of freight at terminals are those that will relieve congestion, receive and deliver freight in the shortest time, pile it in the most compact and efficient manner, and reduce the damage claims and high cost of handling. A machine is yet to be built that will accomplish all of these things. There has been a great deal of criticism of the two-wheel hand truck, but as a matter of fact, the two-wheel truck with plenty of muscle between the handles is a mighty good all around tool. It is a crow bar, battering ram and truck all in one. It is used to good advantage for getting into small corners and in connection with piling equipment, on short hauls, especially, when there is a great deal of sorting to do. On the longer hauls the electric tractor, industrial load carry truck and trailers, which work together, go a long ways toward solving the problem of freight handling.

The stationary electric freight elevator is indispensable in the warehouse and two-story transit shed.

Light portable electric stacking elevators and inclined power conveyors are very necessary in connection with the two and four-wheel trucks in the piling of freight inside the shed and warehouse. Also ship conveyors for the loading and unloading of ships are most essential. For the accommodation of the second floor of the two-story transit sheds, the outside portable platform, similar to those that have been installed by the Port of Seattle, are very important. With this equipment, it is possible to land the freight from the ship's hold with the ship's tackle to the second floor level on these platforms with as much ease as it could be unloaded on the first floor wharf.

The installation of loading out chutes, running from the second floor level to the cars on depressed tracks or outside platform surface tracks, and also to the ship's hold on the water side, is important. With these inclined gravity chutes it is possible to load out goods from the second floor into cars very cheaply, and in actual practice it has been demonstrated that some sacked freight, for shipment by rail, can be loaded into cars more economically by use of gravity chutes from the second floor than it could have been trucked into cars from the first floor.

Whip hoisting machinery similar to that used at the Bush Terminals in New York is very efficient, and new warehouse designs should contemplate the use of whip hoists, and even warehouses that have been built can be equipped with these hoists very cheaply. This equipment consists of an "A" frame located on the roof of warehouse placed directly above a line of high doors in the side wall of warehouse, to which is attached a block for the accommodation of the hoisting cable.

It can safely be stated that the locomotive crane is a most necessary piece of equipment in connection with the open wharf.

A piece of heavy handling equipment is most essential on one or more of the terminals in a harbor for the handling of extremely heavy lifts. This type of crane should be the heavy handling stationary revolving type of crane.

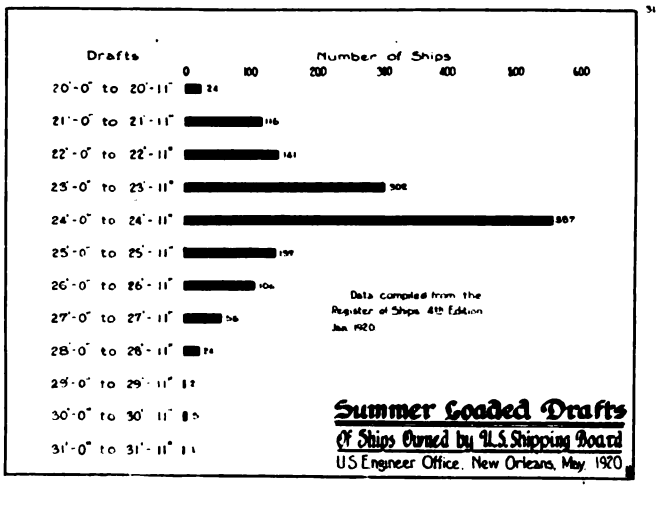
Modern coal handling equipment for the Pacific Coast harbors is very essential in order to give good service to the steamship companies.

The Port of Seattle Commission has, up to date, installed on their terminal facilities, mechanical equipment valued at approximately $950,000.

Summing up the requirements for the handling of freight in the different port cities along the western coast, the following mechanical handling equipment divided into two classes, heavy and light, should be considered, as they are all suitable for the freight that is handled to and from water carriers, wharves and railroad cars in the Pacific Coast ports.

I. Heavy Equipment.
1. Locomotive cranes.
2. Stationary heavy capacity revolving cranes.
3. Floating heavy capacity revolving cranes.
4. Portable gantry bridge cranes.
5. Electric magnets.

II. Light Equipment.
1. Portable electric stacking elevators.
2. Electric tractors and trailers.
3. Inclined power conveyors.
4. Ship conveyor elevators.
5. Stationary electric elevators.
6. Whip-hoist machinery for warehouse.
7. Portable gravity roll conveyors.
8. Inclined gravity chutes.
9. Portable second-floor platforms.
10. Coal conveyors for coaling ships.



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CURRENT NEWS

NOTE.—This department will include news items of professional or personal interest concerning individuals and organizations in the Army, National Guard, Reserve Corps, Reserve Officers' Training Corps, the Service Schools, the U. S. Engineer Department, other departments or bureaus of the Government, and other related activities, both civil and military.

In the PROFESSIONAL NOTES section will appear news items, short articles and digests on matters relating to current developments in engineering and allied sciences and the art of war—of special interest to the military engineer.

Contributions to these columns, whether from original sources or from other periodicals, are solicited from all our readers. Such contributions should be submitted in time to reach our office not later than the 15th of the month preceding each issue of THE MILITARY ENGINEER.

U. S. Engineer Department

FIRST NEW YORK DISTRICT

Col. EDW. BURR

Observations on tidal flow through open-pile piers.—Current meter observations have been made by this district to determine the effect of the substructure of open-pile piers and of the hulls of ocean liners lying in their berths on the velocity of tidal flow within the pierhead lines, with results shown on the accompanying diagrams. Observations were taken during both flood and ebb tide, at the surface and at intervals of depth of 10 feet. The readings were very irregular, and the velocities shown at each station are the mean of all observed. To accomplish this, the mean ordinate of the velocity-time curve for each depth at each stage was computed. The mean tide level for the period of observations at each station was then found, and the mean velocities, as determined above, were plotted at their proper depths, and a mean vertical velocity curve for the stage obtained. The mean velocity was then determined by taking the mean velocity at .2 and .8 of the depth from the mean vertical velocity curve.

At stations distant several hundred feet from the pierhead line, no revolutions of the meter were obtained, but the rating curves for these meters show that a velocity of at least 0.2 foot per second is required to overcome the friction of the meter and cause it to register.

The depth of water between piers 54 and 56, and piers 56 and 57 is 40 feet throughout; between piers 35 and 36, 24 feet; and between piers 36 and 37, 26 feet.

The principal dimensions of the vessels noted in the diagrams are as follows (in feet):

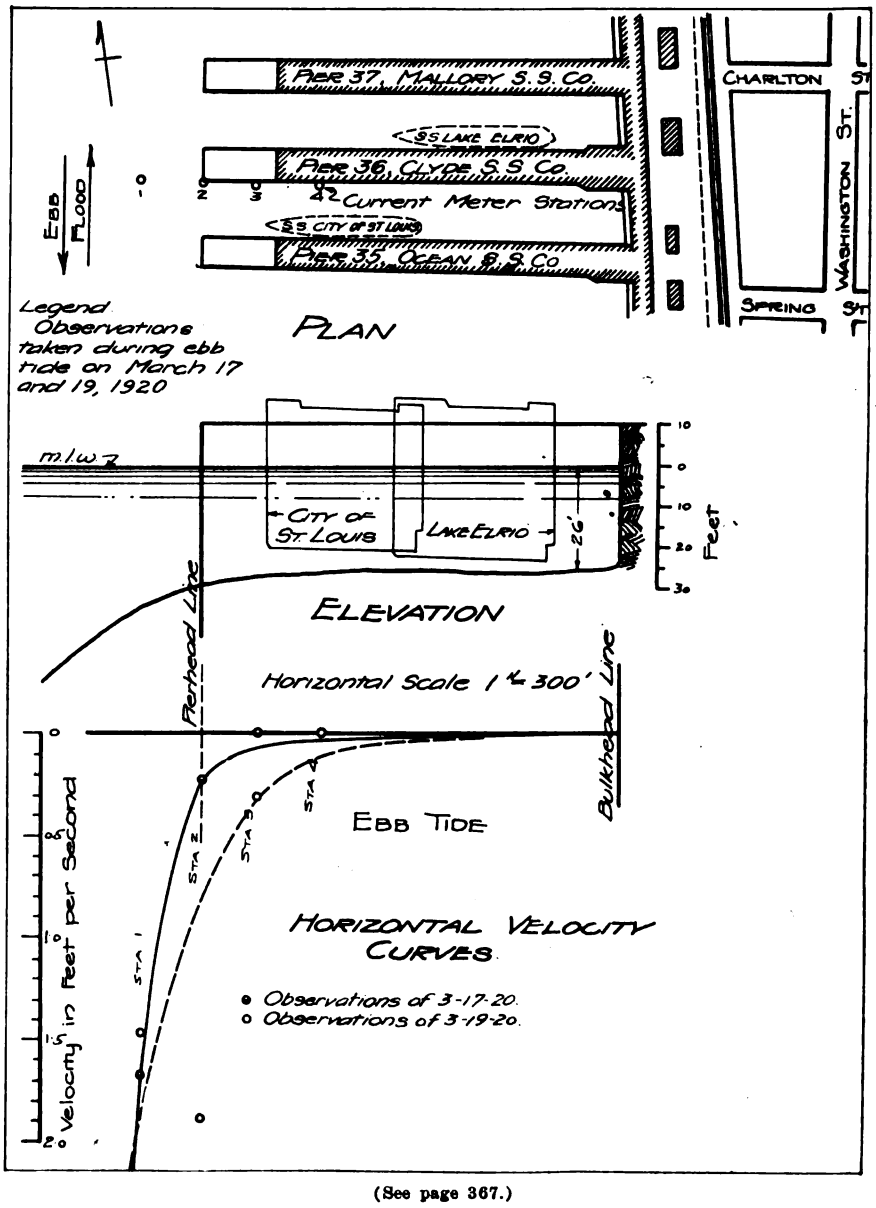
Steamship	Length	Breadth	Loaded draft
Mauretania ___	762	88	36
Ascania ______	466	56	27
Rochambeau __	559	64	27
Lake Elrio ____	392	48	24
City of St. Louis	372	50	21

Piers 54, 56 and 57 are commonly known as the Chelsea Piers. Conditions at these piers are somewhat abnormal since the tidal flow is blocked on either side by solid structures. The strongest tidal currents, moreover, occur on the opposite side of the river.

At Piers 35, 36, and 37, there are no abnormal obstructions between the bulkhead and the pierhead lines for a considerable distance upstream and downstream, and a relatively strong tide current runs just off their outer end.

The observations show that the substructure of open-pile piers and the hulls of vessels lying alongside them have a very marked effect on the tidal flow. Through a continuous series of piers, built and spaced as in New York Harbor, there is practically no tidal flow except at the outer fifth of the length of the pier. The observations are not sufficiently extensive to afford comprehensive data on the effect of different kinds of piers and of the obstruction caused by the vessels, but a comparison of the diagrams will show that the substructure alone has a large retarding effect.

The observations were taken by Mr. W. B. Whitney, Jr., Chief of Party, under the direction of Mr. W. L. Kuehnle, Assistant Engineer. The information contained in this article is abstracted from a report made by Junior Engineer Floyd C. Bedell to the District Engineer.



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PHILADELPHIA DISTRICT

Lt. Col. W. B. LADUE

Contract was let on April 29, to the American Dredging Company for dredging to 35 feet in the main channel of the Delaware River through the lower part of Philadelphia Harbor. The work will begin opposite the foot of Jackson St. and extend upstream as far as available funds will permit. About $400,000 is available for payments. This sum should be sufficient to extend the work to about the foot of Washington Avenue. Work will be started immedately.

The bucket-ladder dredge *Corozal*, purchased from the Panama Canal, is being overhauled. Dump scows and other plant necessary to the operation of this dredge will be assembled during the coming season, and it is expected that the *Corozal* will be placed in operation on maintenance work during 1921. During 1920 it is proposed to rent her to private parties for work under certain contracts in the Delaware River.

Maintenance dredging with the seagoing hopper dredges *Delaware* and *Manhattan* was resumed on the river below Philadelphia during April.

Captain PAUL A. HODGSON, Corps of Engineers, has been relieved from duty as Assistant in this District, and sailed on May 5 from San Francisco for the Philippine Islands for duty with the 3d Engineers.

Mr. H. G. MCCORMICK, Assistant Engineer in charge of battery construction at Fort Saulsbury, Delaware, left the district on May 24 for the Louisville Engineer District. He will have local charge of the construction of a lock and dam on the Ohio below Louisville.

BALTIMORE DISTRICT.

Col. J. P. JERVEY.

Work on dredging the 35-foot channel into Curtis Bay, which was stopped by ice in December, was resumed by the contractor, The Sanford & Brooks Company, March 23d.

Work on the new 35-foot depth channel into Spring Garden, Baltimore Harbor, was started by The Arundel Corporation, March 19th.

Contract for redredging to project depth of 8 feet in Broad Creek River, at Laurel, Del., was awarded to the Sussex Paving Company. Work started in April, 1920.

The Maryland legislature passed a bill authorizing the City of Baltimore to float a loan of $50,000,000 for improvement of the port.

Considerable difficulty is being experienced in getting mechanics and laborers for work on fortification projects.

WILMINGTON (N. C.) DISTRICT.

Maj. J. R. D. MATHESON.

The seagoing hopper dredge *Absecon*, which was rented from the Wilmington, Del., district, left on April 17 for Galveston, after working for several months on Cape Fear Bar with the dredge *Cape Fear*.

A survey of Cape Fear Bar has been authorized with a view to a possible change in the position of the channel and the construction of a jetty to maintain same. The tidal currents at the mouth of the Cape Fear River cause a continual westwardly shifting of sand, which produces a corresponding shifting of the channel. The channel across the bar is now near the western limit, and is in the form of a reverse curve. A new natural channel appears to be forming near the eastern side of the bar, and in prolongation of the channel in the river. This new channel it is proposed to improve. The jetty would assist in maintaining the new channel by preventing the further encroachment of sand from the east.

Bids will be opened on June 28 for the sale of the clamshell dredge *Hercules* and the steam launch *Mercur*, which have become surplus in this district.

JACKSONVILLE DISTRICT.

Lt. Col. W. J. BARDEN.

Under contract with the R. G. Ross Co., extending the north jetty of the St. Johns River about 1,200 feet shoreward, and grading about 2,500 cubic yards of material at the site of the extension, was completed during the past month.

The contract with P. Sanford Ross Co., Inc., for dredging and rock removal at Drummond Creek, part of the improvement of the St. Johns River, Jacksonville to the Ocean, was completed during the past month. This work consisted in completing the channel to a depth of 30 feet and width of 300 feet.

Under contract with the R. G. Ross Co., extending the north jetty of the St. Johns River about 1,200 feet shoreward, and grading about 2,500 cubic yards of material at the site of the extension, was completed during the past month.

Work was started in May on the contract with the Seaboard Dredging Co. for dredging, rock removal, and disposition of material in Sarasota Bay. The work is to partly complete a 7-foot channel, 100 feet wide in waterway connecting Tampa Bay with the town of Sarasota, on Sarasota Bay.

Work under contract with the United Dredging Co. for dredging in Hillsboro Bay was started in May. This will consist of dredging in Tampa and Hillsboro Bay project, channel to be secured having a bottom width of 200 feet and a depth at m. l. w. of 27 feet.

MOBILE DISTRICT.

Maj. R. S. THOMAS.

Removal of water hyacinths.—An allotment of $2,350.00 was made for removing water hyacinth from the tributary streams of Mobile River, near Mobile. The material for this work has been ordered, and operations will begin at once. In the future such work will probably have to be done every year as this plant cannot be exterminated by any known practical means. The present and most efficient method of spraying with a solution of arsenic and soda only kills the heavy top growth, and prevents the hyacinth from obstructing navigation. Its appearance in this locality was first observed about the year 1903, but it has not spread as rapidly as is usually the case, due probably to the fact that these tidal streams are slightly salt during the dry season.

U. S. dredge Wahalak.—The U. S. 20-inch hydraulic pipe-line dredge *Wahalak* while working in Mobile Bay Ship Channel during February removed 882,549 cu. yds. of material, consisting of about 70 per cent mud, 20 per cent sand, and 10 per cent shells. The actual pumping time was 467 hours, and the average amount of material per pumping hour, 1889.8 cu. yds. This was the first full month's operation of the *Wahalak* after installing fuel oil-burning equipment, which has added appreciably to her efficiency and output. Based on yardage removed per pumping hour, the above is the best monthly record made during the past 5½ years by the *Wahalak*, or any other dredge of similar size working at this locality. During August, 1914, the dredge removed 915,763 cu. yds. of material from Mobile Bay Ship Channel, consisting of 90 per cent mud and 10 per cent sand. The material removed per pumping hour was 1,737.7 cu. yds., or 152.1 less than during February, which contained three less working days. During March, 1920, the performance was 807,261 cu. yds. in 475 working hours, or 1,700 cu. yds. per hour.

NEW ORLEANS DISTRICT.

Maj. E. J. DENT.

Intracoastal Waterway.—Specifications have been prepared for widening and deepening the Intracoastal Waterway from the Calcasieu River to Sabine River. The existing section of this canal is about 6 feet deep at mean low gulf and 40 feet wide on the bottom; these dimensions to be increased to 9 and 90 feet, respectively, over such length as available funds ($230,000) will permit.

The Lake Arthur Dredging Company, the contractors for the dredging between Mermentau and Calcasieu Rivers, started one dredge on the eastern end May 17, 1920.

The route of the Intracoastal Waterway between Bayou Terrebonne and Bayou Black has been approved by the department. The Police Jury of Terrebonne Parish are now raising funds for the purchase of the necessary right-of-way. The U. S. dredge *Grossetete* is continuing work on the portion in Bayou Black.

Floating plant.—This district has recently installed oil-burning systems on its two sea-going hopper dredges *New Orleans* and *Benyaurd*, and both plants thoroughly overhauled at the New Orleans Naval Station. The Staples & Pfeifer mechanical system was installed on the *Benyaurd* and the Dahl mechanical system on the *New Orleans*.

The dredges are now laid up, pending request from other districts for their services, as it is planned to stop all dredging on the bars at Southwest Pass until the jetty extensions are completed.

The U. S. tug *Donovan* is being overhauled and a steam steering gear, electric-light plant and oil-burning system (Lockett atomizer) installed. The work was being done at a private yard, but is now being held up by the metal workers' strike.

The tug *Cumberland* has been rented by the Norfolk District to tow the dredge *H. S. Taber* and equipment to that district. Her departure is also being delayed by the metal workers' strike. The tug *Deland*, recently purchased by the Philadelphia office from the Shipping Board, was rented by the Norfolk office and turned over to this office for use during the absence of the *Cumberland*.

This district has recently installed the Higgins atomizer system on the snagboat *Denison*, and at Plaquemine Lock. The dredge *Lake Charles* has the Dahl mechanical system, the U. S. dredge *Delatour* the Higgins system, and the U. S. steamer *Hyacinth* the Papillon atomizer system. It is intended to install oil-burning systems on the *Cumberland* and *Delamar* when annual repairs are made.

Mr. J. L. HORTENSTINE, Assistant Engineer, in charge of the work at the Passes of the Mississippi River, and in the employ of this office for the past 16 years, resigned and has gone into private work. He will be replaced by Mr. Frank D. Cefalu, Asst. Engr., who has been in local charge of the Burrwood substation, Southwest Pass, Mississippi River. Mr. Cefalu will be relieved by Mr. Robert G. Lynn, Junior Engineer, who has been in the main office. Mr. R. P. Rordam, Junior Engineer at Burrwood substation, and in the service of this office for the past 9 years, has resigned to go into private practice.

GALVESTON DISTRICT.

Maj. L. M. ADAMS.

Contract was authorized on April 23, 1920, with Hazell, Connerat and Quist Co. for the repair of three highway swing bridges over the Brazos River—Matagorda Bay Section

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of the Intracoastal Canal. The work is to cost $11,400, and is to be completed by July 30, 1920.

The 20-inch sea-going hopper dredge *Galveston* returned to Galveston Harbor on May 15, after being employed for 6 weeks removing a shoal between the jetties at Sabine, Texas.

The 20-inch pipe-line dredge *Col. A. M. Miller* is now engaged in dredging the harbor at Beaumont, Tex., enlarging the channel by the removal of a portion of Harbor Island.

Col. SPENCER COSBY and Maj. C. L. HALL have been relieved from duty in this district, and Maj. L. M. Adams assigned as Dist. Engr.

Mr. CHAS. CROTTY, formerly Capt. of Engrs., Supt. of Floating Plant, has resigned to accept a more remunerative position with the Harbor Commisson of Houston, Tex.

Mr. E. T. KIRK, Junior Mechanical and Electrical Engineer, resigned from the service to take up other work.

Mr. F. C. WARNER, assistant engineer of the Wilmington, Delaware District, has been transferred for duty in this district.

Mr. L. P. MORRISON, recently discharged as Captain of Engineers, has been re-employed as junior engineer in this district.

FLORENCE (ALA.) DISTRICT.
Lt. Col. LYTLE BROWN

Progress on the Wilson Dam.—The construction of the Wilson Dam at Muscle Shoals on the Tennessee River has been discribed in previous issues. Preparations for pouring concrete on a large scale are now practically complete. The river is in flood and has reached the highest stage attained during the last two years, flooding out all the coffers. No serious damage is anticipated, and when the flood has subsided the placing of concrete in the dam proper will be started

The dredging fleet for the sand and gravel supply is now here. This consists of the 15-in. suction dredge *Indiana* from the Cincinnati District, the 15-in. suction dredge *Pettus* from the Montgomery District, two towboats, fifteen barges and two launches. The *Pettus* made the trip from Florida by way of the Mississippi, Ohio and Tennessee Rivers, without mishap.

The first two of seven large traveling derricks with 90-foot booms are partly erected. Two mixing plants, containing two 4-yard mixers and two 2-yard mixers, are ready for operation.

The problem of procuring supplies and material is a difficult one, in view of prevailing market and traffic conditions. The cement requirements demand an average shipment of eight cars of cement a day for the next year or two. It is planned to ship this largely in government owned cars, since no adequate guarantee can be secured from the railroads to handle it with their own equipment.

The labor force employed has averaged between three and four thousand men. This force is recruited without serious difficulty from the surrounding cities. A large construction camp has been erected, and conditions as regards messing, housing, and sanitation are excellent.

Widows Bar lock to be built.—The construction of Widows Bar lock on the Tennessee River 6 miles below Bridgeport, Ala., will be begun at once. Sufficient funds are now available only for the construction of the lock. This part of the work includes a cofferdam containing 100,000 feet board measure of timber; earth excavation amounting to 17,600 cubic yards; 2,300 cubic yards of rock excavation; 9,500 cubic yards of fill; and 16,600 cubic yards of concrete. The clear dimensions of the lock will be 60 by 300 feet. The dam will be 1,300 feet long with a lift of 10.2 feet, probably of the timber-crib type.

This lock and dam will provide 6-foot slackwater navigation up to Hales Bar lock, 33 miles below Chattanooga, Tenn. It is the first of a series of five locks and dams proposed to give 6-foot navigation between Hales Bar and the head of the pool of the Muscle Shoals power dam No. 3. All of these five dams have low lifts and no power development is contemplated in connection with them.

PITTSBURGH DISTRICT.
Lt. Col. H. B. FERGUSON.

Work of assembling plant, building sidings, camp, shop, etc., for the construction of Lock and Dam No. 4, Allegheny River has been started. This work is being done by hired labor.

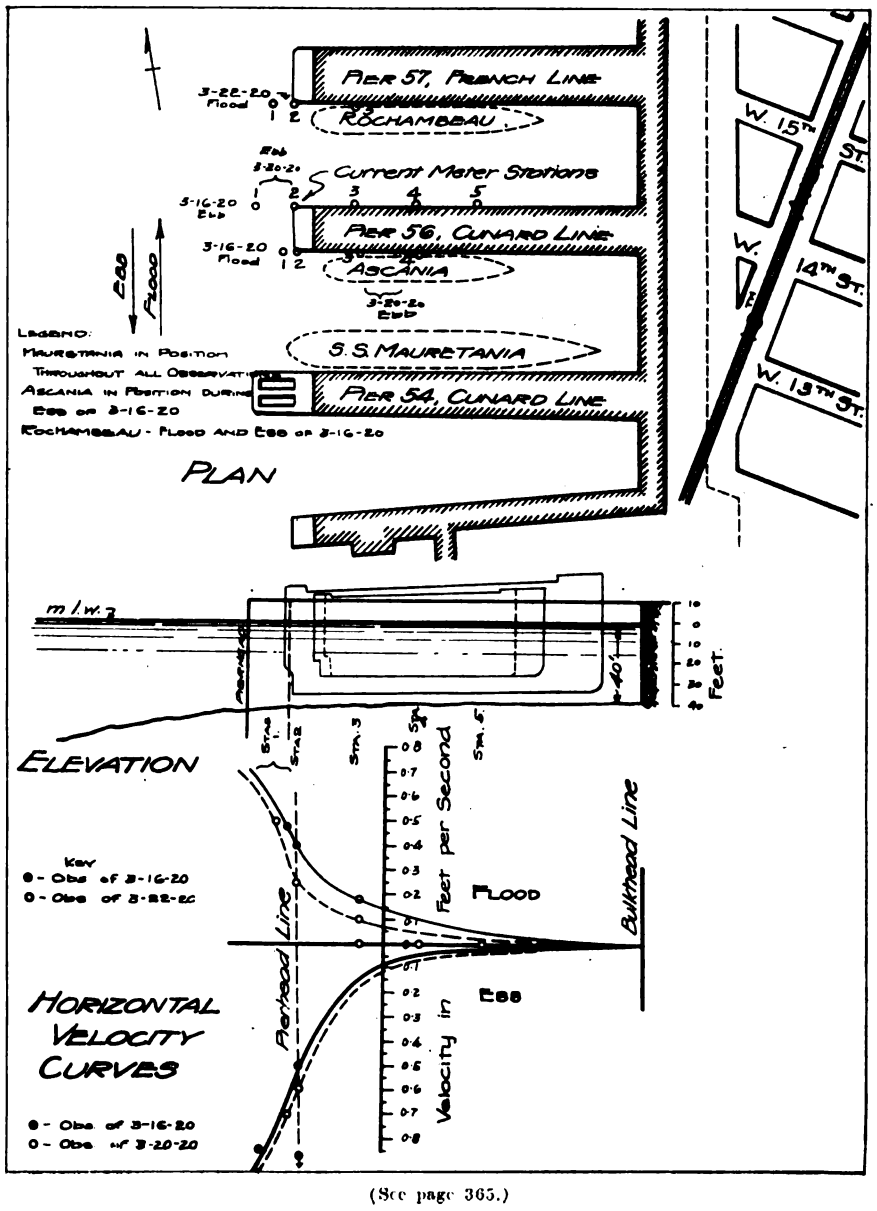
Captain W. M. CHUBB, Corps of Engineers, in charge of the operation and construction on the Monongahela River, has resigned to accept a position as engineer with the Winchester Arms Company, New Haven, Conn. A. B. McGrew, Assistant Engineer, has been placed in charge of operation, and E. H. Beechley, Junior Engineer, in charge of construction.

WHEELING DISTRICT.
Lt. Col. C. W. OTWELL.

Steel sheet pile cofers for Ohio River dams.—The first attempt to utilize interlocking steel sheet piles in the construction of an Ohio River dam was made at Dam No. 19 in 1909, and was abandoned, due to restricted working area caused by timber bracing within the inclosure, 39 feet 2 inches by 270 feet, which prevented satisfactory progress. The masonry was 30 feet 10½ inches and the shecting 36 feet long, with top about 16 feet above low water. It was realized early in the attempt that the type of cofferdam then in use was not as economical as that known on the Ohio River as the box type.

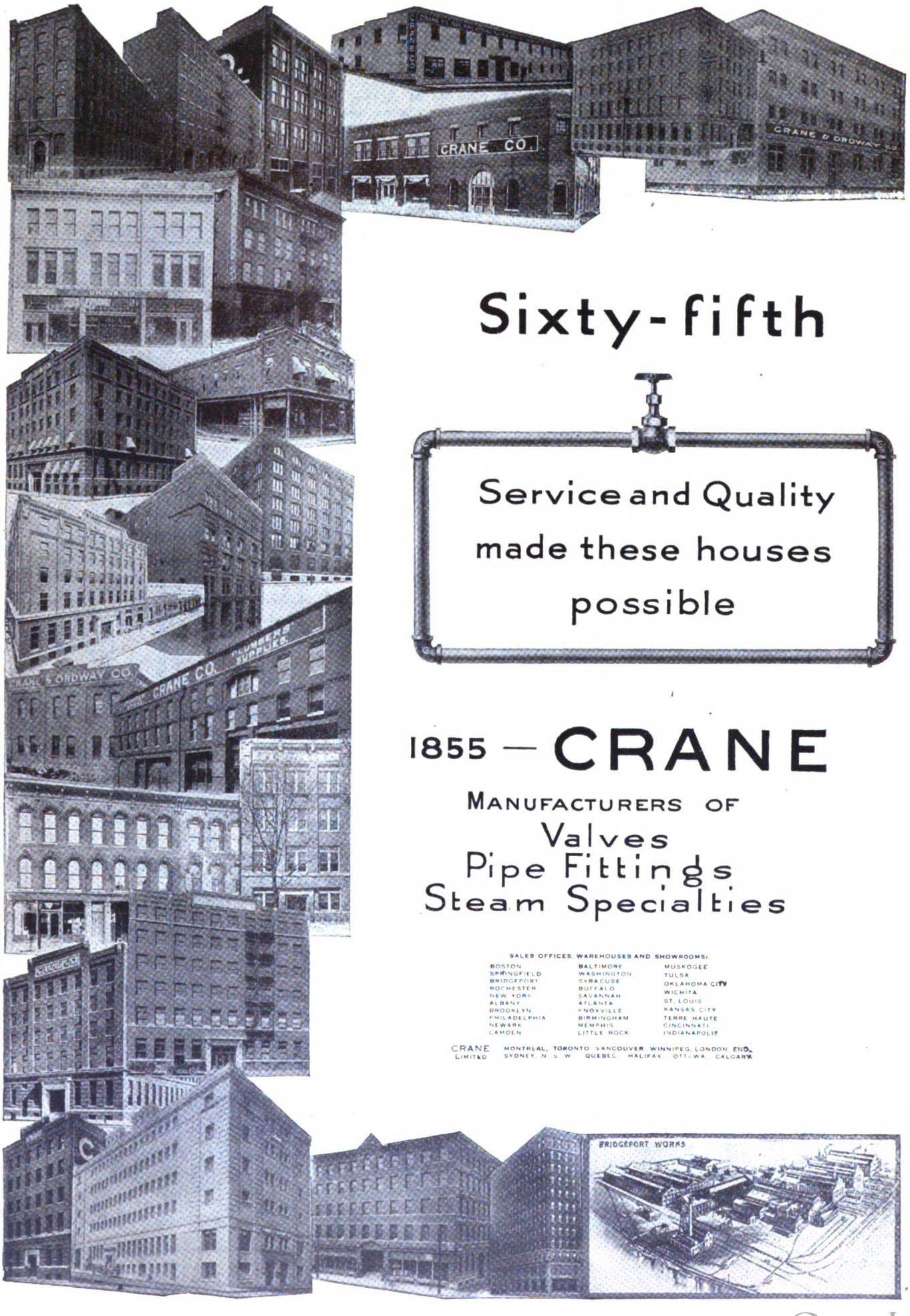
Another contractor attempted to use a steel cofferdam at Dam No. 16, Ohio River, during the season of 1914. The inclosures were 47 by 70 feet, and only two successive sections of the work were constructed, when future attempts were abandoned, owing to restricted area in which to work and excessive pumping. The masonry was 35 feet wide, and the length of shecting 35 feet, with the top about 13.5 feet above low water.

A third attempt with steel sheet piling cofferis now successful at Dam No. 23. Enclosures are 42 by 160 feet, built of 30-foot 14-inch Lackawanna steel piling, driven to rock, held in position on the inside of the inclosure by 12 by 12 inch and 14 by 14 inch suitably disposed timber bracing, and on the outside by banking to within 5 or 6 ft. of the top. The top of the shecting is about 16 ft. above



(See page 365.)

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low water, and the masonry is founded on and keyed into a hard gray sandstone. Work is carried on inside the cofferdam until a 12-foot stage is reached, giving a head of 26 feet. The masonry is 35 feet in width, thus leaving ample room for construction forms and conducting water to the battery of three 10-inch centrifugal pumps. A sand-bag ditch 2 feet high and 18 inches wide takes care of all leakage which is usually handled by one 10-inch pump. Three sections of 160 feet each have been completed. The lower course of timber bracing, which is set 2 to 4 ft. above rock, is concreted in place, but all other timbers are removed. The timber bracing is such as to leave clear openings or pockets approximately 13 feet square. The design of foundation calls for a channeled cut 3 by 6 ft. in the rock, which serves as a key to resist sliding. This cut is formed by drilling vertical holes in line close together and broaching the intervening rock between adjacent holes. This method was adopted as the bottom row of timber prevented the use of channeling machine. The work is und r contract with The Dravo Construct on Co. of P ttsburgh, Pa., in immediate charge of J. S. Miller, Supt. The main detail for the conduct of the work were carefully designed in the home office of the contractor, and during construction are rigidly adhered to.

It is too early in the life of this contra t to make any reference to the question of economy of the steel coffer as compared to the usual box-coffer type generally preferred by Ohio River contractors. However, for a working season frequently interrupted by river stages higher than 16 feet the advantages of the steel coffer are unquestionable as judged by the experience at Dam No. 23, compared with others in the district.

The advantages of the steel cofferdam briefly stated are: Enclosure quickly unwatered after each rise; little or no cleaning up to do; no plant to remove and return before and after each rise; less excevation required; less plant, and therefore smaller labor force required; also less of an obstruction to navigation when built in sections successively from one side. The disadvantages, as compared to box cofferdams, are: Slower progress for favorable working season; probable excessive cost of pumping when computed on the basis of entire work, and activities inside the cofferdam always more or less restricted by timber bracing. Both types of coffer are subjected to damage during and after construction, also each should be properly designed and carefully constructed. Therefore, advantages and disadvantages with respect to these features are balanced. However, it is considered pertinent to mention that, owing to shorter period required for building a section of the steel type there is less risk of damage before completion than for an equal length of box cofferdam, an important consideration in river work. G. W. Bebout, Asst. Engr.

LOUISVILLE DISTRICT.
Lt. Col. G. M. HOFFMAN.

The construction of Lock and Dam No. 45, Ohio River, by hired labor will shortly begin, no bids having been received after advertising four times.

The brick powerhouse at Lock and Dam No. 48, Ohio River, will soon be started by hired labor, all bids received having been rejected.

It is expected to finish and put in operation by the end of the season, the new lock at Louisville (No. 41, Ohio River), and also Lock and Dam No. 43, 3 miles below West Point, Ky. Locks and Dams Nos. 44 and 45 will be begun, by hired labor. Lock and Dam No. 48, below Evansville, Ind., is being constructed by contract, but will probably not be finished this season.

Lieut. Col. G. M. HOFFMAN, district engineer, will be relieved prior to August 15, in order to attend the next course at the War College.

Assistant Engineer H. G. MCCORMICK, recently transferred from the Wilmington (Del.) Dist. will take charge of the construction of Lock and Dam No. 45, Ohio River.

DULUTH DISTRICT.
Lt. Col. F. A. POPE.

Duluth-Superior Harbor.—Statistical report of marine commerce for the navigation season of 1919, issued by the district engineer shows receipts and shipments of 42,895,681 short tons, a decrease of 10,850,677 tons under 1918, and an increase of 10,366,380 tons over 1909.

Receipts of coal at head of lakes to May 31, 1920, amounted to 476,806 tons, a decrease of 1,416,506 below the corresponding period of 1919.

The navigation season covered a period of 240 days. Record load during the season 15,355 short tons of iron ore. Steamer arrived in harbor July 5th at 6:15 p. m., and departed at 12:35 a. m. July 6th. In port just 6 hours and 20 minutes.

The Duluth Canal was closed with ice from January 5th to March 19th. Such a condition has obtained heretofore for only short periods of a few days at a time, the current as a rule having kept the canal open. The great field of ice in Lake Superior doubtless had its effect on the current this year. Coast-wise navigation in Lake Superior opened April 16, 1920, and inter-lake navigation April 21.

Work on government harbor improvements began April 28th with dredge *Gaillard* to remove shoals at East Gate Basin. This work was practically completed June 15. This dredge goes to Keweenaw Waterway, Michigan, to widen the lower harbor of refuge.

The Duluth-Superior Dredging Co. began work on the Superior Harbor Basin the latter part of April. During the month of May, a total of 161,857 cubic yards of sand and soft material were removed. This company now has two large dipper dredges and one hydraulic pump on this work in order to hasten its completion on account of labor conditions. The 2,083,000 yards in this contract should be removed by the middle of July and the contract completed. No further contract work will be let this season.

The Annual Report of the Duluth City Harbor Master lays great stress upon the necessity for a breakwater in Lake Superior to protect the Duluth Harbor entrance.

Contract dredging in Superior Harbor Basin and dredging with government plant at East Gate Basin was resumed about the middle of April.

Keewenaw Waterway (Mich.).—Bids invited recently for stone work shows a great lack of contractors on this class of work and it may be the general industrial condition which precludes their bidding at the present time. The U. S. plant is therefore doing its utmost to keep the works in fair condition.

The Legal Department of the United States is about to begin condemnation proceedings to secure the land necessary for the cut through Princess Point to straighten the channel at that place which is very much desired by vessel interests.

Rainy Lake, Minn.—It is understood the Lighthouse Department expects to place a number of large arc lights at certain points throughout the lake to eliminate dangers which beset operators of small boats in the narrows separating the numerous lake islands.

GENERAL NEWS OF THE DISTRICT.

A very successful dinner and reunion of the Engineer Officers from the Lake Superior District who participated in the World War, was held at the Kitchi Gammi Club, Duluth, Saturday evening, June 12th. At this meeting a local branch of the Society of Military Engineers was formed. The idea of forming such an association was enthusiastically received by all present and by many others who were unable to attend.

The receipts of coal in the early part of June show considerable increase which would indicate the arrival of cars at the mines which was given as the principal reason for the shortage in shipments. The Oliver Mining Company has been shipping coal all rail from the mines in Illinois through to the iron mines on the Minnesota ranges, something which has never happened heretofore. This was made necessary in order to keep their iron mines in operation, even though with great expense.

The 1920 budget for industrial building in this district is about $12,000,000.

Nine millions will be expended by the Minnesota Steel Co. in the enlargement of its plant.

On the 3rd, 4th, and 5th of June, the International Joint Commission held meetings at Duluth; on the 7th at Superior, Wis., and on the 8th at Ashland, Wis., in connection with the deep-sea route from the head of the lakes, and through the St. Laurence River. Interested perosns testified as to the resources of Minnesota, Wisconsin, and the Northwest generally. The District Engineer at Duluth tendered the Commission the courtesies of his office and showed them about the harbor before their departure.

Carrying charges on iron ore to lower lake ports have been fixed for the season of 1920 at $1.00 per gross ton.

From present indications iron ore shipments from the Lake Superior District will make a record during the 1920 season.

The U. S. Supreme Court handed down a decision March 8, 1920, on the boundary line between the states of Minnesota and Wisconsin along the upper and lower St. Louis Bays and St. Louis River. The Court supported the contention of the State of Minnesota that the boundary was the center line between the shores of the two bays and also the river. As a result of this decision nearly $50,000 in taxes collected by Wisconsin authorities on West Duluth dock property will have to be returned. Interested attorneys claim that the Court's decision apparently reverses the decision in the U. S. Circuit Court of Appeals at St. Louis in 1910, which affirmed that the boundary line was the center of the channel of the St. Louis River and not a line midway between the shores. It was this decision of 1910 that led the Wisconsin authorities to tax the West Duluth docks and finally caused the state boundary controversy.

The Duluth papers have contained articles lately which give evidence that big developments affecting this District are pending in the steel industry as a result of the picking up of large blocks of property suitable for industrial plants by outside parties just opposite the Minnesota Steel Company's plant. These purchases aggregate a thousand acres on the Wisconsin side of the St. Louis River. The report states that a vast amalgamation of the leading independent steel manufacturing interests of the country with a capitalization second only to the U. S. Steel Corporation is among the possibilities. The proposed merger

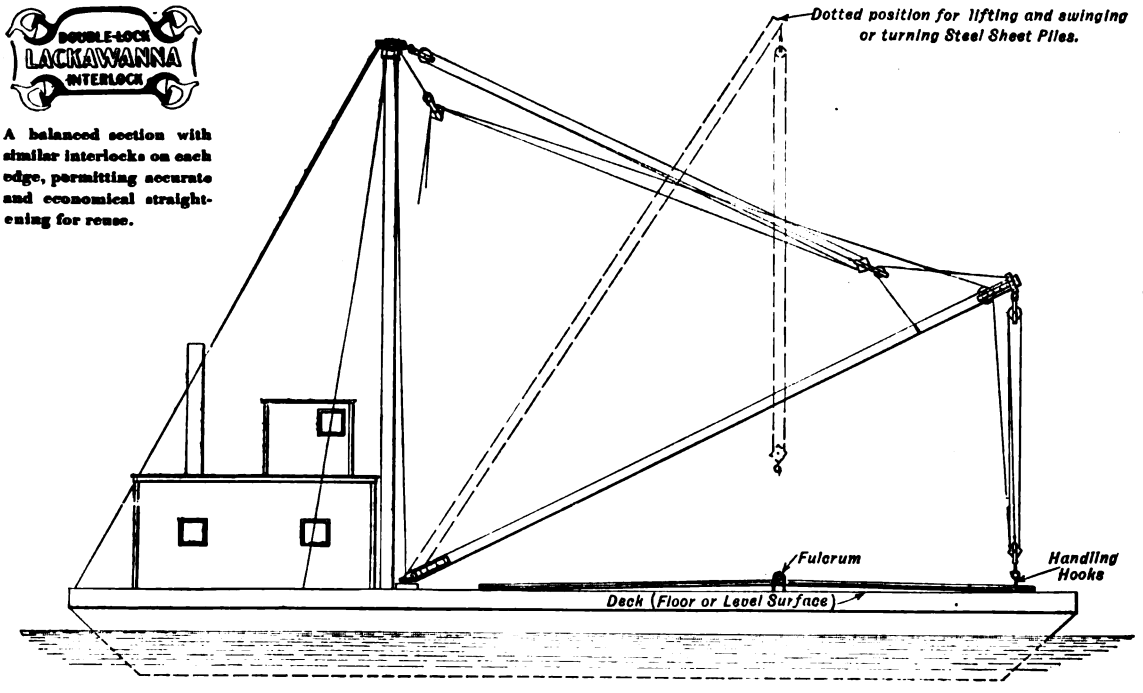
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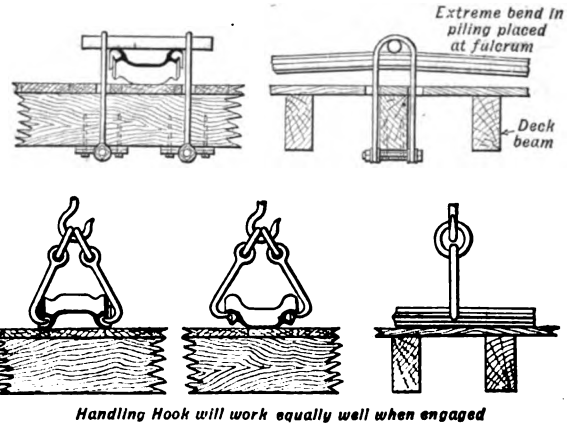
A balanced section with similar interlocks on each edge, permitting accurate and economical straightening for reuse.



Due to its uniform section a bar of used and bent Lackawanna Steel Sheet Piling can be straightened without fear of any twisting effect.

A simple method of straightening that was very successfully applied to bent steel sheet piling from the cofferdam for raising the U. S. S. Maine at Havana Harbor in 1911, and one which experience has proven preferable, is illustrated. A level floor, such as the deck of a scow, or the ties of a railroad track, is selected, and at a point about under the center of movement of a derrick boom, two links are securely fastened. Through these a pipe is inserted to act as a fulcrum against which the sheet piling section is set with point of extreme bend under the fulcrum, against which the sheet piling section is set. The weight of a few men will in extreme cases bend the section so that it will go under. The piling section is then raised by taking hold of one end and the upward lift and pull continued until the piling section is bent slightly past straight to allow for springing back. A badly bent piling section can be straightened in a very short time by repeating this operation, each time putting the point of extreme bend under the fulcrum.

Decidedly short kinks, especially near the end of the sheet piling section, are more economically removed by heating or cutting off.



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would take in companies holding iron ore properties on the Minnesota ranges with manufacturing plants in the East, in order that they might be in a position to compete with the Steel Corporation for western trade in finished steel products in the event of the "Pittsburgh plus" freight basis being discontinued as a result of the recent inquiry of the Federal Trade Commission.

On Feb. 25, 1920, the Duluth City Commission was notified by the Railroad Administration that storage charges would be made on all freight east and west bound stored in ports in railroad-owned warehouses and on railroad docks on Lakes Superior and Michigan. The charges are detailed under freight rate authority of the Interstate Commerce Commission No. 22967, Feb. 20, 1920. This is the successful culmination of a determined effort initiated in 1912 to remove discrimination against Duluth dealers. Whether this condition will continue with the railroads under private ownership remains to be seen.

The widow of the late Chester A. Congdon, who donated to the City of Duluth a right-of-way for a drive along the Lake Superior shore to the Lake County line, has now presented to the City and County authorities an offer to pay up to $125,000 for half the cost of the improvement, provided the whole shore drive is improved and paved. The matter is under advisement for acceptance.

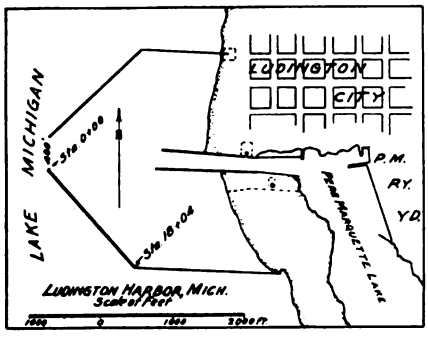
MILWAUKEE, WIS. DISTRICT.

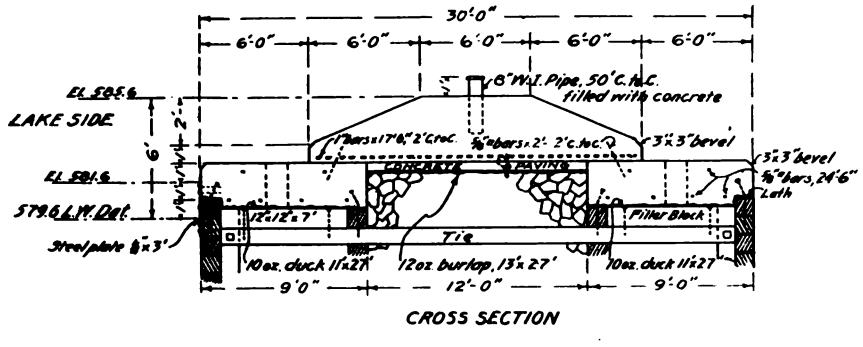
Lt. Col. EDWARD H. SCHULZ.

This district includes the former Grand Rapids District. Mr. J. A. B. Tompkins, who was District Engineer during the war is Principal Assistant Engineer for the entire district. Mr. L. W. Goddard is Assistant Engineer in local charge of the Grand Rapids sub-district.

Bids were opened on April 29, for repairing and placing concrete superstructure on 1,000 linear feet of south breakwater, Ludington, Mich. (See cross section below).

The low bid for concrete foundation blocks was $26 per cubic yard, and for top blocks, $22 per cubic yard.





CROSS SECTION

The lowest bids were greatly in excess of the estimated cost, and this work will probably be done by hired labor.

Caisson construction at Milwaukee, for Indiana and Chicago harbors.—Bids were for cement, 2.51 per barrel, net; for stone and sand, $3.60 per ton; for steel reinforcing, $4.297 per hundredweight for ¾-inch bars, $4.347 per hundredweight for ⅝-inch bars, and $44.397 per hundredweight for ½-inch bars.

The above were all for delivery at breakwater. The bids for cement and steel were accepted. The stone and sand will be purchased and delivered by United States vessel at an estimated cost of $2.50 per ton.

Removing wrecks.—The past winter has been severe in causing wrecks of lake vessels. On March 8, the *Pere Marquette No. 3*, a passenger and freight vessel plying between Milwaukee and Ludington sank off Ludington about ¼ mile due west of the breakwater entrance. The owners have marked the wreck and will shortly decide upon its removal or abandonment to the United States.

FIRST SAN FRANCISCO DISTRICT.

Col. E. E. WINSLOW.

Jetties at the entrance to Humboldt Bay, Cal.—The project provides for two parallel jetties 5,100 feet long. Work closed down in 1917 on account of the war has been resumed. When working on the jetties from 1911-17 the stone was obtained from the local quarries by a combined rail-and-water haul, but since the work has been shut down the long trestle necessary for connecting the railroad with water deep enough to float a car ferry, has been practically destroyed by the teredo. The cost of reconstructing this trestle at present prices would be prohibitive, and as the construction of 4 miles of railroad is all that is necessary to give an all-rail haul from local quarries to the north jetty, provision has been made for building this connecting railroad. The preliminary surveys have been completed; the most suitable route has been selected, and arrangements have been made with property owners for lease of a right-of-way across the several properties for a period of five years. Under the present arrangement the government constructs the connecting link of railroad; the Northwestern Pacific Railroad furnishes the necessary railroad equipment and hauls the stone from a junction point on its road to the north jetty; the contractor quarries the rock, loads it on the cars of the railroad company and delivers the cars over the quarry railroad to the junction point of the Northwestern Pacific.

The project is about 80 per cent completed. The south jetty has been completed to full length, and the north jetty to within about 500 feet of its ultimate outer end. The effect of the rebuldng of these jetties on the channel has been quite pronounced. The depth of 16 feet existing prior to commencement of work has increased to about 27 feet, according to the latest soundings. As was experienced when these jetties wre originally built, some thirty years ago, there has been a very pronounced scour of the north spit. The first rock work to be done, therefore, will be the rebuilding of the inshore end of the old north jetty, originally designed to prevent this scour, which, if not checked, might eventually cut a channel through north of the jetty and thereby defeat the whole purpose of the project.

Crescent City Harbor, Cal.—This project provides for a breakwater 3,000 feet long to protect the harbor from heavy ocean swells and storms. Work has begun, and it is expected that the contractor will make rapid progress on this important project. This harbor is 70 miles north of Humboldt and 250 miles south of the mouth of Columbia River. It is the only harbor on a long stretch of coast line, is the natural outlet for a very extensive area of timber land, and is expected to open up a very important lumber supply.

SEATTLE DISTRICT.

Lt. Col. J. A. WOODRUFF.

Lake Washington ship canal.—A design is being prepared for a movable dam to be erected on the lock wall at the upper entrance of the large lock, to stop the flow of water through the canal and locks, in case a lock gate is wrecked by accident, causing a velocity in the locks so great that the mitering gates can not be closed until the current has been checked.

In general, the dam will consist of a swing-bridge with unequal arms, with center pivot-bearing and rack-and-pinion mechanism for turning. The long arm carries a horizontal truss, 6 wicket girders, 24 wickets and their operating machinery, while the short arm supports the machinery for swinging the bridge, and a concrete counterweight

The bridge can be swung until the long end rests on the opposite wall and the horizontal truss comes in contact with a concrete bumper on the top of each wall. From the horizontal truss, when the bridge is in position across the lock, wicket girders which are hinged to the upstream chord of the truss will be dropped until their lower ends rest against a concrete sill which has been constructed between the walls of the lock at the floor level. The wickets, which are supported by flanged wheels on roller bearings, are lowered into place over a track on the upper flange of the girders; these wickets are placed in horizontal rows, all the wickets in each row being lowered simultaneously, thus diminishing gradually the head as well as the area of the waterway.

The estimated cost of the structure is $300,000. It is expected that the plans and specifications will be completed in about three months, when a contract will be entered into for the fabrication and erection of the entire work except the substructure, which will be constructed by hired labor and government plant.

Salinity tests.—The locks and dams described elsewhere in this issue form a barrier separating the salt water of Puget Sound from the fresh water of Salmon Bay, Lake Union and Lake Washington. Prior to the construction of the locks, Salmon Bay was an estuary of Puget Sound, and large quantities of salt water remained in the bay when the lock gates were closed and Salmon Bay filled with fresh water. The elevation of the surface of Lake Union is 7 feet above extreme

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high tide, and it was originally controlled at this elevation by a wooden dam with sliding gates, at its westerly end. High tide flowed up to the lower side of this dam through a cut between the head of Salmon Bay and Lake Union. This small wooden dam was destroyed in 1903 and again in 1914, allowing large quantities of salt water to enter Lake Union. There was no connection between Lake Union and Lake Washington through which the waters of Lake Union could enter Lake Washington until the completion of the canal.

The present channel between Lake Washington and Lake Union is 26 feet deep. Lake Union has a depth of 40 to 50 feet, and the controlling depth in the channel between Lake Union and Salmon Bay is 32 feet.

Directly above the large lock is a large sump 2,000 feet long with an average width of 200 feet and a depth 6 feet lower than the upper sill of the lock. This sump is connected with the spillway dam by a concrete pipe, the area of which is 30 square feet, its entrance is 4 feet lower than the upper sill of the lock, and its outlet at the spillway is about mean high tide level.

The object of this pipe is to carry back to the lower pool the salt water which finds its way in through the locks to the pool above. How well this object is being accomplished is shown by the following table:

Parts of chlorine per 1,000,000 *parts of water.*

Location.	Depth, in ft.	Jan., 1917	July, 1919	Feb., 1920
Lake Washington, Madison Street—				
	0	4	1.8	3
	50	5	1.8	3
	100	5	1.8	3
	150	5	---	3
	200	4	2.8	3
Lake Union, gas plant—				
	0	13	13.0	7
	10	28	15.0	9
	20	40	32.0	9
	30	1801	1690.0	9
	40	8559	3608.0	4190
	50	8586	5260.0	5040
Salmon Bay, Standard Oil dock—				
	0	57	37.0	21
	10	57	42.0	41
	20	58	146.0	35
	30	816	4633.0	35

Snagging in Lake Washington.—Upon the completion of the Lake Washington Canal and the lowering of Lake Washington to the elevation of Lake Union, about 12 feet, it was found that submerged trees existed at three areas in the lake. Most of these trees were standing vertically or nearly so. One tree, 97 feet high, was located a half mile from shore in 100 feet of water. Another was 2,000 feet from shore in 90 feet of water with only 4 feet of water over the top.

Over 400 such trees were removed or cut off by blasting by the snagboat *Swinomish* after having been located by a wire-drag party of the United States Coast and Geodetic Survey.

After a tree had been located a fastening was made to it by dragging the bight of a large cable held suspended at the proper depth. After the tree was thus placed in the bight of the cable one end of the cable was passed through an eye in the other end and the loop run down to the tree. If it was found impossible to thus lift the tree, a charge of dynamite was lowered to the required depth and the top section cut off and removed. The largest tree removed was 120 feet long and 5½ feet in diameter at the butt, with a 20-foot spread of roots.

The indications are that these trees had been under water for a very long time. All the branches have disappeared, and the trunks are water-logged, and when dried out the wood is very light and porous.

FIRST AND SECOND MISSISSIPPI RIVER DISTRICTS, MEMPHIS, TENN.

Maj. J. N. HODGES.

Construction of two additional dikes on the east side of Robinson Crusoe Island was commenced February 16, but was interrupted by high water in March.

Robinson Crusoe Island is on the west side of the Mississippi River, a few miles upstream from Memphis, and was formed by the Mississippi River cutting through Old Hen Island during the high water of 1912-13.

The dikes are similar to the type extensively used in the St. Louis District, and consist of three piles, from 4 to 6 feet, c. to c. of clusters, depending upon the depth of water. To prevent the cluster of piles being scoured out by the current, they were driven through foot-mats of willow fascines.

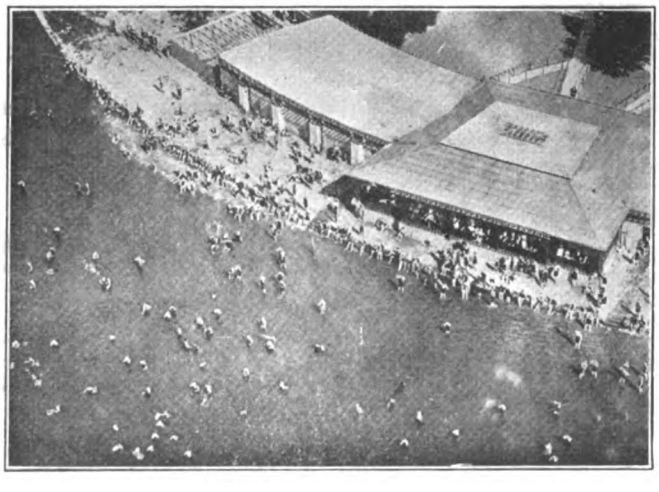
The purpose of the dikes is to deflect the current from the east side of Robinson Crusoe Island and cause it to impinge on the west side of the large sand-bar which has formed in the Memphis harbor, in the hope that the current thus deflected will eventually carry the bar away.

PUBLIC BUILDINGS AND GROUNDS, DISTRICT OF COLUMBIA.

Maj. C. S. RIDLEY.

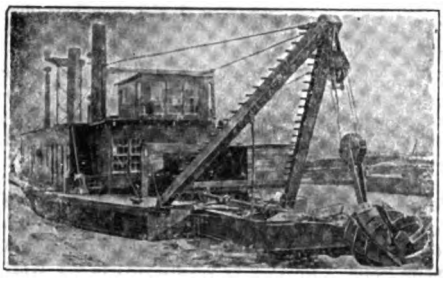
Washington, D. C.—The Office of Public Buildings and Grounds is now operating a bathing establishment in Washington on the tidal basin in Potomac Park. The bath house and beach were originally constructed in 1918 and are now being enlarged and improved. Originally there were 845 lockers for men and 268 for women. With these basic accommodations it provided bathing facilities for a maximum of 10,000 patrons per day. An extension which is practically complete provides 700 additional lockers for men. The beach, which is of artificial construction, is 450 feet long at the life line. The width at the center is 120 feet. It required 25,000 cubic yards of fill. Water is sterilized by a chlorination plant installed at the inlet gates to the basin near the site of the beach. The building is of hollow tile construction, stuccoed, with slag roof. The initial arrangement featured a central pavilion of arrival permitting spectators to pass directly to a view of the beach and dividing men and women into right and left lines passing counters where valuables could be checked and suits rented. The pavilion also included refreshment booth, offices of administration and toilets, in four sections, serving men and women bathers and spectators, on either side of the pavilion. Following the curve of the beach, extend low wings with the top third of the sides open to the air, rows of lockers placed at right angles to a central aisle filled every available foot of space with supplementary dressing booths on the women's side. From the outset the establishment was taxed beyond capacity with long lines of waiting patrons. Various expedients were devised to meet the situation. For the men, a fenced inclosure was provided with a covered check space where their clothes could be placed on coat hangers—an arrangement preferred by many to the use of a limited locker space. For the women a large room was provided with sealed "tote-boxes" for checking their garments. A third system which served a very large number of patrons in a limited space, consisted merely of a coat-check for those who donned and doffed their clothes at home and came in motors to the beach. With additional appropriation permitting extension of the men's wing the first revision of the scheme was to shift the point of arrival of the bathers from the central pavilion to the center of the wing thereby greatly relieving the congestion and mixing of groups. After bathing, the exit line returns them to the central pavilion, as spectators, where parties may reunite and refreshments be obtained. Other changes, the desirability of which had been indicated by experience, were increases of space between lockers, substitution of concrete and steel for wooden floors and lockers, and various detailed modifications tending to save seconds of time and speed up the movement of the line. With the next available funds, the women's wing will be extended with alterations to meet special needs and consideration will be given to more ample provision for spectators.

The establishment was designed by Horace W. Peaslee, architect, and the construction work was supervised by F. F. Gillen, engineer in this office.



Artificial bathing beach in Tidal basin, Washington, D. C.

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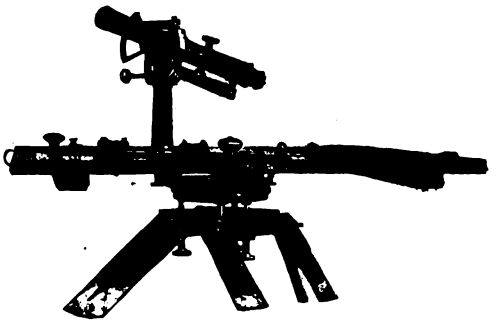
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PANAMA CANAL DISTRICT.

Col. C. S. RICHE.

The District Engineer, Panama Canal, acts both as District and Department Engineer, though two separate offices are maintained. All district work is handled by the Fortification Division, Panama Canal, which is under the control of the District Engineer.

All department work is handled directly by the Department Engineer, by contract or by work order on the Fortification Division, Panama Canal.

Clearings and trails.—Under this appropriation, work is carried on in accordance with the wishes of the Department Commander. Clearings and trails are constructed and maintained so as to carry out the local defense projects.

During October, 1919, at the request of the District Engineer, two aeroplanes made a reconnaissance in the vicinity of Chame Point in order to locate a pass through the foothills of the continental divide. The flight took one hour and thirty-three minutes, and the pass was successfully located. It is interesting to note that this aero reconnaissance accomplished in an hour and a half what had baffled a survey party for three weeks, and it is extremely doubtful if the pass could ever have been located except by aero reconnaissance.

During January, 1920, another aerial reconnaissance was made of the Chagres watershed, and a great deal of useful information was collected.

In the early part of March, a reconnaissance party was sent from this office to investigate the route from Nombre de Dios to Gamboa. Party made the trip in four days and obtained considerable valuable information.

Department engineer work.—Construction of four ponton sheds and one garage at the Engineer Depot, Corozal, C. Z., was started in February, 1920; and completed in May, 1920.

Two survey parties are in the field working on the Progressive Military Map in accordance with the approved project for this department. The dry season here lasts from December to April, inclusive, and it is impossible to do much field work at other times.

Full use is being made of the aeroplane squadron located here. By means of aerial photography, existing maps are being revised and brought up-to-date.

Engineer Troops

SECOND ENGINEERS, CAMP TRAVIS, TEXAS.

Col. E. GRAVES.

The steady arrival of recruits has produced a marked improvement of morale in the Second Engineers. The strength of the Regiment was more than doubled during March. The new men are of excellent material and average 19 years of age. So far none of them are illiterates. At present the drill of these recruits covers four weeks. Infantry drill, Instruction in Physical Training, Small Arms Firing, Practical Military Engineering, etc., are alternated throughout the day, thereby making the course more interesting. The schedule, although very elastic, makes it necessary that each recruit cover each of these important elementary subjects before being returned to his company for duty. The willingness of these new men to do everything required of them and their questions regarding the different phases of the instruction make both the instructors and recruits work harmoniously toward the efficient completion of the course.

SECOND BATTALION, THIRD ENGINEERS, COROZAL, CANAL ZONE.

Capt. D. L. NEUMAN, *Commanding.*

At present there are but three officers on duty with this Battalion, and as a rather heavy program of engineer work is being carried out no garrison school is being held, and no drills except for recruits.

A two weeks' garrison course in topographical surveying for the enlisted men in the battalion has been completed, the students have now been placed on detached service with the Military Survey of Panama and will complete their training in the field.

Detachments from the battalion are engaged in road work on the Pedro Miguel—Empire road; topographical surveying on the Military Survey of Panama; road location survey for the new Gamboa—Alhajuela road; and the refitting and operation of launches to be used on the Military Survey.

Capt. A. L. Ganahl is attending the Engineer School at Camp Humphreys, Va. Capt. D. L. Neuman is commanding the battalion, and in charge of the Military Survey of Panama, and the Pedro Miguel—Empire road. Capt. A. C. Lieber, Jr., is Supply Officer at the Engineering Operating Base and Acting Department Chemical Warfare Officer in Maj. D. D. Pullen's absence. Capt. L. B. Gallagher has received orders to report to the Engineer Examining Board in New York for examination for promotion to captain. Capt. F. Miller is on detached service with the Military Survey of Panama. 1st Lt. J. B. Newman, Jr., went to the States for examination for promotion.

FOURTH ENGINEERS, CAMP DES MOINES, IOWA.

Maj. S. L. SCOTT, *Commanding.*

Regimental insignia, 4th Engineers.—In order to arouse the interest of, and provide suggestions for Engineer regiments which have not adopted a regimental device (see Circulars 444 and 527, W. D., 1919.) We publish herewith the regimental device, 4th Engineers, which will be submitted to the War Department for approval. This device was designated and drawn by the personnel of the 4th Engineers.

Interpretation of the regimental device, 4th Engineers.—The *Spear-head,* representing the Northwest, where the Regiment was organized and recruited, is divided into three segments by means of the Regimental motto, *"Volens et Potens"* (meaning willing and able), and the *Rods bound with thongs* (symbolizing unity and loyalty within the organization).



The *Laurel wreath* in the upper left-hand segment is the official designation of the War with Germany, in which this Regiment took part.

The *Castle* with the numeral 4 above it, represents the 4th Engineers, and the fact that it is enclosed in the *Laurel wreath* indicates that the Regiment was organized for the purpose of taking part in the World War.

The *Blue Ribbon* in the upper right-hand segment, represents the *Vesle River* of France, The *Arrows* represent the armed forces which cross the river to engage the enemy. The *Mailed fist* grasping the *Arrows* represents the 4th Engineers who constructed the bridge which made the crossing possible. In accomplishing this feat there were 210 casualties in the Regiment.

The Esnes-Malancourt Road, represented by the *White ribbon* in the lower segment, was constructed September 26, 1918, by the 4th Engineers and used by two divisions. Sixty casualties resulted from this extremely difficult task of crossing No-man's land. The *Four Bronze stars* represent the following operations for which the Regiment has been officially credited, Aisne-Marne, St. Mihiel, and Meuse-Argonne offensive and Vesle River and Toulon defensive sectors.

The *Blue, white* and *red* in the lower segment represents the colors of Franc, on which soil we fought.

The *Ivy leaves* on the haft is the 4th Division insignia worn by the 4th Engineers duirng the World War.

FIFTH ENGINEERS, CAMP A. A. HUMPHREYS, VIRGINIA.

Col. RICHARD PARK, *Commanding.*

During the past two months the regiment has been getting recruits daily, and a large number of the men for drill have been taking up the recruit course of instruction. A forty-day schedule for recruits has been prepared for all men reporting.

Vocational School courses closed on May 31st, and selected men were put in Trade School classes, which they attend during the morning hours for the summer months. Engineer drills are being carried on in road work, demolition, field fortification, bridge building and surveying. The shortage of officers to properly direct these drills has been overcome by the assignment of five lieutenants, and there have been six more attached for duty.

The influx of recruits has enabled the Vocational Schools to enlarge their activities greatly, and this work is being constantly improved in scope and efficiency.

The Fifth Engineers celebrated its third birthday on the 21st of May, and the program for the day was varied and interesting. Escort to the Color was held at 9 o'clock, followed immediately by a review by General Connor. From the parade grounds the regiment was marched to the Liberty Theater, where band selections were rendered and addresses delivered by General Connor, Colonel Park and Captain Robb.

A number of boxing tournaments were held, and the honors were about evenly divided between the three companies—A, B and C.

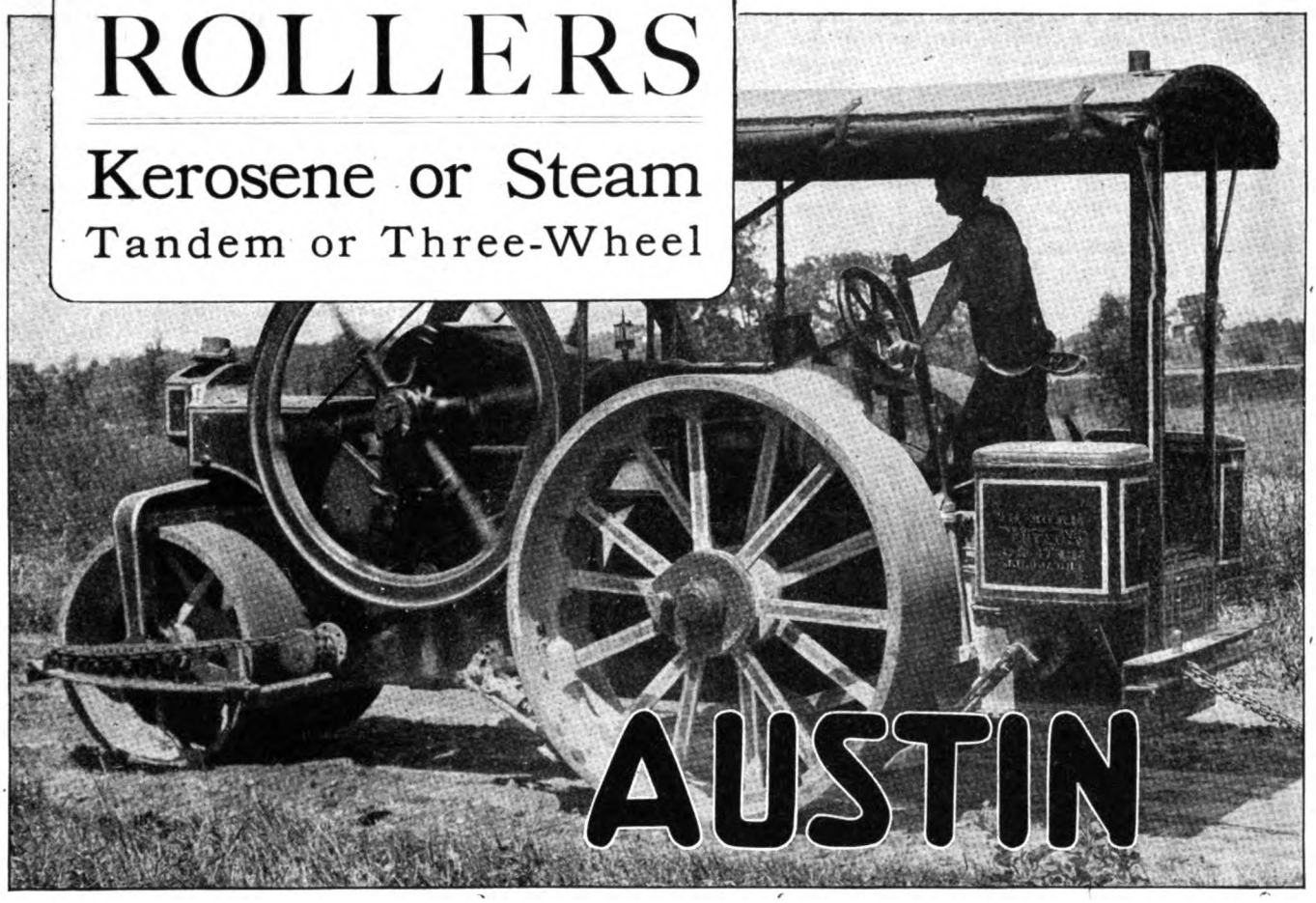
On Flag day, exercises were held in the afternoon in the open air amphitheater, at

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which the Fifth Engineer Band played. On June 16 graduation exercises were held for the Engineer School at the same time and place, and every one on the post was invited. Addresses were given by the Secretary of War and the Commanding General.

A horse show was held on May 12, 1920, at which the Secretary of War was the guest of honor. Many jumping events, a polo race, mounted wrestling, an obstacle race and a race between four-mule chariots were held.

The regiment lost Capt. H. L. Robb and 1st Lieuts. W. J. Regan and John R. Hardin by transfer to the Massachusetts Institute of Technology, but gained Capt. William C. Atwater, Capt. Frank N. Smith, 1st Lts. Frederick B. Butler, Leverett G. Yoder, Wilson G. Seville and Archie T. Colwell, who finished their work at the Engineer School on June 16.

Two excellent bathing beaches have been prepared in Gunston Cove for officers and families and for enlisted men. Rafts, diving towers and spring-boards were constructed, and during the recent hot weather these have proved to be very attractive. Life-guards are maintained at both points, and one company is allowed the beach each afternoon.

The baseball team of the Fifth Engineers has been playing consistently and has won six games in a row. It now stands second in the Camp League with a good chance to win the Camp Championship.

Lt. O. G. HOAAS has gone to Wichita to direct the recruiting activities of the Fifth Engineers in our allocated States and has been doing excellent work in building up the Fifth. The regiment has nearly 700 men.

Maj. H. V. PITTMAN has had complete charge of sixteen counties in West Virginia and has sent in a large number of recruits. He has been recommended for transfer to the Milwaukee District for his good work.

D Company will be formed the end of the month, and Capt. John E. Harris will probably be in command. All new men reporting to the Fifth will be assigned to D Company, and the other three companies will be able to go ahead with their drills without the necessity of drilling new recruits.

The Fifth staged a series of engineer stunts for the benefit of the movie weeklies; the films will be circulated over the country in the pictorial news films for the purpose of stimulating interest in the recruiting drive. A two-line crater was blown with a charge of 800 pounds of ammonal at a depth of 25 feet. The calculation of the charge proved quite accurate. A section of French high wire was destroyed by a Bangalore torpedo. During these stunts the movie men and the large audience occupied elephant shelters in the immediate vicinity. A section of light railway was then blown up with triton, after which a wrecking train rushed to the scene and repaired the damage so that a supply train could pass over. A four-bay bridge was then built with tripod legs, a detachment sent across it with wagons, and it was blown up after them. After dark the searchlights were turned on, and demonstrations were given of signaling with bombs, flares and rockets. Considering the fact that the bulk of the men engaged in the work were recruits of not more than one month's service and that they had had very little time for practice, the performance was quite satisfactory.

SIXTH ENGINEERS, CAMP PIKE, ARK.

Col. C. L. STURDEVANT, *Commanding.*

Since our last issue the regiment has received several trophies in reward for its excellence in athletics during the past fall and winter. It won the championship cup for regimental football teams and second place in the basket-ball league and the relay race.

A base-ball game between the officers of the Sixth Engineers and the 9th M. G. Battalion resulted in a 6-2 victory for the Engineers.

The Engineer polo team took the field for the first round robin on March 19, winning three and tying one of its four periods. The team has been making rapid strides, and good ponies have been developed. Major Worsham is now trying out for the Division polo team against players of much longer experience.

An excellent horse show was staged at Miller Field May 15, 1920. Many fine animals were entered and the exhibition was highly gratifying. The organization, under Colonel Sturdevant, built the riding ring and remodeled the interior arrangements of the field, constructing space for over 1,000 box seats in record time. Receipts from the horse show as reported by Major Hutchings, treasurer, were somewhat in excess of $1,000.

Two interesting cards of races have been held on the new Division Race Track. Colonel Elliott, 30th Infantry, entered his thoroughbreds Lady "A" and Amalgamator. Their races were thoroughly enjoyed.

Colonel Sturdevant has been ordered to Camp Perry to try out for the Cavalry Rifle Team, leaving Major Worsham in command.

The Regiment has just returned from preliminary range practice. Excellent results were achieved by our recruits, and it is expected that almost 95 per cent of our men will qualify the coming season, which for us will open June 19.

The Regiment captured second place in the Division Track Meet recently held. We won more points on track events than any other organization, but lost out on equipment races and the greased pig contest. The Division Track Team has been picked and ordered to the Department Meet. Out of 28 men on the team, we have 11. In addition, two of our officers, Captain Pohl and Lieutenant Hough, have qualified and will join the team upon its arrival at Charleston.

The base-ball team is going strong in the "Argonne" League, but, due to numerous discharges, its personnel is constantly shifting, and we have small chance of being the champions.

An officers' colony is now being established in the regimental area. Small houses are being moved for the purpose. We expect to have quite a settlement here. A large Y. M. C. A. building will be fitted out as an officers' club.

Captain Wieland has been placed in charge of road work, and with assistance of several of our Master Engineers is doing much toward alleviating the bad situation which has previously existed here.

Graduation exercises from Camp Pike College were held on May 8, 1920. The attendance in the regiment and in the camp had been very gratifying. Eighty men of this regiment were graduated at the close of the school term.

Majors Worsham and Hutchings have been ordered to report for duty at Boston Tech. The majors left for their new station on June 9, leaving Capt. Hiram B. Ely in command of the Regiment.

9TH ENGINEERS (MOUNTED), CAMP TRAVIS, TEX.

Maj. R. F. FOWLER.

Although the 9th did not go overseas, it made an enviable reputation during the emergency as an efficient organization, ready for anything. The only real excitement during this period occurred when Villa made his raid on Juarez and the 9th performed its share in protecting El Paso.

The demobilization of the emergency men left us pretty low in numbers, as it did all other organizations. During the last three months we have surely though rather slowly increased from six engineer officers and one hundred and fifty enlisted men to seven engineer officers and two hundred and ten enlisted men, present and absent. Capt. G. A. Counts reported to this organization for duty on March 26th.

The period from January 1st to March 31st was spent in reorganizing, trying out non commissioned officer possibilities, cavalry drill, recruit instruction, conditioning animals, etc.; practically no engineer drill was given, except the usual special duty work, all efforts being made with the limited time and personnel to put the battalion in the proper disciplinary shape.

About three weeks notice was given for the change of station of the regiment from El Paso to San Antonio. Immediately upon such notice work was commenced on the collecting and turning in of property. The distance of Camp Courchesne from Fort Bliss and the shortage of transportation and men, made this feature of the preparation the most difficult to finish in the time available. All escort wagons were used daily and such trucks as could be obtained, but it was necessary to use even the last day to complete the shipping. Headquarters, El Paso District, gave us all the help they possibly could. All organizational property not a part of Equipment "A" or not designated to be taken was shipped by rail; also all excess mules from the train and some horses which were excess or unable to make the trip overland.

Considerable difficulty was experienced in turning in all the property of the train. Besides the equipment for three light ponton divisions, the engineer tools and equipment for a division, cavalry, had to be taken to Fort Bliss after checking and inspecting them. This equipment included the tractors and steel boats and such equipment as had been drawn to go with them.

Orders were issued to take on the march equipment "A," plus extra blankets, surplus kits, and such articles as would add to the comfort of the men or would be of value on the march, and for which there was room. It was planned at first to take one light ponton division, but when orders were received to take no ponton equipment extra mules and scort wagons became available from the train. This allowed us to take more equipment such as heavy forges, extra horseshoes, wagon wheels, kitchen equipment, etc., and still have the wagons fairly light. The inexperience of all concerned in a march of such length in that section of the country, and the lack of knowledge of what might be needed, made it necessary to play on the safe side.

On account fo the depleted strength of the battalion and the fact that a large percentage of the personnel were recruits, it was decided to leave some of the equipment. The headquarters map and tool wagons, and the B Co. tool wagon were shipped by rail. Each company also shipped one-half of its engineer pack equipment, which left extra pack animals for each company. This still left more complete sets of engineer tools and equipment than would be required for us by the number of men present.

Thirteen escort wagons were taken, as follows: Train 4, Hdqrs. 2, A Co. 2, B Co. 3, C Co. 2. Two days' rations and one day's reserve grain were carried. All horse-drawn rolling kitchens were shipped. Company messes were combined into one mess and the motor-drawn rolling kitchen of the train was taken. All ration and baggage, and water carts were shipped. G. I. cans carried in the truck or wagons were used as a substitute. Two light 2-mule wagons which were on hand

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construction, renovation of existing installations, barracks, buildings, procurement of articles and materials for construction and equipment and the furtherance of the Public Utilities.

Before the march there were in the organization only one experienced horseshoer and two experienced packers, the latter being 1st sergeants. Immediately upon notification of the change of station, the company pack trains were organized completely and training commenced. All animals were shod by our own personnel, except those shod by six men from the Remount Depot at Fort Bliss working for one day. Steps were taken immediately for the return of all men from recruiting, military police duty, and schools, but these men were slow in returning and few were available to assist in the preparation for the march. Enough draft and riding animals were kept to give the organization about 25 per cent led animals on the march.

The march each day was conducted as follows: the field and general orders issued by headquarters gave the details of the march. All motor transportation left camp just ahead of the column and proceeded as fast as the roads permitted to the new camp. The 3-ton truck carried from 1 to 5 days' rations, less beef, bread, and ice, kitchen equipment, including two No. 1 field ranges and the mess sergeant, cooks and kitchen police, besides trailing the rolling kitchen. Beef, bread, and ice were received daily by rail, and other rations every five days. The rolling kitchen was turned in at Marfa, as it was found to be of no advantage under this arrangement and somewhat of a disadvantage, as it was difficult to trail on bad roads. The 1½-ton truck carried forges, blacksmith tools, horseshoes, coal, canvas watering troughs, and one horseshoer from each company. The touring car carried one officer. Upon arrival at camp the kitchen was set up, water and rations drawn, and lunch prepared. The forges were set up and the horseshoers then had the time before the arrival of the column to rest; this plan gave the horseshoers more time to work and resulted in better work on account of their being fresh. The advance party consisted of the officer who went ahead in the touring car and the motorcycle drivers. This party selected the camp site, set up the watering troughs when necessary, drew and distributed the forage and dug latrines. The pack trains preceded the column by from one-half to one hour in order to enable them to make their own gait. The wagon train started as soon as it was ready, ahead of the column, but was usually passed within the first hour and a half of march.

The trucks left the column at Sanderson and were away for seven days. A small amount of property was shipped to Comstock by rail, although this was not necessary; the rest was distributed between the trucks and wagons, sending with the trucks that property which was not needed during the seven days. This of course did not allow the sending ahead of the cooks and horseshoers, who were either mounted or rode on the wagons. The two light wagons, each carrying one cook, started each morning as early as possible and preceded the column, in order to prepare lunch at the new camp. During this period also the pack trains carried the watering troughs when necessary.

The watering troughs proved to be indispensable and should be had by every organization; they are not issued. The combined mess proved to be the proper thing as it necessitates less equipment, fewer kitchen police, and makes less trouble in drawing and distributing rations; where companies are at full strength or are liable to be separated, separate messes should be run. It is believed that under conditions which do not justify the sending ahead of a kitchen truck that the motor-drawn rolling kitchen would be of value. Our short experience with the two types showed the animal-drawn to be better than the motor-drawn for cooking, but of course the animal-drawn would not ordinarily be available for the noonday meal. The light wagons are very valuable, as they are ordinarily able to keep up with the column; they are not authorized but every company should have one. The cavalry have them and there is no reason why the mounted engineers should not have them.

Water carts are of value and should be taken in the future, but not those of the present type. It is well to fit the water tank and connection on a four-wheeled wagon, improvised if necessary, with a wagon tongue. The present cart causes sore backs and soon tires out the wheel mule, even if the lead mule is brought back beside the wheel mule. The 12th Cavalry has rigged up such a water wagon, which appears to be very practical. The same should be said of the ration and baggage cart, although the cart should be replaced by an escort wagon. The present type of limber and caisson tool wagon are too heavy for use under adverse conditions, and too liable to be broken. Experiments should be conducted on a lighter limber and caisson wagon to be compared with the escort wagon.

The conduct of the personnel of the organization on the march was all that any one could ask. The spirit was excellent and great credit is due to both officers and enlisted men for that spirit and the thoroughness of the performance of their duties.

The march was made between April 15 and May 22, the distance being about 700 miles.

During the march the 9th Engineers was very cordially entertained by the 5th Cavalry at Marfa, the 12th Cavalry at Del Rio and the 13th Cavalry at Fort Clark. Each of those organizations gave a dinner and dance, and in addition rendered every assistance possible in the matter of supplies and equipment. The organization has taken station at Camp Travis and has been attached to the 2nd Division for training and administration. The camp area is alongside the 2nd Engineers, and through the kindness of Colonel Graves the 9th joined the 2nd in the Exchange and in the Officers Mess.

The battalion is just getting settled in its new home. Quarters for married officers are not available, but those officers whose wives have arrived found no difficulty in obtaining suitable quarters in San Antonio.

Recruits have been coming in rather slowly but at present the battalion is about two-thirds strength in enlisted men and one-third in officers. Training conditions are unsatisfactory, due to the numerous Division details and schools.

Maj. R. G. MOSES left the organization at Del Rio, being transferred to the 318th Engineers at Camp Grant, Illinois.

Capt. R. F. FOWLER joined the column at Comstock and assumed command at Del Rio, on the departure of Major Moses.

Lieutenants MARLOW and GREEN left on June 10th to attend school at the Boston Tech. This leaves the battalion without any lieutenants.

ENGINEER TROOPS IN GERMANY.

Lt. Col. B. A. MILLER, *Chief Engineer.*

The activities of the Chief Engineer's Section, American Forces in Germany, consist in general, of carrying forward the projects in construction, renovation of existing installations, barracks, buildings, procurement of articles and materials for construction and equipment and the furtherance of the Public Utilities.

Vocational schools are conducted with satisfactory results.

Employment of Engineer troops.—Engineer troops are engaged in construction, operation of depots and dumps and infantry exercises. The latter included a review by the Commanding General, American Forces in Germany, at Ransbach, 15 kilometers northeast of Coblenz, on March 5th, followed by field maneuvers March 6th-9th, inclusive.

Approximately 40 per cent of A Co. engaged during March in construction, in making necessary repairs and alterations in the target ranges of the First Brigade, in infantry exercises and in duties of engineers, including normal engineer instruction in bridges, reconnaissance, and pioneering. In addition, a course in musketry was inaugurated in preparation for the coming target practice season.

During the maneuver period, this organization engaged in problems comprising:

1st. Rail movement to review field at Ransbach with review and march to billets at Elgendorf.

2nd. Infantry action involving repulse of an army after a "break-through."

3rd. Organization and consolidation of position, including accessory defenses.

4th. Withdrawal problem—one platoon being assigned to each battalion of infantry for demolition of bridges, destruction of roads and ferries.

5th. Concentration of troops and a return to quarters by brigade march.

Co. "B," organized as a special railway operating unit, continued its training in railway operation activities. The officers and enlisted men in this organization not so engaged received instruction and training in infantry work. This organization is at present armed with rifles, and future extensive training is to be undertaken with this arm to secure maximum efficiency in its use. The problems undertaken by this organization during the field maneuvers consisted entirely of those dealing with the railways of the bridgehead in relation to capacity and movement of troops, transportation, and supplies over such railway lines.

D Co. continues to furnish the personnel for the operation of the Engineer dump at Andernach and has charge of construction, alterations and repairs in the Second Brigade area. In general terms, the problems assigned to this company during the field maneuvers differed but slightly from those assigned to Co. A, though the organization was attached to the Second Brigade while A Co. was attached to the First Brigade.

Operation of public utilities.—Strikes and revolutionary disturbances at various times caused considerable annoyance, it having been necessary at one time to commandeer coal in order to continue in operation the Coblenz gas generating plant. The trolley service was interrupted frequently, due to a lack of fuel and industrial plants at Maven and Nieder Mendig were forced to close for nearly a week. Coal is moving more freely now from the Ruhr Basin, but the supply is still considerably short of the amount needed.

The water supply at Ehrenbreitstein has been increased by the addition of two wells.

Enlistment in the Regular Army.—Enlistments in the Army now average about 1,600 a week. There is a noticeable reduction in reenlistments, which thus far have not responded to the increase in pay. As an inducement to former service men, they are offered, in addition to the two months' leave, an assign-

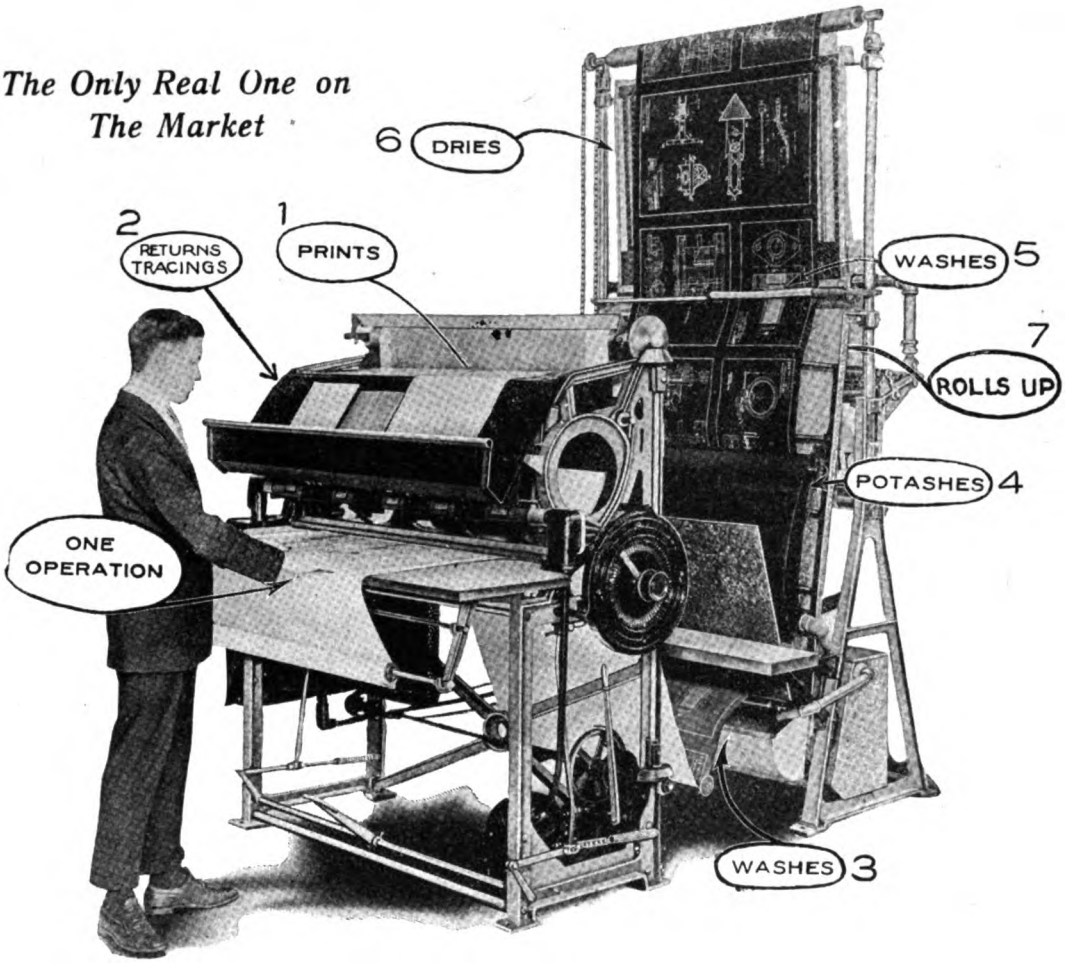
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ment to any branch of the service they may desire, and to any station, provided the particular service they wish has not been filled. This feature is also offered to any man enlisting for a three-year period, the only exceptions being the air service and the motor transport corps, assignments to which are covered by special regulations. Recruiting officers are instructed to report specially the effect of this liberal offer, and whether it acts as a deterrent to re-enlistments for home stations.

APPLICATIONS FOR APPOINTMENT IN THE REGULAR ARMY.

1. The War Department has on file a large number of approved applications, submitted during demobilization, of officers who served during the emergency and who desire permanent appointment in the Army under the provisions of Army reorganization legislation. No further action on the part of such applicants is necessary to insure consideration of their application at the proper time.

2. Emergency officers or former emergency officers who have not now approved applications on file in the War Department and who desire to make application should do so without delay.

3. Applications will be submitted on Form No. 739, A. G. O., and for persons now in the military service will be forwarded to The Adjutant General of the Army through military channels with recommendations. Applications of persons not in the military service will be mailed direct to The Adjutant General of the Army.

4. Application blanks, Form No. 739, A. G. O., may be obtained, upon request, at the headquarters of any divisional camp, at the headquarters of each military department or from The Adjutant General of the Army.

R.O.T.C.

ENGINEER UNIT AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

Maj. H. F. CLARK, *Engineers.*

This academic year is the first one in which the unit has been established, and there are three advanced students enrolled. The compulsory first two years of training has to be given by the technical officers on duty, and the Engineer Officer has given thirty lectures on engineer duties, etc., to the Sophomore class of 620 students.

Attendance at an Institute Summer Survey Camp makes a good supplement to the six weeks at Camp Humphreys, and engineer students of the lower classes can attend both and have no surplus time to spend during the summer.

Charts have been prepared from the various A. E. F. notes and data, and lantern slides, which are used to illustrate the lectures given. Considerable interest has been taken in the charts and many questions asked by the students. Since all the sophomore military science work is theoretical, some novelty, in a few lectures, has been improvised in order to break the monotony.

A small model of a piece of artillery was camouflaged and discharged before one class to demonstrate flat-tops, trap-door cover to piece, etc. A section of double-apron wire entanglement was erected on the platform before another class, using tape for the wire and setting the screw pickets in cast-iron standards.

The lecture on explosives was amplified by timing various kinds of fuse and exploding an electric cap by the exploder box. This lecture, and its details, seemed to be more appreciated by the students than any other.

A class of about 25 advanced engineers is expected to be enrolled next year. The summer camp this year will have about 25 men from Tech.

ENGINEER UNIT AT WEST VIRGINIA UNIVERSITY.

Capt. H. SWENHOLT, *Engineers.*

The Engineer Unit West Virginia University R.O.T.C. really started work on October 20, 1919. The number of students enrolled in the unit is 78, of which 17 are contract men taking the Advanced Course, 27 are enrolled in the Basic 2 course and 34 in the Basic 1 course.

The amount of time allowed by the University authorities for military instruction amounts to four hours per week. In order to fulfill the requirements of five hours' military instruction per week specified by Special Regulations, No. 44, it is necessary to hold military periods Saturday afternoons during the early spring. This fits in nicely, as more and better work is accomplished in one four-hour period than could be accomplished in four one-hour periods. Especially is this true of the course in Military Map Making, and in the tracing of field fortifications.

The Engineer Unit is organized into a separate Engineer Company, and all the officers are members of the Advanced Class. It is a particularly well-drilled company, due to the fact that the cadet officers are excellent, and also to the fact that the material comprising the Engineer Company consists of exceptionally high-class men. Only those men were enrolled in the Engineer Unit who expressed a preference for that branch of the service. For that reason we were assured that a good spirit would prevail in the organization. A very large percentage also of the men now enrolled in the unit and not in the Advance Class will sign the contract and will become eligible for Reserve Commissions in the Corps of Engineers. This supposition is warranted because of the fact that of the 17 men of the entire corps that signed the contract at the beginning of the present semester, 8 were members of the Engineer Unit.

While it is true that the situation described above tends to make a better Engineer Unit, it is a question as to whether it should be continued. The Corps of Engineers is not benefited as much as it would be if more men received the Engineer Instruction, even though they did not eventually sign the contract. At the present time a plan is being considered whereby every man entering the University and taking an Engineering course will be automatically assigned to the Engineer Unit and transferred to the Infantry Unit only if he specifically makes a request for such transfer. Heretofore the reverse has been the case, and it has been found difficult to interest students who already have an assignment and perhaps N. C. O. rank in the Infantry Unit.

The Engineering Faculty of the University co-operates in every way possible with the Military Department. Every request made by the Military Department has received courteous consideration and has been granted. Credit for a summer course has been granted to students who attend a Basic Summer Camp. The Engineering Courses, however, are very rigid, and students have no opportunity to elect different subjects, as in the Letters and Science Courses. The military work is compulsory for all physically fit students during the Freshman and Sophomore years. Students in Engineering, however, who elect to take military work during the last two years and sign the contract, can not substitute this military work for some other course. It is additional work for the student concerned. No effort has been made as yet to change this situation, as it is not considered desirable to have the student drop any course, which might greatly handicap him in his civilian occupation. Besides it would appear that the Military Department would be more successful and more efficiently fulfill the purposes of the R.O.T.C. as the quality of the men in the R.O.T.C. is raised, if these men can be drawn into the Corps in sufficient numbers.

THE R.O.T.C. AT THE UNIVERSITY OF ALABAMA.

Maj. CHARLES W. COCHRAN, *Engineers,* P. M. S. and T.

The University of Alabama is rich in historical interest. December 18, 1820, one year and four days after ratifying the Constitution, the General Assembly passed an act establishing the University.

The site for the erection of the buildings was selected 1¼ miles east of the courthouse of Tuscaloosa. The University was opened for the admission of students on April 12, 1831.

On April 4, 1865, Federal cavalry set fire to and completely destroyed all the buildings except the astronomical observatory. The erection of new buidings was begun in January, 1867, and the University was again opened for instruction April, 1869. The institution has grown steadily under the able management of its various presidents until today it ranks as one of, if not the leading, university of the South.

The military feature is no new experiment, as the school was for a number of years a noted military college.

The campus is not excelled for beauty by any in the United States, and the facilities for drill are excellent, while the grounds surrounding the University afford the best of opportunity for tactical and topographical training.

Three units have been organized here, viz., Engineer, Infantry and Coast Artillery, with a total enrollment of about 400. The course is compulsory for freshmen and sophomores and open to other students who desire to enroll. Total credits for a degree required by the University are 60, of which 6, or ten per cent, are allowed the student taking the four-year military training. Three officers, one for each unit, and six enlisted men are detailed for instructions.

The training has been carried on in compliance with S. R. 44.

A rifle team of 20 members has been organized to compete for the championship of the Southeastern Department R.O.T.C. Arrangements are under way for a big military field day, consisting of mass athletics and competitive drills. The program to be arranged so as to give every man an opportunity to show what he can do.

Prizes will be offered in the following events: Company baseball team, company track team, relay race, high jump, broad jump, boxing, tug-of-war, company having best rifle team, best-drilled company, company having fewest absences during year, company showing up best at inspection, best-drilled cadet, best-drilled squad. The business houses of Tuscaloosa have offered the prizes. Perfect harmony exists between the University and the R.O.T.C., and a live, progressive unit is the result.

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Personals

Changes in personnel.—The following changes in the commissioned personnel of the Corps of Engineers have occured since the last issue of THE MILITARY ENGINEER:

Maj. Gen. LANSING H. BEACH has been appointed a member of the Board of Ordnance and Fortification, relieving Maj. Gen. William M. Black, U. S. A., retired, of that duty.

Brig. Gen. WILLIAM D. CONNOR has been assigned to the command of Camp A. A. Humphreys, Va., and the Engineer School, relieving Col. Clement A. F. Flagler.

Col. E. EVELETH WINSLOW has been appointed Division Engineer of the Pacific Division, relieving Col. Charles L. Potter. In addition to the above duty, Colonel Winslow has been detailed in the 18th Lighthouse District, relieving Colonel Potter.

Col. CHARLES L. POTTER has been appointed Division Engineer of the Western Division, and detailed in the 15th Lighthouse District, relieving Col. Curtis McD. Townsend, retired.

Col. HARRY TAYLOR has been appointed a member of the Anchorage Board, representing the War Department, relieving Maj. Gen. Lansing H. Beach.

Col. CLEMENT A. F. FLAGLER has been appointed Department Engineer, Hawaiian Department; District Engineer, Honolulu; and Commanding Officer, 3rd Engineers, Hawaii. In addition he has been detailed in the 19th Lighthouse District, relieving Col. Henry C. Newcomer, who is ordered to return to the United States and report to the Adjutant General for instructions.

Col. JAMES C. SANFORD has been appointed Division Engineer of the Northeastern Division, and detailed for duty in connection with lighthouses in the 3rd and 9th Lighthouse Districts, relieving Col. William C. Langfitt.

Col. SPENCER COSBY has been appointed Division Engineer, Southeastern Division, relieving Lieut. Col. William J. Barden. Prior to this detail Colonel Cosby was District Engineer at Galveston, Texas. His present station is Savannah, Ga.

Col. JAMES P. JERVEY has been appointed Division Engineer of the Eastern Division (at Baltimore, Md.), relieving Jol. James C. Sanford.

Lieut. Col. CURTIS W. OTWELL has been appointed District Engineer of the Wheeling, W. Va., Engineer District.

Lieut. Col. GEORGE P. HOWELL has been appointed Department Engineer, Southeastern Department, relieving Lt. Col. G. R. Lukesh.

Lieut. Col. HERBERT DEAKYNE has been appointed Division Engineer of the Gulf Division, relieving Col. Mason M. Patrick.

Lieut. Col. LEWIS H. RAND has been relieved from station and duty in San Francisco, Cal., and assigned to the command of the 4th Engineers, Camp Dodge, Iowa.

Lieut. Col. MERIWETHER L. WALKER has been appointed Division Engineer of the Central Division, relieving Maj Gen. Lansing H. Beach.

Maj. ARTHUR R. EHRNBECK has reported his arrival in Honolulu, T. H., where he was ordered for duty as Assistant to the Department Engineer. Major Ehrnbeck, prior to this detail, was on duty in the Office of the Zone Finance Officer, New York City.

Maj. WILLIAM P. STOKEY has been detailed as Superintendent of Lighthouses in the 14th Lighthouse District, relieving Maj. Gen. Lansing H. Beach.

Col. T. H. JACKSON has been appointed Department Engineer for the Northeastern Department. His headquarters are at Boston.

Col. R. G. ALEXANDER has been ordered to West Point as professor of drawing to succeed the late Col. E. R. Stuart.

Col. JAMES G. STEESE has been relieved from duty as a member of the General Staff Corps and directed to report to the Commanding General, Western Department for temporary duty in connection with commissioned personnel of the army. Upon completion of this duty Colonel Steese will proceed to Juneau, Alaska, for duty as President of the Board of Road Commissioners for Alaska, relieving Lieut. Col. John C. Gotwals of that duty. Lieut. Col. Gotwals will remain on duty in Alaska as Secretary and Disbursing Officer for the Board.

Maj. EARL J. ATKISSON, who has been engineer instructor at Camp Benning, has been assigned to the command of Edgewood Arsenal.

Maj. WILDURR WILLING has been assigned to duty as District Engineer at Boston, Mass., and detailed for consultation or to superintend the construction of any aid to navigation in the 1st and 2nd Lighthouse Districts, relieving Maj. Gilbert Van B. Wilkes.

Maj. ROGER G. POWELL, until recently on duty overseas as Engineer Purchasing Officer with station in London, Eng., has returned to the United States and has been assigned to duty as assistant to the Engineer Commissioner, District of Columbia.

Maj. EDWARD N. JOHNSTON has been assigned to duty as District Engineer at Wilmington, Del., relieving Col. James P. Jervey. Maj. W. F. Beyer, Chemical Warfare Service, has been detailed as assistant to Major Johnston.

Maj. CHARLES J. TAYLOR has been relieved from duty at Portland, Ore., and assigned to duty as Engineer Officer, Coast Artillery Training Center, Fort Monroe, Va., and as assistant to the District Engineer, Norfolk, Va.

Maj. CHARLES L. HALL has been relieved from duty as assistant to the District Engineer, Galveston, Tex., and ordered to duty in the Office of the Chief of Engineers.

Maj. LEWIS M. ADAMS has been assigned to duty as District Engineer, Galveston, Tex., relieving Col. Spencer Cosby.

Maj. ROBERT P. HOWELL has been relieved from duty as District Engineer at Nashville, Tenn., and assigned to duty as District Engineer, Vicksburg, Miss., and the 3rd Mississippi River District, relieving Capt. John W. Stewart.

Maj. RAYMOND G. MOSES has been relieved from duty with the 9th Engineers (Mtd.) and assigned to the 318th Engineers, Camp Grant, Ill.

Majs. RALPH T. WARD and LEWIS H. WATKINS have been assigned to duty as instructors at the General Service Schools, Fort Leavenworth, Kans.

Maj. RAYMOND F. FOWLER has been relieved from duty at West Point and assigned to the 9th Engineers (Mtd.), El Paso, Tex.

Capt JOHN W. STEWART has been directed to report at United States General Hospital No. 19, Oteen, N. C., for observation and treatment.

The following-named officers have been assigned to temporary duty as students at the Engineer School, Camp A. A. Humphreys, Va.:

Capt. William H. Holcombe,
Capt. John S. Bragdon,
Capt. Earl E. Gesler,
Capt. Alfred L. Ganahl,
Capt. John P. Conklin,
Capt. Mason J. Young,
Capt. Dabney O. Elliott,
Capt. Edwin A. Bethel.

Capt. PAUL A. HODGSON has been relieved from duty as assistant to the District Engineer at Philadelphia, Pa., and ordered to Manila, Philippine Islands, for duty with the 3rd Engineers.

Capt. ALBERT K. B. LYMAN has been relieved from Camp A. A. Humphreys, Va., and directed to St. Louis, Mo., as Secretary and Disbursing Officer, Mississippi River Commission.

Capt. JOHN E. HARRIS has been discharged from the Letterman General Hospital, San Francisco, Cal., and ordered to Camp A. A. Humphreys, Va.

Capt. THOMAS B. LARKIN has been relieved from duty at Camp A. A. Humphreys, Va., and assigned to the Office of the Chief of Engineers.

Capt. GERALD A. COUNTS has been relieved from duty with the 6th Engineers, Camp Pike, Ark., and assigned to the 9th Engineers (Mtd.), El Paso, Tex.

Capt. RAYMOND A. WHEELER has been relieved from duty as assistant to the District Engineer, Providence, R. I., and ordered to the Infantry School, Camp Benning, Ga.

Capt. HOWARD S. BENNION has been relieved from duty in the Office of the Chief of Engineers and assigned to the Office of the Assistant Chief of Staff, Director of Purchase, Storage and Traffic.

The provisional appointments of Lieutenants Walter L. Medding, Roy M. McCutcheon, Bennet H. Bowley and Geo. M. Steese have been made permanent, they having been found duly qualified by a Board of Officers. These officers have since been promoted to the grade of captain.

Maj. VIRGIL L. PETERSON has been relieved from duty at Camp A. A .Humphreys, Va., and assigned as Assistant to the District Engineer, Maj. Wildurr Willing, at Boston, Mass.

Capt. ROBERT M. FOX has been relieved from duty at Fort Bayard, N. M., and assigned to the 8th Engineers (Mtd.), Fort Bliss, Tex.

Lieut. WALTER S. OLSON, Chemical Warfare Service, recently discharged, has been appointed engineer on the Drainage and Waters Commission of Minnesota

Lieut. Col. E. B. MORDEN, recently provisional appointee, has been appointed permanent chief of the Bureau of Street Cleaning of Philadelphia. During the war Colonel Morden was constructing quartermaster at Camp Custer, Battle Creek, Mich., and subsequently constructing quartermaster of the Philadelphia Army Supply Base.

The resignations of the following-named officers of the Corps of Engineers have been accepted:

Capt. William B. Wilson,
Capt. Freeman Clarkson,
Capt. James B. Cress,
Capt. W. Morris Chubb,
Capt. Clifford H. Springer,
Capt. Rudolph C. Kuldell,
Capt. Edward P. Morton,
1st Lieut. Bernard E. Baer,
1st Lieut. William M. Howe,
1st Lieut. Robert A. Love.

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The following-named officers of the Corps of Engineers have been ordered to Boston, Mass., for a course of instruction at the Massachusetts Institute of Technology:

Captains—
Holland H. Robb,
George J. Richards,
Raymond G. Moses,
William A. Snow,
Thomas D. Finley,
Wilburn H. Henderson,
Ludson D. Worsham,
Ralph G. Barrows,
Robert R. Neyland, Jr.,
Stanley L. Scott,
Daniel Noce,
Henry Hutchings, Jr.,
Herman H. Pohl,
Gerald A. Counts,
Hiram B. Ely,
Kenneth M. Moore,
Thomas D. Stamps,
Girard B. Troland,
Llewellyn B. Griffith,
John P. Dean,
Patrick H. Timothy, Jr.,
Leland H. Hewitt,
Preston W. Smith,
Charles F. Baish,
James M. Young,
Thomas H. Nixon,

First Lieutenant—
Lemuel Pope, 3rd.

The following-named officers of the Corps of Engineers have been relieved from the Engineer School, Camp A. A. Humphreys, Va., and ordered to report for duty at the educational institutions indicated after their names (R. O. T. C.):

Capt. Earl E. Gesler—Iowa State College, A. & M. A., Ames, Iowa.
Capt. Donald A. Davison—Yale University, Sheffield Scientific School, New Haven, Conn.
Capt. Layson E. Atkins—University of Illinois, Urbana, Ill.
Capt. Patrick H. Tansey—Oregon Agricultural College, Corvallis, Ore.
Capt. Michael C. Grenata—University of Kansas, Lawrence, Kans.
Capt. Lucius DuB. Clay—Alabama Polytechnic Institute, Auburn, Ala.
1st Lieut. Harry A. Montgomery—Rose Polytechnic Institute, Terre Haute, Ind.
1st Lieut. Howard L. Peckham—University of Tennessee, Knoxville, Tenn.
1st Lieut. Edwin P. Lock, Jr.—Missouri School of Mines, Rolla, Mo.
1st Lieut. Albert Riani—State University of Iowa, Iowa City, Iowa.

The following-named officers have been relieved from duty at Camp A. A. Humphreys, Va., and ordered to report for duty to the commanding officers of the organizations indicated after their respeitive names:

Maj. Harold G. Smith, 4th Engineers, Camp Dodge, Iowa.
Maj. Charles E. Perry, 1st Engineers, Camp Taylor, Ky.
Capt. Hugh Miller, 2nd Engineers, Camp Travis, Tex.
Capt. Frank N. Smith, 5th Engineers, Camp A. A. Humphreys, Va.
Capt. Horace H. Braun, 318th Engineers, Camp Grant, Ill.
Capt. Mason J. Young, 7th Engineers, Camp Gordon, Ga.
Capt. Hubert W. Collins, 1st Engineers, Camp Grant, Ill.
Capt. Frank B. Hastie, 318th Engineers, Camp Taylor, Ky.
Capt. Arthur P. von Deesten, 4th Engineers, Camp Dodge, Iowa.
Capt. Tattnall D. Simkins, 9th Engineers, Camp Travis, Tex.
Capt. Frank M. S. Johnson, 4th Engineers, Camp Dodge, Iowa.
Capt. Aubrey H. Bond, 7th Engineers, Camp Gordon, Ga.
Capt. Frederick S. H. Smith, 2nd Engineers, Camp Travis, Tex.
Capt. Robert D. Ingalls, 6th Engineers, Camp Pike, Ark.
Capt. Eugene F. Gaebler, 318th Engineers, Camp Grant, Ill.
Capt. William C. Atwater, 5th Engineers, Camp A. A. Humphreys, Va.
Capt. Anderson T. W. Moore, 8th Engineers, Fort Bliss, Tex.
1st Lieut. John H. Veale, 1st Engineers, Camp Taylor, Ky.
1st Lieut. Henry C. Wolfe, 6th Engineers, Camp Pike, Ark.
1st Lieut. Henry Berbert, 6th Engineers, Camp Pike Ark.
1st Lieut. John M. Harman, 1st Engineers, Camp Taylor, Ky.
1st Lieut. David W. Griffiths, 2nd Engineers, Camp Travis, Tex.
1st Lieut. Bernard S. Stearns, 1st Engineers, Camp Taylor, Ky.
1st Lieut. Leslie L. Groves, Jr., 7th Engineers, Camp Gordon, Ga.
1st Lieut. Frederic B. Butler, 5th Engineers, Camp A. A. Humphreys, Va.
1st Lieut. Wilson G. Saville, 5th Engineers, Camp A. A. Humphreys, Va.
1st Lieut. Frederick A. Platte, 4th Engineers, Camp Dodge, Iowa.
1st Lieut. Karl B. Schilling, 6th Engineers, Camp Pike, Ark.
1st Lieut. John H. Elleman, 1st Engineers, Camp Taylor, Ky.
1st Lieut. William D. Wanamaker, 318th Engineers, Camp Grant, Ill.
1st Lieut. Beverly C. Snow, 7th Engineers, Camp Gordon, Ga.
1st Lieut. Otto Praeger, Jr., 7th Engineers, Camp Gordon, Ga.
1st Lieut. Newell L. Hemenway, 6th Engineers, Camp Pike, Ark.
1st Lieut. Chester K. Harding, 318th Engineers, Camp Grant, Ill.
1st Lieut. William V. Hesp, 4th Engineers, Camp Dodge, Iowa.
1st Lieut. William C. Bennett, Jr., 9th Engineers, Camp Travis, Tex.
1st Lieut. Claude H. Chorpening, 6th Engineers, Camp Pike, Ark.
1st Lieut. James P. Jervey, Jr., 5th Engineers, Camp A. A. Humphreys, Va.
1st Lieut. George S. Witters, 4th Engineers, Camp Dodge, Iowa.
1st Lieut. Harvey D. Dana, 5th Engineers, Camp A. A. Humphreys, Va.
1st Lieut. John P. Dietrich, 2nd Engineers, Camp Travis, Tex.
1st Lieut. William A. Callaway, 318th Engineers, Camp Grant, Ill.
1st Lieut. Howard V. Canan, 4th Engineers, Camp Dodge, Iowa.
1st Lieut. Vere A. Beers, 7th Engineers, Camp Gordon, Ga.
1st Lieut. John B. Hughes, 5th Engineers, Camp A. A. Humphreys, Va.

The following-named officers of the Corps of Engineers, having been examined as required by law and found qualified, were promoted to the ranks indicated:

To be Brigadier General, U. S. A.—
Col. Henry Jervey.

To be Colonels:
Lieutenant Colonels—
Herbert Deakyne,
Spencer Cosby,
Jay J. Morrow,
James P. Jervey,
James B. Cavanaugh,
George P. Howell,
Charles W. Kutz.

To be Lieutenant Colonels:
Majors—
George B. Pillsbury,
Gustave R. Lukesh,
John R. Slattery,
Curtis W. Otwell,
Albert E. Waldron,
Francis A. Pope,
Gilbert A. Youngberg.

To be Majors:
Captains—
John R. D. Matheson,
Charles J. Taylor,
Edwin H. Marks,
Earl North,
Gilbert Van B. Wilkes,
John C. H. Lee,
Frank S. Besson,
Albert K. B. Lyman,
Creswell Garlington,
Daniel D. Pullen,
Carey H. Brown,
Oscar N. Solbert,
Beverly C. Dunn,
Donald H. Connolly,
Raymond F. Fowler.

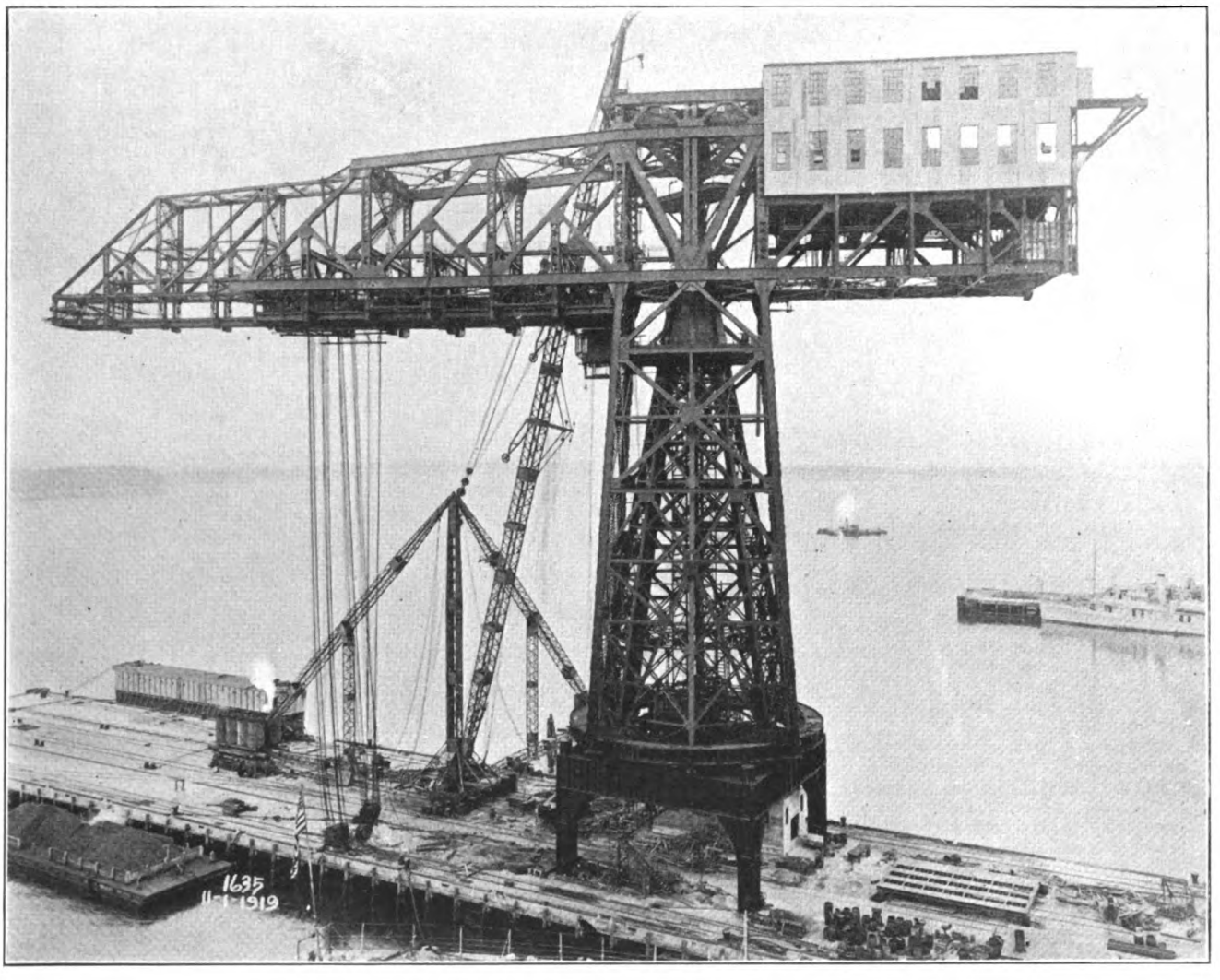
To be Captains:
1st Lieutenants—
Hans Kramer,
Albert G. Matthews,
Amos B. Shattuck, Jr.,
Leland H. Hewitt,
Michael C. Grenata,
Preston W. Smith,
Thomas F. Kern,
Ralph E. Cruse,
Lewis T. Ross,
Charles F. Baish,
Clarence L. Adcock,
Keryn ap Rice,
Charles S. Ward,
Henry M. Underwood,
James B. Newman,
James M. Young,
James C. Marshall,
Walter E. Lorence,
Bennett H. Bowley, Jr.,
Robert D. Ingalls,
Walter L. Medding,
Warren A. Lyon,
Albert C. Lieber, Jr.,
Robert K. Munroe,
Eugene F. Gaebler,
William C. Atwater,
John A. Strang,
George J. Nold,
John P. Dean,
Patrick H. Timothy, Jr.,
Hugh J. Casey,
Robert E. Hamilton,
Patrick H. Tansey,
Lucius DuB. Clay,
Lloyd E. Mielenz,
Pierre A. Agnew,
Alexander M. Neilson,
Hoel S. Bishop, Jr.,
Charles E. McKee,
Robert H. Elliott,
Samuel D. Sturgis, Jr.,
Thomas H. Nixon,
Anderson T. W. Moore,
Reginald Whitaker,
Eugene M. Caffey,
Leonard B. Gallagher,
F. Russel Lyons,
Fernando T. Norcross,
William N. Thomas, Jr.

To be 1st Lieutenants:
All 2d Lieutenants of the Corps.

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SC-19

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The appointments of the following-named officers of the Corps of Engineers have, by order of the President, been honorably terminated:

Capt. Simon Medine,
1st Lieut. Philip N. Cristal.

The following named emergency officers of Engineers have been honorably discharged the service, their services being no longer required:

Capt. Victor Willits,
Capt. James M. Ranck, Sr.,
1st Lieut. Clark B. Carpenter,
1st Lieut. Ralph G. Shankland,
1st Lieut. Morgan H. Patten.

HAL M. SCOTT, former captain of Infantry, 32nd Division, U. S. A., has been elected chief engineer, and John P. Bonner, former captain of Trench Mortars, 2nd Division, U. S. A., has been elected resident engineer, of the Greenbrier & Eastern R. R. Co., with headquarters at McClungs, Greenbrier County, W. Va. Construction has just been begun on this railroad, which will connect with the Sewell Valley R. R. at Rainelle, W. Va., and will be about 12 miles in length.

LEWIS E. KNERR, former captain of Engineers, U. S. A., has resigned his position in the Tacoma (Wash.) city engineer's office to become constructing engineer of the Seattle (Wash.) Hemlock Mills, Ltd.

Maj. RAY W. BERDEAU, formerly with the U. S. Engineers, on New York harbor improvements, has left for Hong Kong, China, in the employ of the Vacuum Oil Co.

HENRY WELLS DURHAM, formerly Major, Engineers, with the American Expeditionary Forces, has received from the French Government the *Mérite Agricole*, a decoration conferred in recognition of his work on road construction and maintnance during his service abroad with the Division of Construction and Forestry.

L. FRED PATSTONE, recently Major, 217th Engineers, U. S. Army, has resigned as city engineer of Manila, P. I., to accept the managership of the China Development Co., with offices at 34 Nanking Road, Shanghai.

Lieut. Col. GEORGE D. SNYDER has been commissioned Colonel, commanding the 22nd Regiment, Engineers, New York Guard. He joined the regiment in 1915, serving with it on the Mexican Border in 1916, and when it was reorganized for the World War as the 102nd Engineers he served with it in all the actions with the 27th Division in Belgium and France. Colonel Snyder is a member of the firm of Jacobs & Davies, Inc., consulting engineers, builders of the Hudson tunnels.

Brig. Gen. WILLIAM L. MARSHALL, formerly Chief of Engineers, U. S. Army, for the past ten years consulting engineer to the Secretary of the Interior, has tendered his resignation on account of ill health. As we go to press the death of General Marshall at Walter Reed Hospital is announced. Notice later.

Capt. GEORGE M. SHEPARD, Engineers, recently discharged from the Army, has accepted a position with L. P. Wolff, Consulting Engineer, St. Paul, Minn.

Col. GEORGE A. JOHNSON of the Construction Division of the Army, has resigned his commission to assume his duties as the directing head of the engineering firm, Johnson & Benham, with offices in New York City and in Kansas City, Mo. The specialty of the organization whose general direction Colonel Johnson will assume, is the design, construction, supervision and management of water supply and sewerage plants and other public utilities.

Capt. BILLINGS WILSON, Corps of Engineers, U. S. Army, has resigned from the service, effective April 1, to take a position with Francis Lee Stuart, consulting engineer, New York City.

Capt. JAMES N. GLADDING, recently returned from overseas service, has received the appointment of city manager of Albuquerque, N. M., taking the position made vacant by the resignation of A. R. Hebenstreit. Captain Gladding was formerly city engineer of Albuquerque.

Capt. WILLIS G. WHITTEN, Engineers, U. S. A., (1st Lieut., Corps of Engineers, Regular Army), died at Coblenz, Germany, March 13, 1920. He was born in Nebraska, Oct. 10, 1892, and was apponted a second lieutenant in the Engineer O. R. C., June 11, 1917. He was commissioned a second lieutenant, Corps of Engineers, in the Regular Army July 7, 1918, and was appointed a temporary captain the same date.

E. A. MORITZ, office engineer, U. S. Reclamation Service, Denver, Colo., has been appointed project manager of the Flathead Project, with headquarters at St. Ignatius, Mont.

G. R. SOLOMON, recently colonel U. S. A., officer in charge of engineering branch Construction Division of the Army and formerly of Solomon-Norcross Co., consulting engineers, Atlanta, Ga., has resumed engineering practice as vice-president of the Fuller Industrial Engineering Corp., 949 Broadway, New York City.

C. F. LEWIS has resigned his position with the U. S. Bureau of Public Roads to open offices in Greensboro, N. C., under the firm name of Spoon & Lewis, consulting engineers. The firm will render general consulting service, giving particular attention to highway and municipal work.

Maj. ROBERT C. WHEELER, chief of water supply section, Construction Division, U. S. Army, recently discharged, and at the time of leaving associated with Capt. Harry Barker, New York City, in the general practice of engineering, sailed March 16 for Athens, Greece, with a party of engineers organized by Ford, Bacon & Davis to prepare plans and estimates for the water supply and sewerage of Athens. Major Wheeler will be in charge of the work on water distribution, sewage collection in that city and methods of sewage disposal. The work will require about six months and on its completion he will return to New York and resume active participation in the work of his firm.

W. G. CALDWELL, formerly captain, Engineers, U. S. A., has been appointed highway engineer of Waukesha County, Wis., with offices in Waukesha.

Col. THOMAS MANN RANDOLPH TALCOTT, civil engineer, died at Richmond, Va., May 7, aged 82 years. He was born in Philadelphia, in 1838, one of the sons of Capt. Andrew Talcott, formerly of the Corps of Engineers, U. S. Army.

During the Civil War Colonel Talcott served as Lieutenant of Engineers in the Confederate Army. His professional career was devoted to railroad engineering and administration.

U. S. ENGINEER OFFICE, First District, New York City, Room 710, Army Building, 39 Whitehall Street, New York City.—*To whom it may concern:* Whereas navigation is obstructed and endangered by wreck of a wooden boat, name unknown, sunk in the Hudson River between Hazards Landing and Dupont Dock, N. J.: Notice is hereby given, that unless said vessel is removed by the owner within thirty days from July 8, 1920, it will be removed by the United States under authority of law. Sealed proposals will be received here until 12 M., August 9, 1920, and then opened, for removing said wreck. Information on application.

Discharge of Regular Army officers from emergency commissions.—Under authority of a General Order, issued June 5, 1920, all officers of the Regular Army holding advanced rank, who have not been discharged from their emergency commissions, are discharged therefrom effective June 30, 1920.

Value of top soil for highways.—Top soil should be used for foundation wherever possible. It is claimed that this is proven advantageous by observation in the State of Ohio. Shallow side ditches for quick drainage entirely away from the road into the fields are preferable to deep side ditches and the holding of water contiguous to the road for long periods. Stability of berms is increased by shallow ditches. Soils and drainage need study in conjunction with highway building. Railroad grading methods have had too much influence in highway construction.—*Eng News-Record.*

A comparison of steam and electric motive power.—Mr. A. H. Armstrong, of the General Electric Co., recently delivered an address with the above title before the Schenectady section of the American Institute of Electrical Engineers, from which the following is taken:

During the winter of 1917-18 our railways fell down badly when the need was the greatest in their history. It is true that the cold weather conditions were unprecedented and the volume of traffic abnormal, but the weakness of steam-engine haulage was disclosed in a startling manner.

In marked contrast to adjoining steam-engine divisions, the 440 miles of electrified section of the Chicago, Milwaukee and St. Paul R. R. continued to do business as usual throughout the trying winter of 1917-18. Freight and passenger trains were brought over the electrified tracks on schedule time or better; in fact, it was customary to make up on the 440-mile electric run fully two hours of the time lost by passenger trains on adjoining steam-engine divisions.

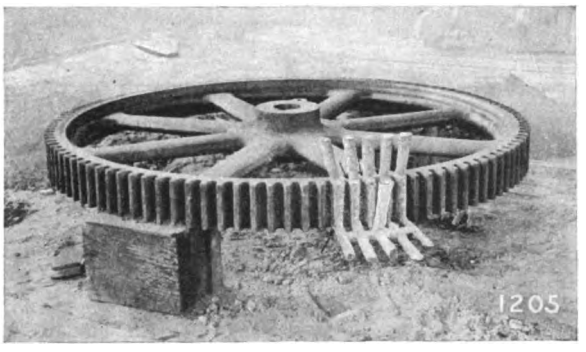
The author, in discussing other advantages of electrification, points out that a large reduction in non-revenue producing ton mileage would be made by eliminating locomotive tenders and locomotive coal, and also in the reduction of railway coal, by reason of the great savings that could be made burning fuel in large modern power stations under the most efficient conditions possible, rather than under the boilers of 63,000 locomotives now in service throughout the country.

Without considering water power as a means for generating electricity, he estimates that the electrification of our railroads would in 1918 have saved more than two-thirds of the consumed by the railroads that year.—*Eng. and Cont.*

Graduation exercises, Engineer School.—Graduation exercises were held in the open-air ampitheater near Harris Hall on June 16, 1920. Gen. W. D. Connor, the Commandant of the School, gave a talk to the graduating class. He was followed by Secretary of War, Newton D. Baker, who gave the address of the day. Music was furnished by the Fifth Engineer Band. Practically the entire Post attended.

A large number of officers, students and instructors, have received orders relieving them from the school. Almost all will go to duty with troops.

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Professional Notes

of Military and Engineering Interest

Heights of vessels and clearance of bridges.—An investigation has recently been conducted by the Port Facilities Commission, United States Shipping Board, to ascertain the maximum height of seagoing vessels above light and load water line, the results of which are of interest in connection with the vertical clearance of bridges, and cable lines across navigable waters.

Data were received as to 53 vessels ranging in gross tonnage from 4,170 to 54,281 and in height above water line from 96.8 to 217 feet.

Fifteen of the 53 vessels have a maximum height above light-water line greater than 150 feet, as follows:

Fifteen vessels of maximum height (in feet)

Name	Built	Gross tonnage	Height Light	Height Loaded.
Aquitania	1914	45,647	217.0	205.0
Leviathan	1914	54,281	192.8	186.5
Stavangerfjord	1917	13,600	191.0	183.0
Carmania	1905	19,524	181.0	173.0
Caronia	1905	19,687	181.0	173.0
Mauretania	1907	30,704	173.0	170.0
Nestor	1918	14,501	168.5	153.0
Henderson	1917	7,493	164.4	157.0
Rotterdam	1908	24,149	162.3	149.0
Geo. Washington	1908	25,569	159.7	154.0
Von Steuben	1901	14,908	154.8	151.0
Noordam	1902	12,531	153.5	135.8
Ryndam	1901	12,527	152.5	135.8
Aeneas	1910	10,049	151.0	136.0
Ascanius	1910	10,048	151.0	136.0
Average (15)	1909	21,014	170.0	159.9

The following table contains data on the more important bridges under which ocean-going vessels pass.

Clearances of important bridges.

Name of bridge.	Type.	Waterway.	Maximum horizontal span in feet.	Vertical clearance in feet.
Poughkeepsie	Cantilever	Hudson River	547	160
Firth of Forth	Cantilever	Firth of Forth	1,700	157
Quebec	Cantilever	St. Lawrence River	1,800	150
Vancouver	Vertical lift	Columbia River	250	150
Glisan Street, Portland, Oreg.	Vertical lift	Willamette River	205	144
Tower Bridge, London	Double bascule with overhead footway	Thames River	280	141
Brooklyn	Cable suspension	East River	1,546	135
Manhattan	Cable suspension	East River	1,470	135
Williamsburg	Cable suspension	East River	1,536	139
Hell Gate	Fixed arch	East River	1,017	135
Queensboro	Cantilever	East River: East span	947	135.6
		West span	1,153	133.6

Of the 53 vessels reported on, 32 have a height above light-water line greater than 135 feet and are therefore unable to pass under the East River bridges.

Of 19 vessels whose gross tonnage ranges from 12,527 to 54,281, 12 exceed 150 feet and 16 exceed 135 feet in height.

Of 18 vessels whose gross tonnage ranges from 10,048 to 11,850, 2 exceed 150 feet and 9 exceed 135 feet in height.

Of 16 vessels whose gross tonnage ranges from 4,170 to 9,996, 1 exceeds 150 feet and 7 exceed 135 feet in height.

Of the 53 vessels, only one, the *Powhatan*, gross tonnage 10,531, is less than 100 feet in height. Its height above light-water line is 96.8 feet.

The vessels built during the war for the Emergency Fleet Corporation, ranging in gross tonnage from 2,020 to 7,898, all have heights less than 100 feet. This is due, however, to the fact that the height of these vessels was, prior to the signing of the armistice, kept as low as possible. Restrictions upon the allowable height of vessels of the Emergency Fleet Corporation have now been removed.

In view of the constant tendency to give deep water access from the sea to important cities at moderate and even considerable distances from the ocean, the restricted heights of bridges are a serious problem.

Facts and figures about pulp and paper.—The annual newsprint requirements of city daily papers vary from about 2,500 tons in the smaller cities to 160,000 tons in the case of the New York Journal, the paper having the largest circulation in the country.

A few of the newspaper companies, such as the New York World, have their own paper mills. The New York Times makes most of its newsprint at its mill in Brooklyn, using pulp from Canada. However, the company recently bought 2,500 tons from the Powell River Company in Vancouver. The cost of this paper delivered in New York, including freight charges amounting to $24, was $125 a ton, which was cheap compared to spot market prices of $140 to $160.

The present abnormal consumption of newsprint is, of course, the result of the unusual amount of advertising. Newspaper advertising in the 16 leading cities of the United States increased from 56,000,000 agate lines in January, 1919, to 80,000,000 in October, 1919.

Whether justified or not there is a general feeling among publishers that there is at least an understanding between the manufacturers. Almost every publisher was reduced on his 1920 contract, with the result that he will have to buy the balance of his requirements on the spot market. With spot sales of $8 to $10 per hundred pounds it is, of course, to the advantage of the manufacturer to sell as much as possible in that way, and still retain his regular customers.

Reports from Canada indicate that the yearly production of newsprint is over 800,000 tons, and that only 120,000 tons are consumed in the country. The mill capacity of Canada is being considerably increased.—*Forest Service Bulletin.*

Aerial photography in map making in France.—During the war, aerial photography was one of the most efficient means of investigation placed at the disposal of the Command. But in addition to general information secured by photographs from airplanes, this method was more specially utilized to complete the existing maps.

The *Plans Directeurs* on scales: 1/5,000, 1/10,000, 1/20,000, were prepared from accurate instrumental surveys or compilation of cadastral maps. Photographs from the air allowed the addition to these maps of all emergency features of the ground (allied and enemy organizations) as well as every change in the prewar cultural features (new roads, trails, demolitions, etc.).

After the armistice, the co-ordination of the results obtained during the war by the employment of aerial photography was contemplated, as well as their utilisation for the needs of peace time.

The use of photographs from the air was chiefly considered as a means of making a new cadastral map or bringing it up to date, and also for the preparation of maps on a larger scale.

The value of these new methods remain to be demonstrated.

As a rule, it may be said, that from the viewpoint of planimetry, photographic surveys give a representation of the details as exact and precise as that obtained with the regular methods of surveying. The efficiency is particularly valuable in case of terrain exhibiting complicated features.

Furthermore, the momentous advantages in economy of personnel and working facilities are obvious. Nevertheless, it must not be forgotten that some difficulties have to be overcome, especially the distortions of the photographs. Further investigations must therefore be made.

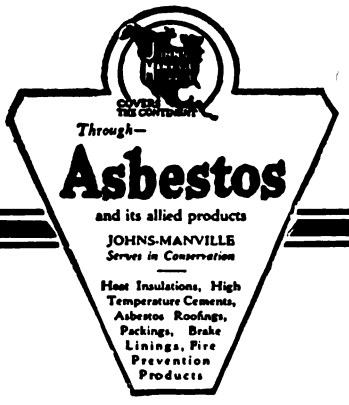
As far as relief is concerned, the use of aerial photographs has not as yet given any great promise of usefulness.

During the war, the duties of the Air Service and the *"Service geographique"* were always distinct.

The personnel of the Air Service was responsible for the taking of photographs (special airplanes, observers) and laboratory work in the development of negatives and printing.

The personnel of the "Service geographique" (working in the "groupes de canevas de tir d'Armee") was responsible for the utilization of photographs from the air for map purposes, restitution of photographs, determination of the location of the various details, siting of these details in the "Plans directeurs," etc.).

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But it may be presumed that in the peace-time organization, in view of the execution of the topographic works necessary for surveying or correcting the maps, the duties of the "Service geographique" will be extended to include all photographic work.—Report from the French War Dept.

Pile and concrete piers for Missouri River bridge.—Timber pile piers constitute a notable feature of the new Missouri River bridge for the Chicago, Milwaukee and St. Paul Railway, at Chamberlain, S. D. The original bridge, built at this site in 1905, was a 1,500-foot pile trestle with a ponton draw span. In 1916, the ponton, which had become old and leaky, was replaced by a temporary 75-foot plate girder swing span on pile piers. To provide for the great quantity of ice and the excessive scour in the 20-foot blanket of sand and silt forming the river bed, the present design was adopted as providing a practically permanent structure within the practicable limits of war-period financing. A portion of the old trestle is replaced by two 300-foot steel trusses on pile and concrete piers, with a 262-foot ponton draw at the east end of the trusses.

The piers are of uniform design, including a main pier and an ice breaker nose. The main pier is about 30 feet above the river bottom, 14 feet wide at the top and 36 feet long, with a wedge-shaped vertical tail. The ice breaker, of similar height and width, and a total length of about 58 feet, has a wedge-shaped nose inclined at an angle of about 30 degrees. As protection against scour the whole pier is surrounded by a willow brush mattress which was woven on scows and, after launching, was sunk by loose rock thrown from barges. In addition riprap was deposited around the pier.

Each main pier contains 7 rows of piles, with 12 piles in each row, capped about 8 feet above high water, the outer piles being battered. Cedar piles 70 to 80 feet long were used, and all were driven to refusal with a penetration of 30 to 50 feet. 12 x 12 inch longitudinal timbers, 3 inches apart, were bolted to the batter piles of the pier, to form a heavy sheathing, while plank sheathing was spiked to the five piles driven to form the wedge-shaped tail. To hold the riprap protection in place, a row of 40-foot piles was driven just outside of the pier, and another row of 30-foot piles, about 4 feet away. Both of these rows of piles were cut off below low water and covered with the stone fill around the pier. Midway between high and low water levels is a 30-inch concrete slab thickened to 66 inches at the upstream edge to afford bearing for the crib-work of the ice breaker. It is reinforced, top and bottom, with longitudinal and transverse bars, the latter being looped around the piles of the outer rows. The slab is also tied to the piles by 12-inch spikes partly driven into the piles and partly embedded in the slab. A timber grillage forms the deck of the pier and supports the shoe castings for the truss spans. A concrete deck slab was originally contemplated, but the grillage was substituted in the interest of speed. The top of the pier is covered with galvanized steel sheeting as protection against cinders and sparks.

The ice breaker, which is built integrally with the pier, contains seven 4-pile transverse bents, spaced 8 feet c. to c. and of varying heights, 5 piles in the wedge-shaped nose and 2 compact groups of 5 piles each behind and against each of the bents. Each bent is capped, and longitudinal struts between the piles of the two inner rows stiffen the entire structure. The horizontal sheathing and the riprap anchor piles of the main pier are extended along the ice breaker. The crib is filled with stone, and riprap is placed along the outside.

Reinforcing bars were laid along the timbering at the slope of the nose of the ice breaker, and concrete was filled over the timbers and bars to a minimum depth of 12 inches At the ridge it is faced by a line of old rails embedded flush with the concrete and anchored by U-bars passing through holes in the web of the rail. To prevent scour at the nose, the concrete is carried vertically downward in the form of a toe wall for 5 feet, and the rail extends to the bottom of this wall.

The substructure of this bridge was commenced in July, 1918, and in January it was ready for the steel erection, which was completed in March, 1919. The new ponton was launched and installed when the ice went out in April.—*Eng. News-Record.*

Commercial traffic on the Panama Canal.—There has been a steady and very satisfactory increase of traffic through the canal, as shown by the following table:

Year (calendar).	Number Vessels.	Tons of cargo.
1915	1,149	4,894,134
1916	1,222	4,83_,496
1917	1,960	7,427,680
1918	2,072	7,294,502
1919	2,134	7,468,167

In the first four months of 1920 the total cargo passing was 3,425,195 tons.

If the capital cost of the canal be placed at $450,000,000, and interest on this sum at 5 per cent, the annual interest charge (not including operating expenses and maintenance) is $22,500,000. For the year 1919 this meant about $3 per ton of cargo.

Safety an important factor in commercial operation of aeroplanes.—After being in operation for nearly a century, neither railroads nor ocean steamers are immune from accidents, and it is probably useless to expect that travel by the air can be rendered more secure than these older methods of travel by land and sea. But it is reasonable to hope that the frequency of accidents may be reduced, thus providing aviation with a relative security, at least equal to that of other methods of locomotion.

For the public safety, and especially in order to give confidence to the passengers, it is necessary henceforth to study devices for absolutely avoiding fires and all dangers of impact on landing.

As a matter of fact, the landing chassis of the large airplanes have received little attention up to the present time. For the war plans we have certain fixed rules, and landing chassis with V struts, joined axles and rubber shock-absorbers have been generally adopted. But with such devices, if the pilot makes an abrupt landing, the fuselage receives a considerable shaking up.

It has been assumed that the shocks are practically deadened in the following proportions:

30 per cent for the pneumatic tires.
15 per cent by the flexion of the nonjointed axles.
55 per cent for the shock-absorbers.

For the war airplanes, nearly all the builders have placed the center of the wheels in front of the center of gravity at a distance about equal to one-quarter of the height of the center of gravity from the ground, corresponding to about 13 or 14 degrees. This gives a device which practically avoids the danger of overturning, but which in certain cases subjects the tail skid to rather severe strains, especially if the fuselage is short.

For the airplanes intended to carry heavy loads, the question of tail skid shock absorbers is an important one, as there is little use of easing the landing if, at the moment when the tail skid touches the ground, all of the passengers are to be rudely jostled about in their seats.—*War Department News Bureau.*

Service pay increase.—After many months of delay Congress on May 14 passed the act granting increased pay to the united services, and the act became law when signed by the President on May 18.

The increases, which are very small, ranging from 10 to 23 per cent of officers' compensation, are in the form of a temporary bonus, effective until June 30, 1922.

The monthly increases for the Army and for corresponding grades in other services are as follows:

Second lieutenant	$35.00
First lieutenant	$50.00
Captain	$60.00
Major	$70.00
Lieutenant colonel	$50.00
Colonel	$50.00

No increases are allowed in the higher grades, and none for retired officers.

The most satisfactory portion of this act is that which provides transportation in kind for the families of officers making a change of station.

The expense of estimating.—When ten contractors make ten separate quantity estimates on a piece of work, the cost is ten times as great as if an accurate quantity estimate had been furnished the contractors when bids were invited. It is commonly supposed that this burden is borne by the contractors. But the contractor must "pass it on" to the public, and it thus becomes a waste—an unnecessary charge against the community.

If the owner goes to the trouble to prepare the plans, it is logical for him to go further and prepare a bill of materials. If there be a mistake in the bill of material, this is easily adjusted in the light of the facts.

This will not eliminate all the contractors' estimating expenses, but it would tend to eliminate chances of mistakes and the additional charges to cover them, and to acknowledge bids. The great variation in bids is often due to variation in quantity estimates quite as much as to variation in unit prices. It is to be remembered also that a contractor must often bid on ten jobs to get one.—*Eng. and Cont.*

Note.—The practice of preparing quantity estimates for the benefit of bidders, and as a uniform basis for canvassing bids, has long been the universal custom of the U. S. Engineer Dept.—Ed.

The roads of France—a summary.—Maj. H. W. Durham, Engrs., in *Good Roads*, gives a most thorough and entertaining account, based on accurate personal observation, of the roads of France, from which the following is taken:

The many routes of France, connecting the principal cities, are generally well aligned—straight. They were not spoiled by too much consideration for local topography and property rights. They were intelligently located in the beginning to meet the needs of the country.

A department of public works exercises complete control of the national routes under

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a comprehensive and continuous plan for development, construction and maintenance. Minor routes are administered by departments and communes. The mileage is, national routes, 24,000; departmental, 18,500; all others, 375,000. The same methods of maintenance are in force on all classes, and all are supervised by the national organization.

The general plan or layout is like that of a spider web, the radiating lines being the national and the connecting lines the departmental routes.

Grades generally do not exceed 3 per cent, and very long tangents, often several miles, are characteristic, greatly facilitating motor traffic. All bridges and culverts are of permanent construction. In the mountains, tunnels, lighted by electricity, are often encountered. The width of the national routes, including berms, varies from 20 to 30 feet.

Drainage is by means of cross ditches through the grassy berms to the side ditches or main drains. Lines of trees grow on the berms, forming the most characteristically striking feature of the French national routes.

All routes are thoroughly marked by signposts at each intersection, with metal arms indicating distances to adjacent towns, both the small towns next in order, and the larger towns on the same route. These signs were evidently designed in the days of horse transport, as the lettering is too small to be satisfactory from the motorist's point of view. During the war it was found necessary to supplement these really attractive markers with large, ugly signboards bearing large painted letters which could be read without slacking speed, even in the dusk.

The minor routes resemble the national roads, as to surface, general construction, signposting, etc. They are generally of less width and not so heavily metalled.

The national routes formerly all ran through the towns, merging into the streets and being often difficult to follow, especially for the foreign motorist passing through at night. Occasionally the modern national routes pass outside the smaller towns lying upon them.

The system of maintenance is perhaps the best feature of the French road system. It is simple, like all good things, but very efficiently administered. It consists in keeping the ditches open and all water off the road, patching pot-holes as soon as they develop, scraping off mud and dust, and respreading binder. When the old surface becomes too worn for minor repairs, a new layer of 2 to 3 inches of macadam is added, and thoroughly compacted with road rollers.

Formerly some of the principal routes, especially in the vicinity of Paris, were paved with Belgian block. These are being gradually replaced by macadam or telford-macadam. As rock is found close to the surface almost everywhere in the country, the supply of road metal is a simple problem—the cantonniers can find it for themselves if necessary. But as this rock is rather soft and of indifferent wearing quality, the labor of maintenance is heavy and continuous. For many of the important routes better grades of rock have been transported from the localities where they are found.

The advent of the motor vehicle, which was earlier in France than in the U. S., brought the French engineers their troubles. The problem was not, as with us, to provide new routes, as there were ample numbers in existence. But the high-speed motor soon proved destructive to the wearing surface of simple, water-bound macadam. Before the war road maintenance was barely able to keep pace with the destruction wrought by the motor vehicle, and experiments with bituminous binders were in progress.

In its general plan and efficient maintenance the French road system is a model for the world. But the French roads will not stand up under heavy motor traffic without unduly heavy maintenance, and at best they are dusty in summer, which is not only a nuisance, but involves the waste of enormous quantities of material. A better wearing surface must be found for the principal routes at least.

In three important respects the French roads are superior to those of any other country:

(1) In the national system of control, with its splendid organization, independent of politics.

(2) In a complete original plan and layout, and good design and construction, making extensive new work unnecessary.

(3) In continuous and systematic maintenance on a simple and effective plan.

With such a foundation it may be expected that French road engineers will successfully meet the grave problems of motor traffic which now confront them.

The best French roads are not equal to the best American roads. But the French road system, as a whole, is greatly superior to that of America, in layout, design, construction, administration and especially maintenance.

Water power in Canada.—Practically every great industrial center in Canada is now provided with hydro-electric power, and the system is being rapidly extended. A great variety of industries are served.

The water-power resources of Canada are estimated as easily 20,000,000 horsepower, of which 3,385,000 will be usefully developed when plants now under construction are completed. The tendency is toward the installation of large units, 76.3 per cent being contributed by units of 2,000 horsepower or more.

The total capital now invested in central stations is $370,000,000, an average of $210 per primary horsepower.

With a development of 274 horsepower per thousand of population, Canada is surpassed in this development only by Norway. The enormous reserves still untouched are a guarantee of continuous industrial expansion and prosperity.—*Jour. West. Soc. of Engrs.*

Public hearings on Great Lakes-St. Lawrence River deep waterway.—Hearings on the proposal to construct a deep waterway from the Great Lakes to the sea via the St. Lawrence River were held in a number of American and Canadian cities in May and June by the international joint commission of the United States and Canada.

The commission's itinerary, announced recently, included hearings at North Bay, May 7; Marquette, May 10 and 11; Fort William, 13 and 14; Winnipeg, 15 and 17; Grand Forks, 18; Regina, 20; Calgary, 22 and 24; Billings, 26 and 27; Boise, 31; Cheyenne, June 2; Denver, June 3; Omaha, 5 and 7; Des Moines, 8; Aberdeen, 9; Minneapolis, 11 and 12; Duluth, 14 and 15; Superior, 16; Ashland, 17; Milwaukee, 18 and 19; Toledo, 21; Lansing, 22; Windsor, Ontario, 23; London, Ontario, 24; St. Catherine's Ontario, 25; Hamilton, Ontario, 26; Buffalo, 28 and 29.

Permanent type of check dam in Southern California.—Check dams of a permanent type of reinforced concrete construction have been successfully used to control storm waters out of the foothills in Ventura county and to prevent expensive erosion, which in the past has ruined many acres of valuable tableland.

In places where the fall is 3 or 4 per cent and greater, the storm waters have cut narrow channels as deep as 50 feet in the valuable flat lands, and if not controlled they become deeper and wider every year. The banks and side walls of the channels are all soil, and there are few bowlders or rocks of any kind in the bottoms.

The design of the dams which have been constructed is the result of study of local conditions. They are of reinforced concrete and open, box-like construction, the sides of which are thin panels supported by cut-off walls, which penetrate 5 feet into the solid sidewalls of the channel. The excavations for these cut-off walls are just wide enough to receive the concrete, so there is no back-filling, and the chances of percolation around the cut-off walls are reduced to a minimum.

The water falls over a semicircular spillway into a pool, or water cushion, formed by a baffle wall between the sides. Where it is desired to raise the bed of the channel 25 feet at once, it is the practice to have the first water cushion 8 feet deep and a second below, 3 feet deep. The result of placing one of these dams in a channel is the filling up of the channel above the dam with silt and, while this is taking place, a cutting or lowering of the bed below. After the channel is filled above and a sufficient grade established for the water to carry silt, the portion below will fill again. The outlet must be so designed that the structure will not be endangered by this lowering of the channel.—*S. W. Builder and Contractor.*

U. S. ENGINEER OFFICE, Room 710, Army Building, 39 Whitehall Street, New York City.—Complaint having been made regarding delays to southbound trains on the Third Avenue elevatel line, New York City, at certain hours of the day through the opening of the Harlem River drawbridge, a public hearing to consider the matter will be held before the undersigned at Room 512, Army Building, 39 Whitehall Street, New York City, at 10 a. m., July 27, 1920. Interested parties are invited to be present.—EDW. BURR, Colonel, Engrs.

Naval strength and programs of leading nations, May, 1920.—The following is the displacement tonnage of all war vessels built and projected (including all now building) for the navies of the world:

Nation.	Built.	Projected.	Total.	Per cent of total projected.
Great Britain	2,457,777	141,370	2,599,147	6
United States	1,126,637	900,515	2,027,152	39
Japan	555,821	811,020	1,366,841	36
France	524,209	154,168	678,377	7
Italy	285,021	146,922	431,943	6
All others	628,158	130,780	758,938	6
	5,577,623	2,284,775	7,862,398	100

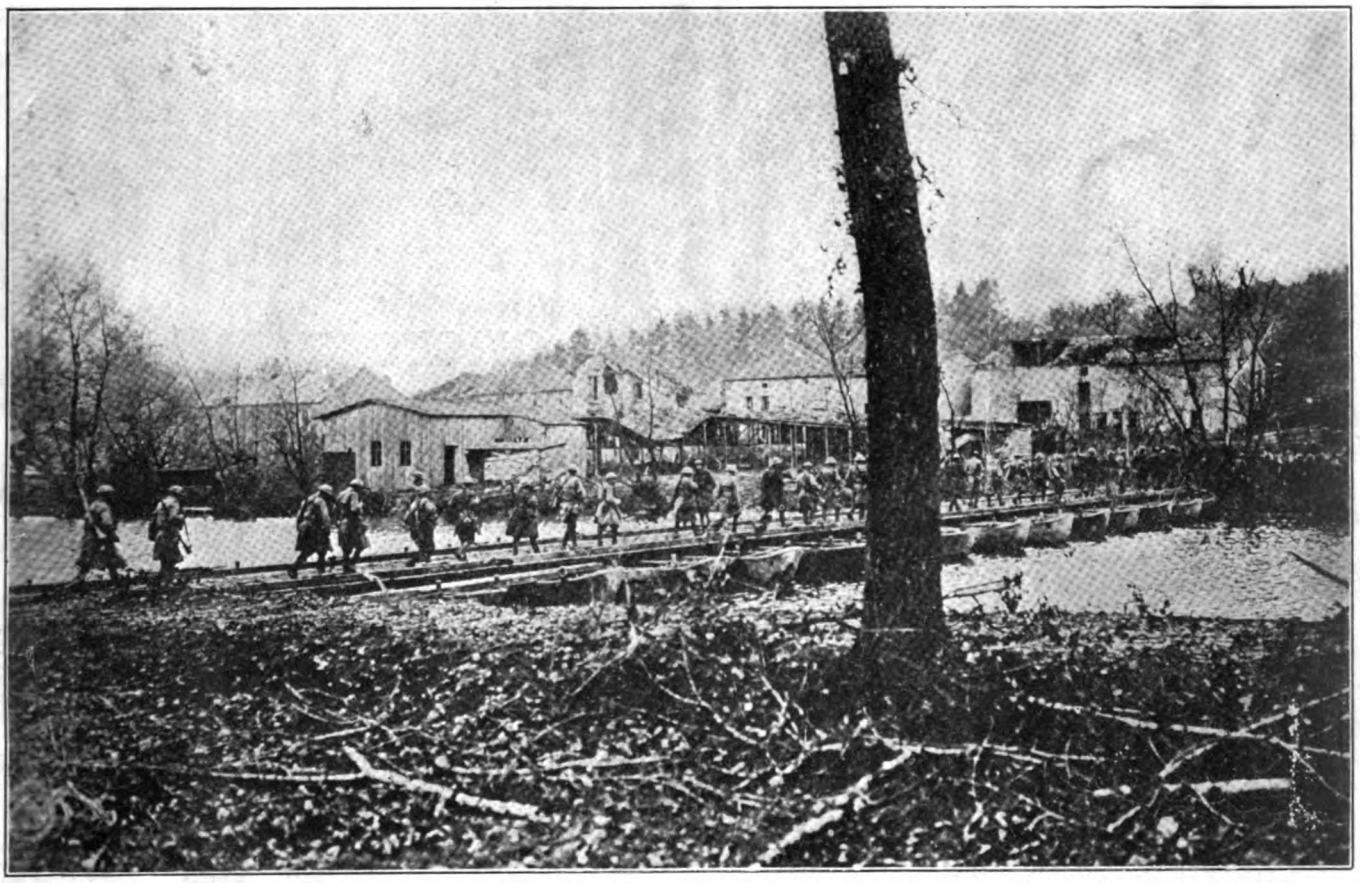
Of the tonnage projected or under construction by the United States almost half is battleships of the big-gun (dreadnaught) type.

Peace on earth, but perhaps not on the water.

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VOL. XII. SEPTEMBER-OCTOBER, 1920 NO. 65

The Military Engineer



Stokes mortar platoon crossing ponton, also on their way to the front. Dun-sur-Meuse, France, November 6, 1918

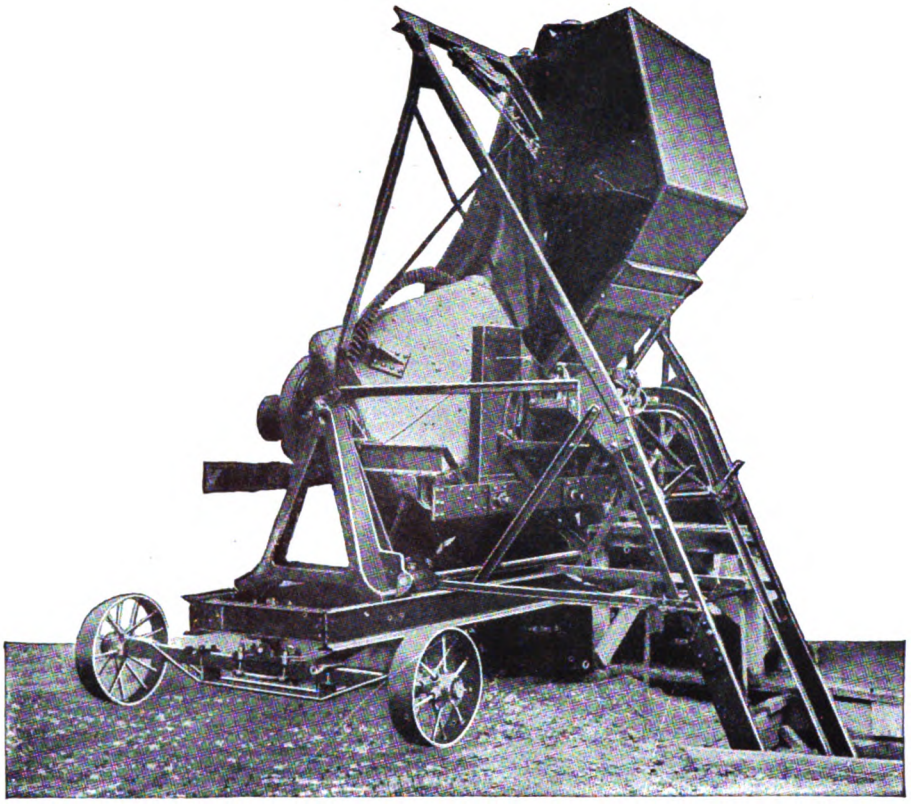
JOURNAL OF

THE SOCIETY OF AMERICAN MILITARY ENGINEERS

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Future Coast Defense Artillery

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William Louis Marshall

Major General, U. S. Army

Chief of Engineers, July 2, 1908-July 11, 1910

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Regulation of the Level of Lake Superior

and the Development of Water Power at Its Outlet

By

L. C. Sabin

U. S. Assistant Engineer

THE usual water-power development requires natural or artificial reservoirs which may be drawn upon in the months of low supply, such use resulting in considerable changes in elevation of the water surface of the reservoir. In the development of power at the outlets of the Great Lakes this condition is materially modified. The reservoirs are already provided, and are of such size, compared with the drainage areas and consequent volumes of discharge, that the flow is unusually well distributed throughout the year; but on account of the paramount importance of navigation, the reservoirs may not be drawn upon to an extent which would increase the fluctuations in the level of lake surface, lest the depth of water available for navigation in the channels and harbors be unduly reduced.

Within the past few years a system of regulation of the outflow of Lake Superior has been evolved, which is of interest because of the size of the reservoir and the success of the undertaking. A brief description of the development of the water power at the outlet of Lake Superior, and the works constructed to maintain the elevation of the lake surface within narrower limits of variation than those obtaining under natural conditions, forms the subject of this paper.

Hydraulic conditions

Lake Superior has a surface area of 32,060 square miles, and drains a basin 76,134 square miles in extent. Its maximum depth being in excess of 1,000 feet, it is the largest single volume of fresh water on the globe. The St. Marys River, which forms the outlet, connecting it with Lake Huron, is about 64 miles in length, having a total fall of from 18.3 feet to 23.6 feet, according to the relative stages of the two lakes. The discharge from the lake under natural conditions varied from 52,000 to 122,000 cubic feet per second, with an average discharge of about 82,000 cubic feet per second.

The greater part of the slope in the river is concentrated at the St. Marys Rapids, where, in a distance of less than a mile, the fall under natural conditions varied from 15 to 19 feet; but since the improvement of certain portions of the river by dredging new and enlarged channels, the fall at the rapids has varied from 18 to 21 feet. The possibility of developing about a hundred thousand horse power at this point was early appreciated, but its accomplishment is not yet complete.

The St. Marys Rapids cut through a Potsdam sandstone formation creating a natural regulating weir. The controlling cross-section at the head of the Rapids under natural conditions had a total area of about 16,000 square feet. Of this about 2,000 square feet was between the islands, while the area of the main channel was about 14,000 square feet, with mean depth of about 6 feet. The area of the lake surface bears so great a ratio to the area of the drainage basin that with no inflow the mean discharge for three months would lower the lake surface only 9 inches, while the increment of discharge for 1-foot rise in stage is approximately 25 per cent of the mean flow. Due to these conditions, the elevation of the lake surface, as indicated by monthly mean gauge readings, was maintained within a range of about 3.3 feet, the recorded monthly mean stages showing a minimum of 600.8 and maximum of 604.1 feet above mean tide at New York.

Encroachments on the cross-section of the outlet channel by the construction, in 1887, of the international railroad bridge, crossing the rapids at about the critical section, and the closing of portions of the channel in connection with the early water-power developments, reduced the area and discharge of the outlet and the natural increment of discharge per foot rise in lake level. On the other hand, the flow through the power canals introduced the possibility of drawing down the lake surface by reason of the use of a greater volume of water than would have been discharged under natural conditions. Attention was therefore drawn to the need of compensation for the water withdrawn for power purposes, and of artificial works and restrictions to replace the regulation offered by the natural conditions which were being interfered with.

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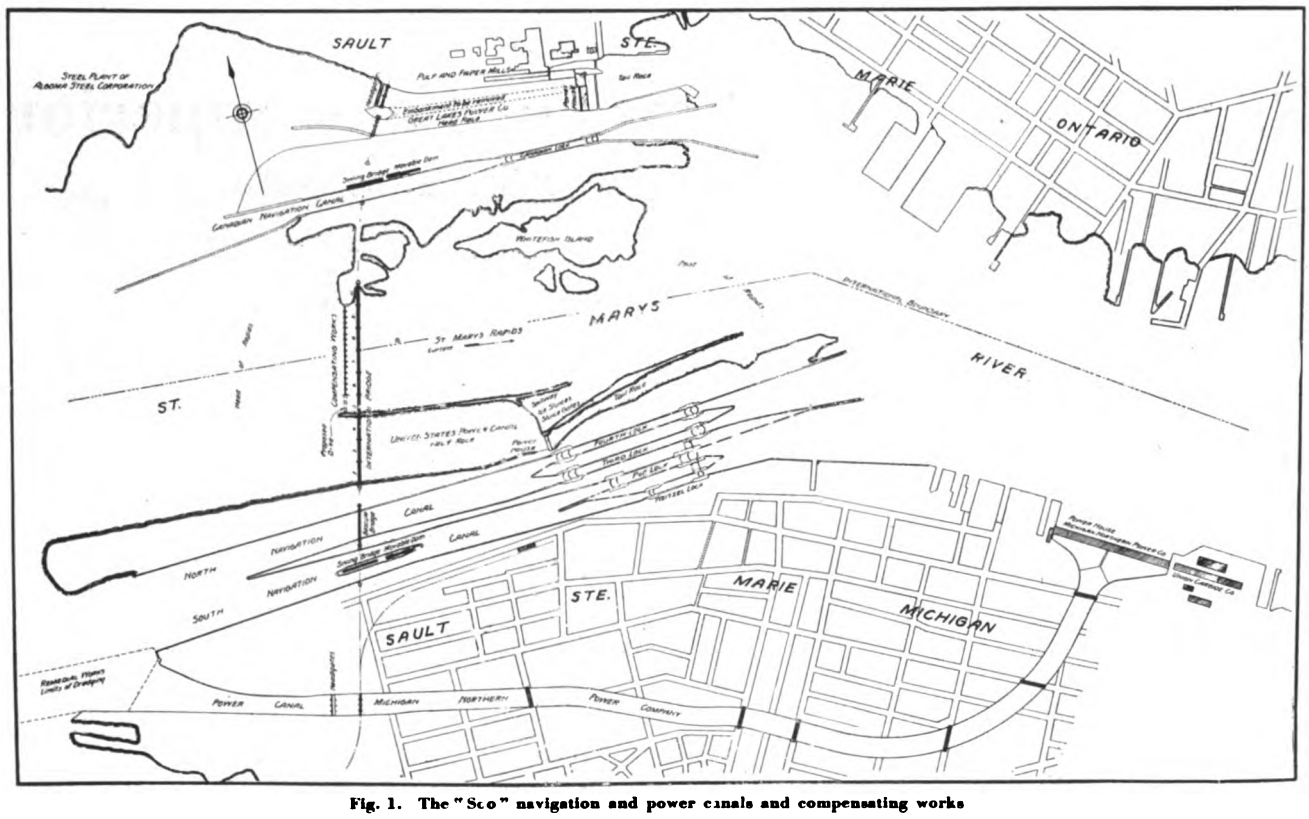


Fig. 1. The "Soo" navigation and power canals and compensating works

Improvements for navigation

The works that have been carried out for the benefit of navigation may be briefly outlined as follows:

The Northwest Fur Company built a small lock on the Canadian side of the rapids in 1797-98, to facilitate the passing of the rapids by canoes engaged in the fur trade. This lock was destroyed in 1814 by United States troops. The first canal for the passage of ships was built by the State of Michigan in 1853-55. The tandem locks of this canal were destroyed in 1888, by excavation for the Poe lock. In 1881 the Weitzel lock, built between the State locks and the American shore, was completed, and in 1896 the Poe lock was opened, being constructed on the site of the old State locks. The present ship lock on the Canadian side was opened in 1895.

None of the above works for the benefit of navigation appreciably obstructed the flow in the rapids at the critical section. Two new locks have recently been opened, one in 1914 and one in 1919; their construction would have obstructed, to some extent, the flow in the river if no power development had been made, but as the power canal extended farther into the rapids, the obstruction is considered under that head.

The present lockage system comprises one lock on the Canadian side, 900 feet long, 60 feet wide, with 18-foot depth, and on the American side one lock 515 feet long by 80 feet wide, with 13-foot depth; one lock 800 feet long, 100 feet wide and 18-foot depth, and two locks 1,350 feet long, 80 feet wide and 24½-foot depth.

Artificial obstructions in outlet

The first encroachment on the cross-section at the rapids was due as stated, to the building of the international bridge in 1887. This bridge originally had ten spans, numbered from south to north, with nine piers in the rapids, and its construction cut off about 14 per cent of the original cross-section area of the rapids, and about 8 per cent of the flow.

Power development was initiated in 1887, when the Edison Sault Light & Power Company was organized, and the following year built a canal through a strip of land lying between the ship canal and the river bank, along the upper part of the rapids. The interests of this company were divided later between two allied companies—the Chandler-Dunbar Water Power Company and the Edison Sault Electric Company. In 1892 a permit was granted to the latter to build a dike extending downstream from the international bridge to its power house. The construction of this dike cut off the free flow, in a section about 500 feet in width, through the two southerly spans of the international bridge, the obstruction being estimated to be about 9 per cent of the mean flow.

On the Canadian side, the Ontario Light & Power Co., whose works were purchased later by the Lake Superior Power Co., built a canal in 1889, partially obstructing a small stream between the islands, and this obstruction was later made complete. This company, in connection with the construction of compensating works in the rapids in 1901, also closed the area under the tenth, or northerly, span of the bridge.

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The effect of these various works, exclusive of the compensating works above span 9, to be referred to later, was to confine the natural flow to bridge spans 3 to 9, inclusive, reducing the cross sectional area of the rapids at or near the critical section by about 42 per cent, and the discharge at mean stage by about 23 per cent.

No measurements of discharge had been taken prior to the placing of a part of these artificial obstructions, and the observations made shortly afterward were somewhat fragmentary. It appears, however, that after the placing of the obstructions the increment of discharge of the stream per foot rise in stage was about 18,000 c. f. s., and that the obstructions had cut off about 19,000 c. f. s. If no water had been used through the power canals to offset this obstruction, the effect would have been to raise the mean lake level of Lake Superior by about 1 foot.

Present power development

Great Lakes Power Company. The company which began the construction of a power canal on the Canadian side in 1889 became financially embarrassed, and its property and franchises were taken over in 1895 by the Lake Superior Power Co., which completed the canal and began the use of water in December of that year. Since that time the canal and power plant have been enlarged, and the use of water has increased from about 2,000 c. f. s. in 1896 to nearly 14,000 c. f. s. at present. The plant, which is now owned by the Great Lakes Power Company, is still in process of enlargement.

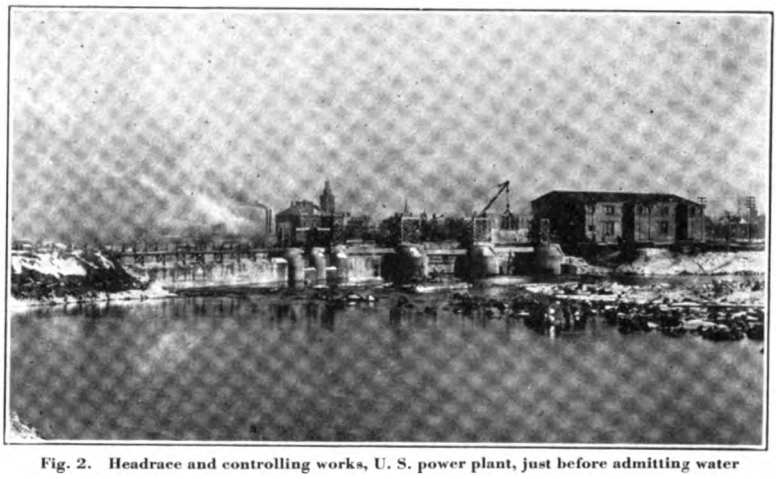


Fig. 2. Headrace and controlling works, U. S. power plant, just before admitting water

The headrace is about 3,000 feet long, and when completed will have a width of about 400 feet and depth of 13 feet. The plant is intended to utilize a flow of about 23,000 c. f. s. The power installation is divided between a ground wood mill, the old power station, and the new power station. The ground wood mill equipment consists of 12 horizontal units of 5 runners each, direct connected to wood grinders, the turbines being 34-inch new American type, with rating of 240 horsepower, each at 18-foot head. In the old power station there are four 51-inch vertical McCormick turbines, having a rating of 350 horsepower at 18-foot head, but not now used to full capacity. The shafts are connected through gearing to horizontal generators. In the new power station the equipment consists of 24 units of 53-inch Allis-Chalmers wheels, rated at 950 horsepower at 18½-foot head. At present about 14,000 c. f. s. is used in the plant, but with full flow a development of about 35,000 horsepower would be possible.

United States Power Plant. The construction of a power plant adjoining the rapids on the American side, carried out in 1888 by the Edison Sault Light and Power Company (later the Edison Sault Electric Company), and the extension of this plant under War Deparment permit of 1892, has been referred to above. Under another permit, granted in 1903, the company built, in 1906, a new power house farther out in the rapids, and extended its headrace and tailrace accordingly. The new power plant comprised four units, 72-inch vertical Leffel turbines, with generators mounted on the same shaft.

The rivers and harbors act approved March 3, 1909, directed the Secretary of War to acquire all lands and property lying between the St. Marys Falls Canal and the international boundary line, and provided that any excess of water in the St. Marys River not required for navigation be leased for power purposes by the Secretary of War upon such terms as he might consider best calculated to insure the development thereof. The lands and property so acquired included the canal and power plant of the Edison Sault Electric Company. The power plant, with a limited amount of power, was then leased to the company for a period of thirty years. This lease provides for the payment by the company of $12.00 per year for each horsepower that can be delivered on the switchboard of the plant.

Since the power canal interfered with the construction of the new navigation canal leading to the third and fourth locks, the United States extended the headrace of the power plant by constructing a dike leading downstream from the fourth pier of the international bridge to join the plant, thus shutting off the natural flow under spans 3 and 4 of the bridge, and including this area in the headrace. At the same time the first span of the bridge was removed and replaced by a fill so that the new headrace included the area under spans 2, 3 and 4, and this new headrace was deepened to minimum of 5½ feet for width of 200 feet, to provide for the desired flow with less loss in head. (See Figs. 1 and 2.)

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In order to compensate for thus cutting off the natural flow under two additional spans, the United States constructed, at the lower end of the headrace or forebay, and just north of the power house, controlling works, consisting of three sluice-gates, each 15 feet high and 34 feet 4 inches long, between centers of end bearings, giving 33 feet clear opening. In case of high water in Lake Superior these sluice-gates may be opened and will pass a greater volume of water than passed spans 3 and 4 under natural conditions.

The works installed at the lower end of the headrace also include two ice passages of 16-foot clear opening, and about 5-foot depth, closed by stop logs between concrete piers 8 feet wide, and a concrete weir 150 feet in length, with crest near mean high water level. The purpose of the weir is not to assist in regulation of flow, but to relieve excessive high water caused by unusual weather conditions or fluctuations in the use of water.

The sluice-gates are of the Stoney type, being constructed of steel and composed of three horizontal girders with upstream sheathing. The gates are 4 feet thick throughout the center 21 feet of the length, decreasing to 2 feet 4 inches at the bearings. They are provided with end thrust rollers to keep them in position, and the roller nests of the main bearings operate against vertical cast steel bearing plates, secured in recesses in the piers. On the upstream side of the gate at the bearing are two vertical angles, with but slight clearance between them and the vertical face of the pier recess. When the gates are closed, this joint soon fills with débris, or may be calked, if desired, to make the joint practically watertight. At the ends of the gates watertight steaming chambers are provided to thaw the ice forming at the junction of the gate and pier in case winter operation is required. A timber cushion is attached to the bottom of the gate, designed to bear on the timber sill.

The spacing of the piers is the same as the penstocks in the power house, 49 feet, so that in case it is decided to extend the power plant the extension may be built directly below the gates, and the piers will form a part of the permanent construction, while the gates will serve to close individual penstocks when needed.

The piers for the gates are of concrete, 16 feet wide, 28 feet long, and about 28 feet high. The upstream starling is protected from ice by sheathing of 60-pound rails. The piers are founded on Potsdam sandstone bedrock.

The sills are made of two pieces of 12 by 12 inch oak timber, set side by side in concrete and flush with the floor of the apron, which is paved with vitrified brick. The excavation for the sill concrete was also carried to rock, but for a portion of the aprons above and below the sill a layer of concrete 4 feet thick was placed on the compact sand filling overlying the rock and protected from wash below the gates. Each pier was designed to be anchored to the rock near the upstream end with nine 1-inch square twisted bars, extending 5 feet into the rock and 5 feet embedded in the concrete. In drilling for these anchor rods in the first, or south, pier, a water-bearing seam was encountered. This seam was filled with grout under pressure, the number of rods was increased to 24, and the length in the rock increased to 12 feet to guard against sliding of the upper layer of rock in case of excavation downstream from the pier. The rock was also drillel and grouted in the first gateway and anchor rods placed under the first concrete sill.

As already stated, the plant as purchased by the United States had an installation of four 72-inch vertical Leffel turbines, with generators on the same shaft capable of developing a total of about 2,000 horsepower at 15-foot head. After the execution of the lease the company desired additional power, and the United States therefore extended the power-house southward to cover an additional penstock that had already been provided, and installed one additional unit. This unit consists of one Allis-Chalmers 60-inch, single, vertical turbine, rated 925 horsepower at 17-foot head, with a General Electric 625 K. W. generator, mounted on same shaft. The present capacity of the plant is about 3,200 horsepower at 17-foot head.

Michigan Northern Power Company. The construction of a power canal on the American side was begun in 1887 by the St. Marys Falls Water Power Company. A canal about 3 miles in length was projected to run through the city of Sault Ste. Marie from above the ship canal to connect with the river 2 miles below the locks, and since the transmission of electricity had not then been perfected, it was proposed to supply each manufacturing plant with separate turbines.

This company failed, and its right-of-way was purchased by the Michigan Lake Superior Power Company, which in 1898-1901 constructed a canal extending from just above the upper entrance of St. Marys Falls ship canal to a point about a mile below the locks, where the power house is located. The present owner of the plant is the Michigan Northern Power Company.

The canal, or headrace, is about 2 miles in length and has a cross-sectional area of about 4,400 square feet. Near the upper end of the canal are located head gates, capable of shutting off the flow and permitting unwatering the canal. At the lower end the canal expands into a forebay leading to the power house, which is about a quarter mile in length with 81 open penstocks and tail pits, three of which are used for spillway purposes to dispose of ice and trash.

The company operated from 1903 to 1914 under a War Department permit issued in accordance with the terms of the rivers and harbors act of June 13, 1902,

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the use of water increasing from about 8,500 c. f. s. in 1904-5 to about 11,000 c. f. s. in 1906-14. The use of water under this permit being made subject to water-level conditions, the company was restricted in its operations, the permitted flow being reduced in low water.

On account of the character of the foundations of the power house, the full head could not be utilized at first, and only about half of the total number of units was installed. The plant was purchased by the Michigan Northern Power Company in 1913, and under the terms of a lease from the United States, to be referred to later, the power house was strengthened, the remaining penstocks supplied with turbines, and the use of water increased to about 30,000 c. f. s. in 1917. With this flow the loss of head in the canal is about 3 feet, and the power developed is about 40,000 horsepower on switchboard.



Fig. 3. Compensating works in rapids, from Span 7 of International Bridge First four gates, Canadian side

The plant installation consists of 78 units, each composed of 4 turbine runners on the same horizontal shaft, the runners being arranged in pairs, each pair having a separate draft chest and draft tube. The turbine units in use are 41 McCormick type, installed in 1901-2, 22 S. Morgan Smith units, installed in 1915-16, and 15 Wellman-Seaver-Morgan units, installed in 1916. The electrical equipment consists of 95 direct-connected generators, of which 4 are exciters. Seventeen generators and exciters are on extended shafts.

Restrictions regarding the use of water

Under the rivers and harbors act of March 3, 1909, which made provision for the acquisition by the United States of all lands and property lying north of the St. Marys Falls Canal to the international boundary line, and also empowered the Secretary of War to lease the surplus water for power purposes, the Michigan Lake Superior Power Company made application in 1911 for a lease of water according to certain plans for compensating and remedial works, and certain restrictions that were subsequently approved by the Secretary of War. After the purchase of the plant by the Michigan Northern Power Company, the name of the applicant was changed accordingly. A similar application, including the above plans, was, in 1913, submitted to the International Joint Commission created by the treaty of January 11, 1909, between the United States and Great Britain, and having right of review of proposed works in boundary waters that might affect the natural levels thereof. At about the same time the Algoma Steel Corporation, Ltd., of Canada, made a similar application to the International Joint Commission.

Under date of May 26, 1914, the Commission approved the obstruction, diversion and use of water under certain conditions, which included the construction of compensating works at the head of the rapids, to consist of sixteen Stoney sluice gates of 52-foot clear opening, located above and parallel to the international bridge, and a dike about 200 feet long, extending from the south end of the gates to the headrace dike of the United States Government headrace. Four of these sixteen gates had been constructed in 1902, and title to them secured by the Algoma Steel Corporation, Ltd., subsequently passing to the Great Lakes Power Company, now operating the canal on the Canadian side. The Canadian Company was directed to place four additional gates, and the American company was to place eight gates and the dike on the American side of the boundry.

The power companies were to operate the compensating works gates under the direction of a "board of control" of two members, the American member being the officer of the Corps of Engineers in charge of the improvement of the falls of the St. Marys River. The conditions of the order of approval also provided that should currents caused by operation of the works unduly interfere with navigation, the power company operating the works should take necessary steps to remedy this condition.

The rules laid down for lake regulation require the level of Lake Superior, as measured by monthly mean readings, to be maintained as nearly as may be between the levels of 602.1 and 603.6 above mean tide at New York, giving a range of 1.5 feet. The natural levels (prior to 1887) had a range of 3.33 feet, or from 600.75 to 604.08, and it is known that with the degree of flexibility given by the proposed additional outlets, or canals, and obstructions, or compensating works, it will not be possible to reduce this range to 1.5 feet under all the variations in rate of supply that have obtained in the past.

To guard against unduly high stages of water in Lake Superior, however, it is provided that the rules formulated for the operation of the compensating works, when tested by the physical conditions prevailing in any year of extreme high water in Lake

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Superior under natural conditions, shall give no monthly mean level of the lake greater than the maximum monthly mean actually experienced in said year; in other words, with the recurrence of the amount and distribution of supply in any prior year of extreme high water, the lake must not be permitted to attain a higher level under regulation than it actually did attain under the natural conditions of discharge during that year. To guard against unduly low stages in Lake Superior it is provided that whenever the monthly mean level of the lake is less than 602.1 feet the total discharge permitted shall be no greater than would have obtained at the prevailing stage and under the discharge conditions which existed prior to the placing of any obstructions; that is, prior to 1887.

The conditions regarding construction of compensating works referred to above were incorporated in a lease made by the Secretary of War to the Michigan Northern Power Co. for the use of 25,000 c. f. s. "primary water," with provision that at such times as the flow of river will permit, the United States will allow the use of 5,000 c. f. s. additional flow, to be known as "secondary water." The price fixed for primary water, expected to be continuously available, was $2 per cubic foot year, and the price of secondary water, intermittently available, $1 per cubic foot year.

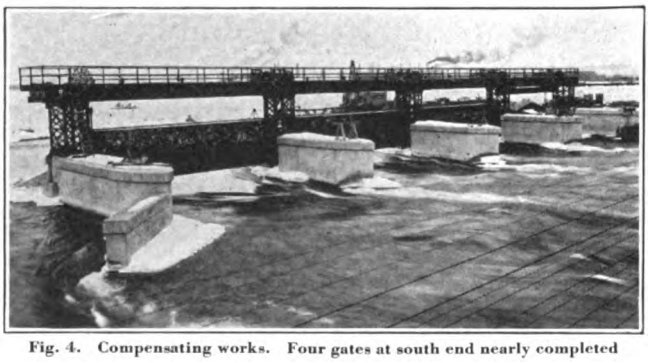


Fig. 4. Compensating works. Four gates at south end nearly completed

Under the terms of this lease the company deepened the entrance to its power canal to reduce cross-currents in the adjoining navigation canal, repaired and strengthened the foundations of the powerhouse to withstand full head of water, and constructed the eight gates of the compensating works required on the American side of the international boundary for regulating the level of Lake Superior.

The company bore the expense of all improvements in the first instance, but retain rentals until the cost of the compensating works and the excavation outside of harbor line at the canal entrance have been repaid, the compensating works remaining the property of the United States.

Compensating works

The compensating works as now built consist of 16 Stoney sluice gates between masonry piers, and are located on a line parallel to, and 150 feet above, the bridge. The structure is continuous and the gates are of such length that a set of four exactly correspond to the length of one bridge span. The section of the stream above span 10 is now occupied by a fill, and a dike will be built to shut off the cross section above span 5, thus giving complete control of all flow in the rapids. The international line is at the pier between spans 7 and 8 of the bridge. (See Figs. 1 and 5.)

The four gates on the Canadian side, first built, were designed under the direction of the late Alfred Noble, and the remaining gates are similar, plans for the eight American gates having been prepared for the Michigan Northern Power Co. by the firm of Noble and Woodward.

The north and south abutments have wing walls for confining the adjoining fills or dikes. The three gate

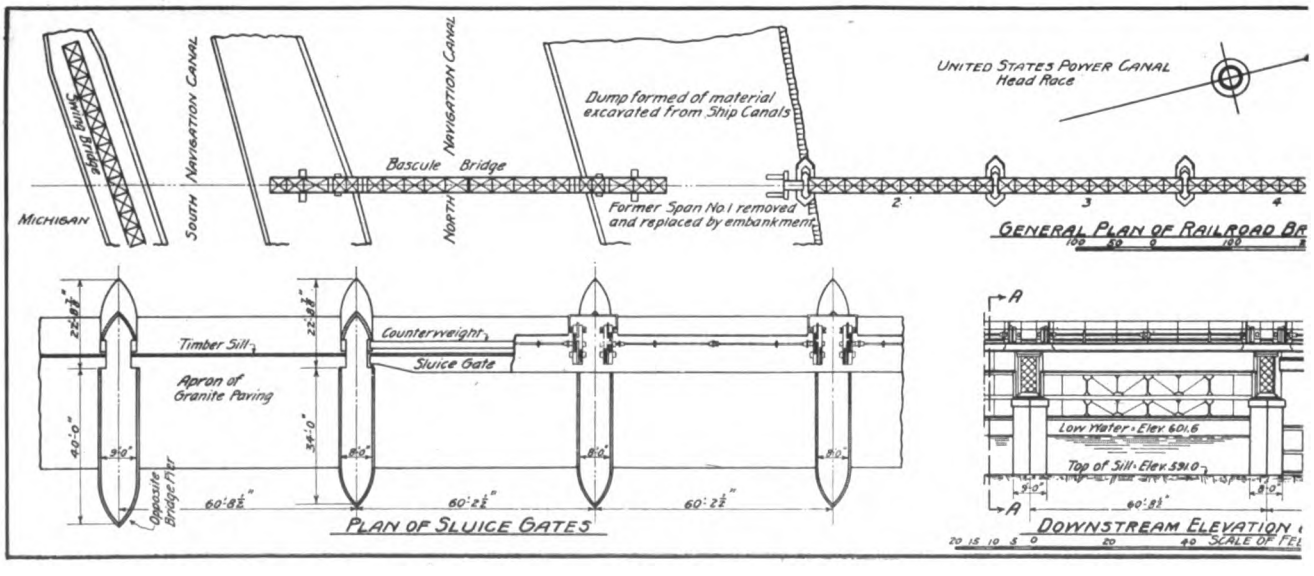


Fig. 5. Compensating works.

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piers that are immediately upstream from the bridge piers are 9 feet wide and 62 feet 9 inches long, while the twelve intermediate piers are 8 feet wide and 56 feet 9 inches long. The piers are recessed on the sides forming quoins to receive the gates, which have a clear opening of 52 feet 2½ inches each.

The gates are of steel, about 13 feet high and 54 feet 6½ inches in length. The four Canadian gates above span 8, built last, have sill elevation 1 foot lower, and consequently these gates are 1 foot higher. The members carrying the main stresses are three horizontal plate girders 5 feet wide for 32 feet of the central portion, reducing to 2 feet 8 inches at the ends. The upstream face has ⅜-inch sheathing, and girders are connected by vertical end frames, 3 cross frames and adequate diagonal bracing. Bearing plates on the back of the end frames run on the rollers of the roller trains, which in turn bear on cast steel tracks bolted to quoins of the piers. A 6 by 12 inch oak cushion extends across the gate at the bottom next the sheathing, forming contact with the oak sill when in place. The weight of the gate is nearly balanced by a counterweight consisting of an open steel box, carrying cast-iron weights and extending across the entire length of the gate. Hand-operated machinery for raising and lowering the gates is located on an overhead platform, supported by steel towers on the piers.

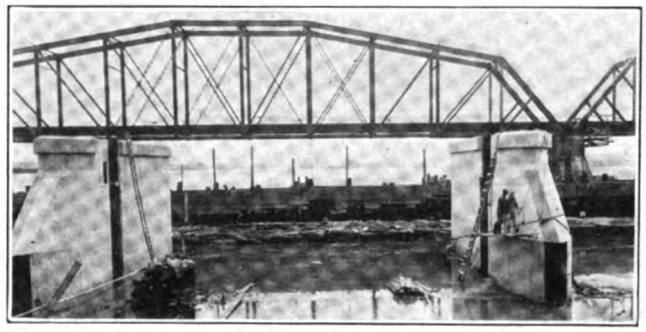
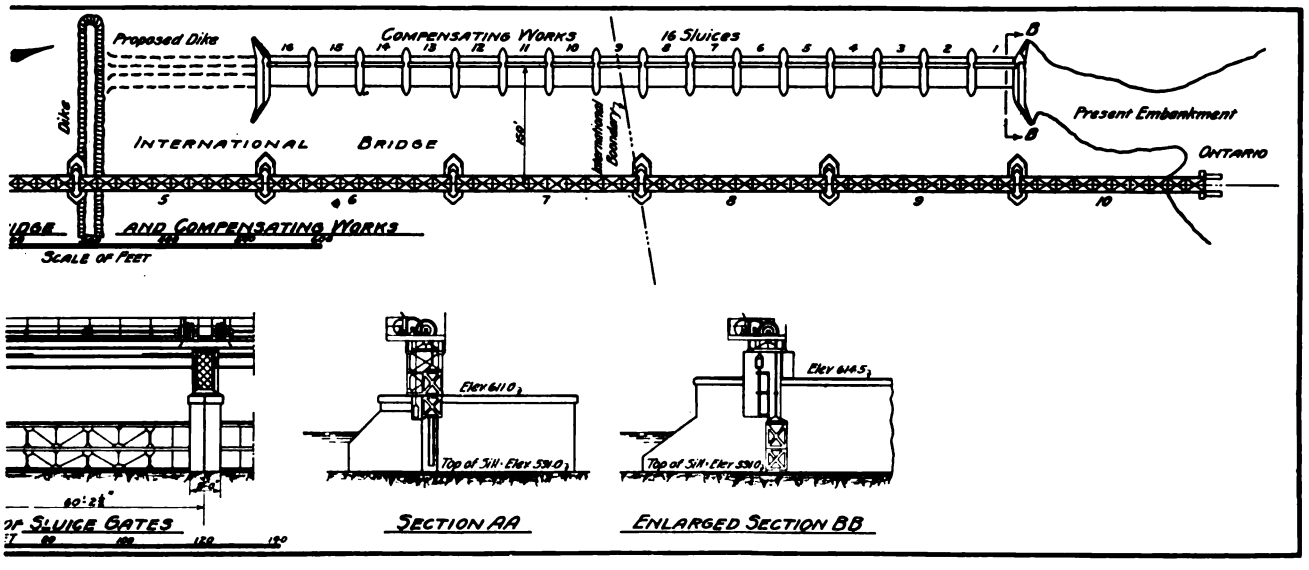


Fig. 6. Compensating works, details of view of piers

The piers are mainly of concrete; the five northerly piers, those built in connection with the first four gates, have the upstream starling, the recesses or quoins, the downstream nose stones and the coping, of cut stone, the starling and the lower quoin facing being of granite, while the remainder is limestone. The bodies of these piers are faced with granite paving blocks, and the aprons between the piers are paved with granite blocks for a length of 39 feet. The other twelve piers were built later and are entirely of concrete. On these piers the upstream nose is protected at the point by steel plate. (See Fig. 6.)

The following details of construction relate only to the eight gates on the American side. The site being at the head of the rapids, where a strong current existed, the Potsdam sandstone rock was practically clear of overburden. As it was necessary to obstruct as little of the discharge cross-section as practicable during construction, the gates were built in sets of 4 the northerly 4 being built first. Each set was constructed within a cofferdam. A breakwater of loose broken rock was first placed above the site of the cofferdam to break the current, and below this the dam was constructed by building 30 by 16 ft. corn-cob cribs of square timber and sinking them by filling with gravel. The bottoms of the cribs were scribed to approximately fit the rock surface. To increase the watertightness of the dam, sheathing was placed along the outside and about 6 ins. from the cribs, and the intervening space filled with cinders. The pumping required was about 4,000 gallons per minute for each cofferdam.

The elevation of original rock surface varied from 590 to 595. With elevation of 591 for gate sills and sluice floors, or aprons, it was proposed to excavate under the piers and sills to grade 589 and under the



St. Mary's River, above Falls

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apron to grade 589.5. At these grades, however, the rock in general was not sound and was underlaid with mud seams so that actual excavation was carried to from 586 to 589 under the piers and for 10-foot width under the sills, and from 587 to 589 under the apron. Grout was also forced under pressure in 2½-inch holes, 2 to 8 feet deep, spaced about 10 feet apart under the sills and piers, and other places where water-bearing seams were encountered. Piers were molded monolithic in wooden forms, the concrete being composed of a rich mixture of cement, sand, screenings and broken igneous rock. Concrete was mixed on floating plant lying just above the dam,



Fig. 7. Compensating works. Inside of cofferdam. Abutment of Pier 17 in foreground

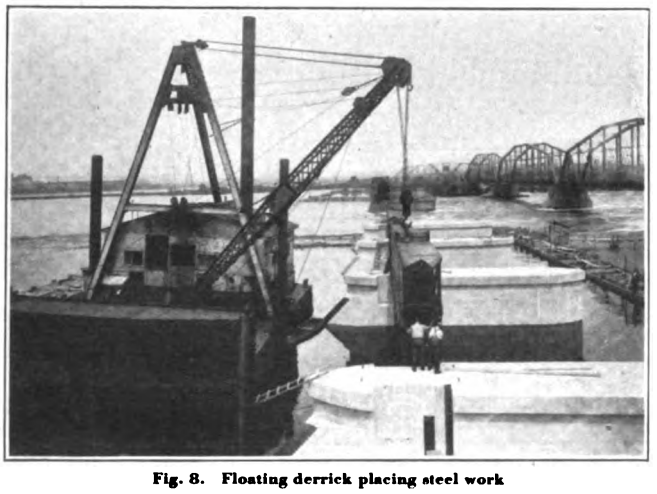


Fig. 8. Floating derrick placing steel work

transported to the pier sites by cars running on an elevated trestle within the cofferdam, and deposited through chutes. The piers were given a rubbed sand finish.

On the completion of one section the cofferdam inclosure was flooded and the cribs used in building the other section. The sluice gates were assembled on land, and, when completed, were hoisted, transported to site, and set in place by floating derrick, the weight of each gate being about 30 tons. The structural work of towers and footbridges and the machinery were also placed by floating derrick. (See Fig. 8.)

The eight American gates of the compensating works were completed, tested and accepted August 28, 1916, and the last four Canadian gates were built in 1918, completing the works as planned, except for the construction of dike above span 5 of the bridge, which has been left open until such time as the power canals on the Canadian side should be completed, and some material just downstream from the gates excavated to allow full flow through the gates.

Operation of compensating works

Water levels have been observed on Lake Superior from 1860 to date. The earlier results were from daily or tri-daily readings of staff gauges, and all depend on the maintenance of proper elevations of bench marks and gauges. Some doubt exists concerning the accuracy of some of the earlier levels, especially prior to 1872. Discharge measurements in the outlet of Lake Superior have been taken at various times since 1896. At that time the bridge piers were already in place, and certain other physical changes had been made, modifying the rate of discharge, but the effect of these



Fig. 9. Compensating works at head of rapids, sluices completed Looking northwest from International Bridge

changes has been evaluated so that the quantity of mean discharge for each month for the past sixty years is fairly well known. The lake levels give the rise or fall for each month; that is, the storage, either positive or negative.

These two factors permit the determination of the supply to the lake. The discharge or outflow, expressed in feet depth on lake surface, plus the storage, with proper sign, gives the supply. This has been determined for each month and may be used in the test of any plan of operation of canals and compensating works that may be proposed. Starting with a certain level on the first of a given month, adding the supply for that month, and subtracting the discharge that is proposed under the scheme of regulation, gives the resulting level on the first of the succeeding month.

In making such tests the earlier the mean level is assumed to be known the more closely can regulation be effected. It should be possible to know the mean level for any month by the first of the next month. In making such tests it is assumed that the gates are

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set on the first of the month and not disturbed until the first of the following month, though it would be possible to operate somewhat more closely by permitting a change each half month.

Before the present works were authorized, such a test was made to show how successful they would prove under the conditions of supply that have obtained in the past. Should the conditions of supply be more extreme in the future the levels can not be retained between limits as narrow as proposed. For any assumed or actual conditions as to discharge capacity, various rules of operation may be worked out, such that certain desired results as to regulation shall be attained or approached.

Under the present conditions the extra cross-section to give additional flow through side outlets—that is, the power canals—has not been provided to the full extent contemplated in the plans, and there is still uncontrolled flow through a small part of the rapids channel, but a rule has been deduced for the operations under these conditions which gives a degree of regulation not far inferior to that which will be possible when the proposed works are entirely completed. Such a rule is shown in the table.

REGULATION OF LAKE SUPERIOR

CONDITION XI

Rule Curve "C" for Operation of Gates of Compensating Works

Month to which gate opening applies	Preceding month.	All gates closed when mean elev. for preceding mo. is below—	4 gates open when mean elev. for preceding mo. is equal or above—	8 gates open when mean elev. for preceding mo. is equal or above	12 gates open when mean elev. for preceding mo. is equal to or above	16 gates open when mean elev. for preceding mo. is equal or above	All gates open, including 2 sluice gates in U. S. Govt. headrace, when mean elev. for preceding mo. is equal or above
February	January	602.64				602.64	
March	February	602.44				602.44	
April	March	602.36				602.36	
May	April	602.32				602.43	602.55
June	May	602.27	602.27	602.37	602.46	602.55	602.55
July	June	602.43	602.43	602.52	602.61	602.70	602.80
August	July	602.65	602.65	602.74	602.82	602.90	603.00
September	August	602.87	602.87	602.95	603.02	603.10	603.20
October	September	603.09	603.09	603.16	603.24	603.30	603.40
November	October	603.20	603.20	603.24	603.27	603.30	603.50
December	November	603.10				603.10	603.50
January	December	602.84				602.84	
Assumed use of water in canals, cu. ft. sec.		43,000	50,000	50,000	50,000	54,500	59,000

Applying this rule to the supply that existed in the past sixty years, 1860 to 1919, inclusive—that is, assuming that the present artificial works had been in place in 1860 and this rule curve were used to regulate the discharge—the level of Lake Superior would have gone below 602.1 during thirty-two months, the lowest level being 601.5 in April, 1911; but the low water would have occurred usually before the opening of navigation, and the level would have been always above 602.1 by the middle of June. The level would have risen above the desired upper limit of 603.6 in only two years—1869 and 1876—and then would not have exceeded the level which existed under natural conditions in those years. In 1869 the water levels indicate a supply to the lake of 3.87 feet in six months, and in 1876 a supply of 3.24 feet in five months. Under such conditions it is impracticable to prevent an extreme rise in level with any reasonable discharge capacity.

Had the supply of 1908 to 1911 occurred under natural conditions of discharge, the level would have gone 0.4 foot below any prior monthly mean and 1.2 feet lower than the computed stage under regulation. This is shown graphically in Fig. 10. The curves for the past four years, 1916 to 1919, inclusive, are also shown. Had the works been completed to the present degree in 1916 the maximum level under regulation would not have reached 603.5, and the low level in April, 1918, which was actually below 601.5, and which under natural conditions of outflow would have reached 601.1, would have been held up to about 602.0.

With the rates of supply to the lake that have prevailed in the past and the natural conditions of discharge of the outlet, the elevation of the lake surface as measured by the monthly mean levels would have fluctuated between limits of 604.1 and 600.3, a range of 3.8 feet. Under the same conditions of sup-

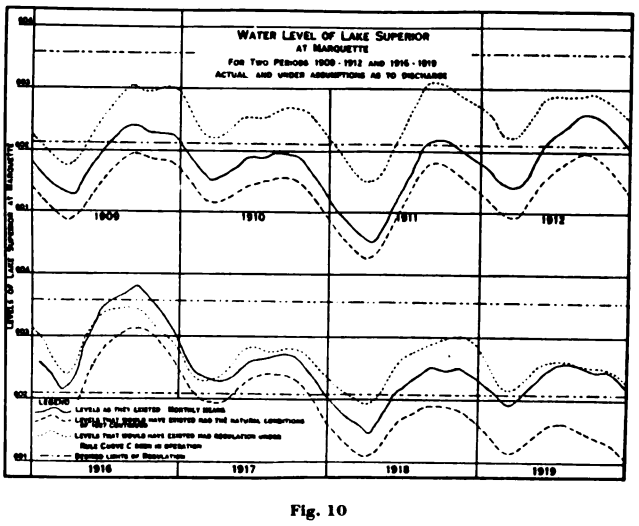


Fig. 10

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ply and the present controlled outflow the range would have been between 604.1 and 601.5, or 2.6 feet. It thus appears that while the outlet of the lake gave naturally a high degree of regulation, it is possible to improve it by avoiding periods of extreme low water and, at the same time, permit the use of the minimum flow for power purposes.

When the works are entirely completed the flexibility of the system will be increased, since the entire flow will be under control; the degree of regulation will not be materially improved, however, but a greater use of water for power will be permissible. What will be accomplished, then, is the continuous use of the natural minimum flow, equal to about 75 per cent of the mean discharge of the river, and a reduction of the fluctuation in monthly mean levels from a range of 3.8 feet to a range of about 2.6 feet. The economic advantage of power development to the extent of some 80,000 horsepower is thus combined with improvement of navigation conditions.

Surveying in France during the War

An entertaining article on "Survey in France during the War," by Lt. Col. E. M. Jack, C. M. G., D. S.O., R. E., appears in *The Royal Engineers Journal* for July, 1919.

The British Field Survey Battalions were charged with the preparation of maps in the field and by compilation, and with sound and flash ranging and map issue. Map publication in quantity was at first carried out in England but was later done by forces in the field.

Among our American forces the opinion is held in some quarters that the *plans directeurs* in France had been prepared prior to the war and in other quarters that they were prepared entirely by field survey. Both ideas are erroneous.

"Belgium was covered with a very fair topographical map, published on 1/40,000 and 1/20,000 scales.

"In France no large scale maps had been published. The Fortress *Plans Directeurs* had been prepared in peace time, for the areas around fortresses and along the frontier, as a secret map. These were topographical maps on the 1/20,000 scale, of good quality but not always up-to-date. For the rest of the area with which we were concerned no maps were readily available except the French General Staff map on 1/80,000 scale.

"A cadastral survey of France had, however, been carried out early in the nineteenth century, but it was never published. . . . This survey is mostly of good quality, but each commune was done independently, and there was no trigonometrical framework. The documents consist of an enormous number of small drawings on 1/2,500 scale.

"An attempt was made to use photographic enlargements (to 1/20,000 scale) of the 1/80,000 map. This was almost immediately found to be useless: . . . An effort was then made to revise the map and correct its errors, using as a basis the photographic enlargement. This proved equally useless. It was therefore decided to start a topographical survey *ab initio.*"

Subsequent efforts led to most careful methods of map preparation.

An interesting sidelight upon the initial mistakes of the British is contained in the final report of our American G.2.C. "The first and most important thing, both from point of view of the Artillery and of the Topographical services, is the establishment of a uniform system of control. This is clearly shown on a report of British 'Maps,' which never recovered, even after four years of war, from initial mistakes, and instead of a comprehensive and complete geodetic system were compelled, up to the end of the war, to submit to the annoyance, confusion and error of a patch-work system devised by various irresponsible surveyors for their immediate needs. The geodetic systems of the different German groups of armies also were different and unrelated, which must have been a source of trouble and confusion. During the period when a unified system of geodetic control is being established, the artillery has in its own hands rough means of sufficient accuracy for bridging over the gap."

The British writer himself decides: "The conclusion is evident, that it always pays in the long run to make your map as accurate as you can in the first instance, as it is then a reliable basis for all subsequent work." This sentence appears to contain the very essence of sound advice in mapping.

In work in the forward or enemy areas use was made of aerial photographs when there was existing sufficient data in the way of old triangulation, cadastral surveys, railway and canal plans or new triangulation established by intersection, to tie in the aerial photographs. Air photos in themselves were unreliable, owing to the errors and distortions to which they were subject. By these methods maps reliable in plan were secured but the problem of contouring remained difficult. Railway and canal plans, the hachured 1/80,000 maps and other available data was used, but the contouring of necessity remained the weak part of the maps.

Some of the difficulties of the surveyors are amusing. "The first surveyor who appeared with a theodolite was arrested as a spy, on the ground that no one but a German would be likely to use such an instrument in our area. These difficulties were enhanced when our men were working in or near an area occupied by French troops, and it became a common experience for topographers to be taken into custody. Eventually, we had to provide every man with an elaborate passport, bearing as many signatures and office stamps as it was possible to crowd on the sheet; after which they were able to do their work with less interruption. It has been said with some truth that in this, as in other services, the difficulties of contending with the enemy were insignificant compared with the obstacles placed in the way by our own friends. One Field Survey Battalion Commander stated that his three chief enemies were rumors, British tanks and Australians. The first caused unnecessary movements, the second picked up and carried away all telephone cables, and the third took anything they saw. In one area the greatest difficulty was experienced in preserving any kind of trigonometrical signal or picket. It was found that there was only one kind of monument that was respected, and thereafter every trigonometrical point was made secure by marking it "*Grave of an unknown soldier of the —th Field Survey Battalion.*"

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Light Railway Practice in the A.E.F.

By

V. R. Irvine

Captain, 14th Engineers (Ry.), A. E. F.

[NOTE. Captain Irvine's regiment was engaged in light railway work in the 3rd British Army North, from August 18, 1917, to May 20, 1918, in the vicinity of Arras. This regiment participated in the Cambrai battle of 1917 and the great offensive of March 21 to April 6, 1918. In the latter battle they lost about one-half of their trackage but saved all of their locomotives, cars and tools. After this drive the regiment constructed and operated about 65 kilometers of new line in addition to the remaining line.

After leaving the British 3rd Army North the regiment constructed standard and meter-gauge tracks for the British 1st Army in the vicinity of Calais until the latter part of July, 1918, when they went to the American 3rd Corps as corps troops, between the Marne and the Vesle. The regiment later went back to Verdun, dividing up on operation, construction and shop work.—ED.]

DURING the war with Germany, in order to relieve the highways of their enormous burden of traffic, it became necessary to develop a supplementary means of transportation. At the end of the war this consisted of a network of narrow-gauge railways along the entire Western front. The gauge of these combat light railways was in most cases 60 centimeter (23⅝ in.). This gauge was adopted by the American, British, French and German armies. The weight of rail used as a standard by the Americans was 25 pounds per yard, the other armies using a somewhat lighter rail which averaged about 20 pounds per yard. The motive power consisted of steam and gasoline locomotives.

The primary function of combat light railways is to deliver ammunition, troops, rations, supplies and engineer material from railheads to points near the front. Troops were taken to and from the trenches, thereby bringing them to the front in a fresh condition and shortening the necessary period of recuperation at the rest camps. During periods of combat inactivity important salvage operations were carried on.

At the rail heads or canal heads the work of the light railways began. Up to these points material was brought by standard gauge or by boat. Material was then transferred to light railways, motor trucks or wagons, either directly or after storage, and carried by them to distributing points in the forward area, such as ammunition, engineer and ration dumps. Railway yards at rail heads should be designed to permit assembly of cars into trains, of direct transfer from standard gauge to narrow gauge, motor trucks, horse-drawn wagons or storage yards. The storage yards should in turn be accessible to these various kinds of transportation.

The field of construction and operation of light railways is within the enemy's field of fire. In their simplest forms these light railways ran perpendicular to the front line, connecting rail heads with forwarding distributing points. Ordinarily these lines were connected by lateral lines at a safe distance from the front, thereby forming a series of loops. These lines were rarely double-tracked as the loops served the same purpose. These loops also had the advantage of providing alternative routes to critical positions in case the line was broken by shell fire at any point.

Experience in the late war has shown that approximately 10 miles of light railway was necessary to each mile of front line, and that one balanced company of trained operating, mechanical and maintenance men would take care of approximately 25 miles of track.

The loads carried on light railways gradually increased in size and weight; in some cases guns 9½ feet over hubs were carried, and the loads reached 3 tons per axle. As a result of the increased loads greater care was necessary in the location and construction of these railways, and it was found that even in locating what was thought to be a temporary track, grades and curves should be kept down to a minimum, as these temporary tracks usually became more or less permanent.

The location of a line of light railway must be determined by the relation of the broad-gauge rail heads to the front-line operation, and by its possible availability for the distribution of ammunition and all classes of army material and the evacuation of salvage material. Also there should be considered its possible means of access to objectives within the enemy's lines, and connection with the enemy's light-railway system in case of an advance. In the event of such an advance the broad-gauge lines would necessarily be brought forward and supersede the light railway until the operation became stable, and the location of the light railway should be made with the idea that the broad-gauge lines of railway could be placed upon the location of the light railway with a minimum effort.

As the reconnaissance is completed and the data plotted on the map the line should be staked out instrumentally on the ground, the same as would be done in standard-gauge practice, and levels run over the center line in such manner that a profile may be compiled and grade lines laid on the profile. One of the principal causes of the breaking down of the light railways in the late war was that the locations were hastily and improperly made and that gradient and curvature were subordinated to speed in location and construction. Any carelessness in location will be paid for in difficulties of operation.

The principles of actual mechanical and physical location differ very little from those laid down for broad-gauge lines. Speed in the location and construction is very important, and some of the refinements that would be used in locating a broad-gauge line would not apply in the location of a light railway, but basically the mathematical problems are the same.

The location of a light railway resolves itself into three general parts:

1. Preliminary location.
2. Map location.
3. Staking the final location on the ground.

It is very essential that, wherever possible, light railway tracks should be concealed from direct observation by the enemy. This may be accomplished by judicious use of slopes of hills, defiles, artificial screens, the rear of large woods,

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or by going through a large wood. Tracks should not ordinarily be located parallel to a road or trench and should not cross at the intersection of two main highways. They should never be located so that the track will be laid along a highway, as they are not only more liable to be destroyed by shell fire but reduce the space for wheel traffic, thereby causing congestion, and they themselves are damaged by that same traffic. Nevertheless they often were laid parallel to the roads.

Grades should not exceed 3 per cent. A level or descending grade toward the front is to be desired, as the movement of the heaviest traffic is in that direction. Grade lines should be laid as close to the natural surface as possible, keeping within the maximum limits, allowing shallow cuts and low fills, as during a severe bombardment the line is liable to be broken in several places at the same time. One night during the German drive in March, 1918, the system of light railway operated by the 14th Engineers for the British 3rd Army North, south of Arras, was broken eighteen times by enemy shell fire. The breaks were all repaired and operations resumed.

In laying grade lines on the profile it is desirable to have the minimum number of fills, for the bulk of grading will be done by hand, which means that fills constructed by this method that are over 1 foot in height will shrink from 10 to 20 per cent and will be soft for a considerable period of time; whereas shallow cuts may be rapidly taken out and the track used as fast as it is laid.

Because of the added frictional resistance of rolling stock on curved track, it was found necessary to compensate the grades on curves. The compensation of curves was allowed at the rate of 0.02 per cent per degree of curve; *i. e.*, a 3 per cent grade on a 5-degree curve is equal to 3.10 per cent on a straight track.

The same principles and formulæ that are used for curves for standard-gauge roads apply on light railways. Curves should not have a radius of less than 50 meters, or 165 feet. Vertical curves should be placed at the meeting points of grades where there is a difference of 0.5 per cent or more.

One of the most important economic elements entering into the operation of light railways is the ballasting of the track, for after the new track had been laid and before extensive operations could take place, it was often found necessary to place some kind of ballast under the track. The material used in order of desirability was crushed rock, slag, gravel, brick bats, cinders, chalk and sand. The kind of ballast used is ordinarily that which can be obtained locally. Chalk ballast was used very extensively by all of the belligerents in France, and this made a very good road bed in dry weather, but it was objectionable, owing to the fact that when it rained the ballast became very slippery and soft, allowing the track to get out of line and surface and making it very hard to rerail engines or cars when they got off. Another objection to chalk is that it shows up very prominently in air photographs, thereby offering an excellent target for artillery fire and bombing.

It was considered that a minimum of 6 inches of ballast should be placed under the ties, extending at least 6 inches beyond their ends, so crushed stone or gravel was used. When chalk was used the slopes were generally banked with clay or earth to prevent waste due to the action of wind or water.

The accessibility of the ballast, the haul and method of loading will determine the rate of ballasting, but it was estimated that the following was a fair average for the work done: For a 6-inch raise under ties, 1,026 cubic yards per mile, or .20 cubic yards per foot of track; 205 man days to loosen and load ballast for 1 mile of track, or one man to 25 feet; 580 man days to unload and place a mile of ballast, or approximately 9.2 feet per man per day. This, of course, is contingent upon train service and other unforeseen circumstances.

The speed at which track laying may be done varies with the local conditions. The French have found that the amount of work which they can do in a day will not under favorable circumstances exceed 3,300 feet, provided the materials used in construction are transported on the line itself. French experience shows 2,150 man days of labor is required per mile of track. This is equivalent to 2.46 track-feet per man per day. British experience shows 1,760 to 2,400 man days is required per mile of track. This is equivalent to from 2.20 feet to 3 feet per man day. It was estimated that American track forces would construct an average of 4 track-feet per man per day.

Narrow-gauge track came in two forms, the rail and ties separately, and the fabricated section. The fabricated sections were in lengths of 5, 2.50 and 1.25 meter lengths. The loose rail came in 30-foot lengths and shorter, and when loose was assembled in sections in material yards.

It is contended by some that the fabricated sections should not be used in future operations, and that all light railway track should be constructed of rail of 30-foot lengths and with wooden ties. This contention is questioned, as the writer maintains that the fabricated sections are absolutely essential in the forward areas where the track is broken repeatedly by enemy shell fire, as making repairs at night where it is impossible to use lights, the method using the longer rails and ties would be absolutely inadequate. As has been stated before, on the night of March 21, 1918, the 14th Engineers had eighteen breaks in their main-line track, in each case the sections were removed and new sections installed without the aid of lights and with a minimum amount of confusion and noise. This would not have been possible if track had been torn out, wooden ties laid and new rail spiked into place, though it would be ideal to have this form of track on a salvage or back line that was not continually subject to enemy shell fire. The same argument is put forth with regard to the metal ties and the wooden ties, as it is an established fact that the wooden ties are far superior to metal ties, once they are in place, but the metal ties are more easily transported and more adaptable.

There have been a number of arguments brought forward advocating the adoption of a guage of 28, 30 and 36 inches for light railways, but the writer believes that only two gauges of track should be used—the standard gauge (4 feet 8½ inches) and the narrow gauge (23⅝ inches), as the primary object of using the light railway is the rapidity of construction and mobility of the system. If the gauge is widened to 30 or 36 inches, no heavier power would be used, and the cost of initial construction would be almost as much as a temporary standard-gauge railway. It should be borne in mind that the light railway is only a temporary expedient, and with an advance or retirement of any magnitude the light railway would immediately be replaced by standard gauge. Therefore, if conditions would warrant laying 30 or 36 inch gauge track, the same conditions would warrant laying standard-gauge track.

The operation of light railways was similar to that of standard railways with the exception that the light railways were operated by telephone-dispatching system of verbal orders and a positive manual block.

In dispatching trains it is essential to have simplicity and flexibility; after various experiments in the war with Germany, an adaptation of the simple Manual Block Sys-

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tem was found most satisfactory. By this system the interval between trains was measured by distance instead of time. The road should be divided into sections or blocks into which only one train with full rights would be allowed at any one time, but others going in the same direction may be admitted but will be limited by the presence of the train ahead.

For example:

A———B———C———D———E

A to E represents a main track divided into four blocks or sections, with operators at each of these points. "A" represents the railhead where the dispatcher is located. The dispatcher wishing to start a train "A" to "E" calls up control at "B" and ascertains whether block "A" to "B" is clear. If clear, train leaves terminal, dispatcher notifying "B" train has left and at what time, recording time on his train sheet. On train sheet is also recorded make-up of train, name of conductor, engine number, number of cars and tonnage. After train has left terminal, or control at "B" has been notified that train is on the way, "B" calls up "C" and ascertains if block "B" to "C" is clear. If clear, "B" displays signal "block clear" and train need not stop at "B." If block "B" to "C" is occupied by train coming in opposite direction, "B" displays stop signal, and all trains approaching must stop before reaching signal. As soon as trains pass "B," operator there notifies all operators interested and movement continues. When any train passes any block, operator at that point immediately notifies dispatcher at "A" giving time of arrival or departure, also notifies control next ahead. This method may employ either telegraph or telephone, the latter being preferable for light railways. For example: Extra 1728 with ammunition and Extra 2196 light, en route from "A" to "E." Extra 1824 with salvage en route from "E" to "A." The dispatcher decides that Extra 1824 would meet Extra 1728 at "D" and Extra 2196 at "C." He calls operator at "E" before Extra 1824 leaves there and gives him the order: Extra 1824 will meet Extra 1728 at "D" and Extra 2196 at "C"; the order being given to the conductor verbally. A similar order would be given to Extra 1728 at "C" and 2196 at "B." Extra 1728 being a movement *outward* would occupy the main line. Extra 2196 being light, although outward bound, would take passing track at "C."

This method was quite safe, flexible, easy of operation and a saver of time. The greatest advantage was the ease with which meeting points could be changed. Trains were forbidden to pass any station where an operator was located without a "proceed" signal. Due to the slow speed maintained over the system it was not necessary to give the meet order at the station in advance of the actual meeting place, but it may quite often be given at the station where the meeting would take place.

During the war it was the experience of one American light-railway unit that due to the excess tonnage handled and the shortage of cars (never more than 120 to a division and averaging 75 to 80) there was an average daily car loading, for a period of five months, of 3.6 times per car and a maximum of 6.1 times per car.

The tonnage was classified and moved in order of priority according to the following schedule:

A—Ambulance
  Engineer reinforcements
  Personnel
B—Ammunition
  Engineer stores
  Rations and other supplies
  Road metal.
  Canteen stores.
C—Empty cars required for immediate movements.
D—Other empties.

Because of the lack of facilities for weighing the loaded cars, each commodity was classified and given a tonnage rating as follows:

	Tons.
Ammunition	10
Coal	10
Engineer material:	
Camouflage	4
Elephant iron	4
Trench-boards	4
Lumber	6
Wood	6
Logs	6
Cement	9
Miscellaneous	4
Forage	5
Light railway ballast	10
Light railway track assembled	8
Light railway rail	10
Light railway miscellaneous	5
Miscellaneous army tonnage:	
Empty shell cases	4
Salvage	5
Ordnance	9
Sand	10
Personnel	4
Rations	5
Road metal	10
Water	8

Six combat divisions were supplied by light-railway units operating 270 miles, with 2,086 officers and men and the following equipment:

47 steam locomotives.
25 gasoline locomotives.
752 20-foot cars.

Between the nights of August 4 and 9, 1918, inclusive, 23,125 men were moved by light railway an average distance of 10 miles, 35 men to the car, with full equipment. Fifty-nine trains were used, hauling 694 loads, or 11.75 cars per train. Assuming that the movement could have been made with trucks, 18 men to a truck, it would have required 1,280 truck loads to accomplish the same results. The maximum movement of troops in any one night was 6,175.

Between March 29, 1918, with a beginning of 30 miles, and February 1, 1919, with a total of 585 miles, American light railways in France handled a total of 860,652 tons, as follows:

	Tons.
Ammunition	166,202
Coal (except L. R.)	6,379
Engineer material	86,555
Forage	21,700
L. R. ballast	160,360
L. R. coal	17,305
Miscellaneous L. R. material	76,456
Miscellaneous army tonnage	81,146
Personnel	52,770
Rations	77,901
Road metal	98,857
Water	15,021

The maximum daily tonnage was:

	Tons.
Ammunition	640
Coal (except L. R.)	210
Engineer material	1,065
Forage	372
L. R. ballast	2,360
L. R. coal	114
L. R. material (miscellaneous)	708
Army material (miscellaneous)	298
Personnel	160
Rations	903
Road metal	1,080
Water	194
Total	8,104

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Equipment: 104 steam locomotives, 51 gasoline locomotives, 1,695 20-foot cars.

Personnel: 55 officers and 2,585 men.

Mileage: 442.

The equipment used by the American light railways consisted of 2-6-2 type steam locomotives with a weight on drive wheels of 23,500 pounds, and a tractive effort of 62,025 pounds; and gasoline locomotives of 0-4-0 type weighing 14,000 and 8,000 pounds rated at 50 and 35 horsepower, respectively. The cars consisted of gondola, flat and tank types, with 4-wheel trucks 15 feet on centers.

The steam locomotives were found to be faulty in that the center of gravity was too high, thereby causing a great number of unnecessary derailments. It is recommended that exhaustive tests be made with the different types of locomotives used by all the belligerents, and a locomotive designed for general use, with a low center of gravity, similar to that used by the Germans.

All cars were faulty in the coupler construction, and a great amount of trouble was caused by cars becoming uncoupled or by the draw bars being bent when cars were being pushed around sharp curves. The main fault with the gondola car was that the sides dropped down instead of swinging out as in the British type. The sides of the American car were held up by a "T" stanchion, which, after very little use, was burred on the end and soon became a source of great annoyance.

There were a number of box cars shipped to France, but they were not found to be practicable. When loaded they were very easily derailed, and as ambulance cars were not a success.

The gasoline engines were too lightly constructed and required constant overhauling. A more rugged and simple type of engine is suggested, something similar to a heavy duty 2-cylinder engine.

The mechanical repairs were taken care of by a central shop at Abainville, where a very elaborate plant was installed and it was the plan to have all heavy repairs made at this central shop. At each rail head there was a similar machine shop and roundhouse. Experiments were made with shop trains at the rail heads which proved very satisfactory, and it is recommended that in any future campaign the system of using shop trains exclusively be adopted; *i. e.,* a shop train of 7 or 8 standard-gauge cars at each rail head fully equipped to carry on any class of repair work, supplemented by a light railway shop train of three cars for each operating company. These light railway trains can be used in the forward areas as near the front as safety would allow, with a reserve of standard shop trains at some central point. In this way all equipment would be mobile and easily advanced or brought back as the exigencies of the campaign dictated. It was found that even temporay shops at rail heads, which became more or less of a permanent character, in some cases had to be abandoned or destroyed in a retirement, such as happened to the 12th Engineers in the March 21, 1918, drive on the Somme.

The central shop as established at Abainville was of a very permanent character, and when the largest advance was made the haul back to the shop was almost prohibitive on account of the great distance, whereas if shop trains had been in use they would simply have been advanced with the armies and been available for immediate use when this advance halted.

The original plan for raising light railway units consisted of a regimental organization of separate operating, mechanical, maintenance and construction companies, but it was found that the regimental organization was cumbersome, and the units became widely scattered. It is recommended that the future organization be based on a balanced operating and mechanical company with the unit of organization a battalion, which would normally operate and maintain a railroad operating division of approximately 75 miles of light railway main line, one company covering approximately 25 miles. This would allow the battalion commander, who would hold a position analogous to a division superintendent, to co-ordinate all operating, mechanical and maintenance forces under his jurisdiction. It would make a more cohesive unit for administration.

A new source of skilled workmen.—Twelve thousand engineer soldiers are a part of the cutting edge of the new army. As matters now stand, it is a ragged edge. When the organizations of the World War were demobilized the old scheme of keeping up the army by voluntary enlistment went into effect again. Five thousand men have volunteered for service with the Engineers. So there are seven gaps and five teeth where there should be twelve teeth in that cutting edge.

The nation's need of men in industry prevents a campaign for skilled workmen to learn the tricks of the war-job of the Engineers. It is wrong to take this skill away from the business of production. But there must be some fit material for filling those seven gaps in the line.

You know men who need training and cannot afford to stop work. You know men who lack the punch of knowing how—and you know businesses that need the kind of men these men would be with half a chance. The Engineers can take these men and give them training that will fit them to be good workmen, can give them experience that will help them become foremen, can educate them along many lines, and can keep them clothed, fed, and in that healthy, husky state of body and mind that gets in the job with "Let's go, boys," for a password.

There is enough sport, comfort, and pay for beginners to make a "hitch" worth while. Any man who served for the first time during the emergency—when there was no time for direct self-betterment—can sign up for one year. If he wants a full course he can take three. Tell about this chance to the young men you know who want to get somewhere. Tell the manager of your business how he can get back a better man by lending his "comers" to the Engineers, A card to the Chief of Engineers will bring a man with the facts.

Bomb and bullet proof magazine has double roof.—Two-story, reinforced concrete explosive magazines designed to be bullet, fire and bomb proof against ordinary attack from either land or air, were built in Panama during the war. The second story is in reality formed by a double roof, the upper 7 inches thick and 7½ feet above the lower, which also serves as a floor and is 2 feet thick. In time of peace the upper story is intended for the storage of inflammable but non-explosive materials; in time of war it is to be filled with earth. All walls are 2 feet thick, and the footings, walls and roof of the lower floor are heavily reinforced with 70-pound steel rails. Ventilation is secured by zigzag ducts. The outer end of each duct is closed by a steel-plate door, and the inner end by closely spaced bars.—*Eng. News Rec.*

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Is the Use of Narrow-Gauge Railways Profitable in War?

By

William Kelly

Lieutenant Colonel, Corps of Engineers
Formerly Division Engineer, 42nd Division, and
Corps Engineer, 4th Corps, A. E. F.

DURING the World War the Germans started the use of narrow-gauge (60 cm.) railways for distribution on their Western front shortly after that front became stabilized. They were probably led to the adoption of this kind of equipment by the fact that they had large manufacturers who supplied the bulk of the world with this class of equipment for industrial purposes before the war. The increasing shortage of animals and of essential supplies for motor transportation forced them to a greater and greater development of their narrow-gauge systems till toward the end of the war practically all of their distribution at the front was accomplished by this means.

The allies followed the lead of the Germans in this as in a number of other developments of the war. The British went in for narrow-gauge railways on a very large scale. The French were much more moderate in this respect and confined the use of their narrow-gauge systems almost entirely to the distribution of artillery ammunition.

When we entered the war our allied advisors insisted that we must make ample provision for narrow-gauge equipment. In the absence of personal experience we could not but follow their advice, and we proceeded to invest in two or three million dollars worth of such equipment and to organize for its use. A number of articles have been written on the excellent work of this organization both on the British front and on our own, but the writer has never seen any expression of opinion, as a result of this experience, as to whether it is advisable to include the use of such equipment in our plans for future wars; his experience with such equipment is not as broad as that of many other officers, but has been sufficient to convince him that in future all our mechanically operated light railway equipment should be designed for standard gauge, and it is with the hope that some good may result from discussing this subject that this article is being perpetrated.

One has only to see a 12-ton, 60-centimeter locomotive to recognize that it is an abortion. It is about as badly handicapped for getting over the ground as a Chinese woman with bandaged feet. It has the power to haul heavy loads and to develop good speed, but it is so top-heavy that it can not develop its power or speed except on a perfect track. If the same engine were provided with longer axles to fit standard gauge, it could do its work over nearly any kind of track.

It should be clearly understood that the writer is not attacking the use of light railway equipment, but is maintaining that such equipment should be made for standard gauge.

The advantages generally claimed for the narrow-gauge system are:

1. The track materials are lighter than for standard gauge, and therefore a greater length of track can be transported with a given amount of transportation;

2. Sharper curves and steeper grades can be used than with standard gauge;

3. The track can be made up in sections ready to lay, which greatly increases rate of laying.

The writer is willing to admit the value of these claims for a railroad on which to operate cars pushed by hand or hauled by animal, but maintains that the minute mechanical traction is introduced, these claimed advantages disappear.

The weight of the track material, the sharpness of curves, and the steepness of grades all depend primarily upon the weight and design of the equipment to be operated and only to a limited extent on the gauge of the road. There is no reason why equipment of practically any desired weight can not be designed to operate on standard gauge as well as on 60 centimeter.

It is true the standard track requires longer ties, which increase the weight of track material, but this is more than offset by the greater care required in preparing the subgrade and the greater amount of ballast needed to keep the track in line so that the narrow-gauge locomotives can operate over it without constant derailment.

The writer has discussed this question with a number of railroad engineers and has found them uniformly of the opinion that the mechanical and practical difficulties and the amount of labor required are greater for the construction of a 60-centimeter track, suitable to carry a given weight of mechanically operated equipment, than they would be for a standard-gauge track for the same equipment.

So much for the technical engineering side of the question. Let us now consider the tactical or military side.

The narrow-gauge road can be developed very satisfactorily for position warfare, but its usefulness is at once lost if there be an advance or retreat. The British lost all their light-gauge equipment on two or three different occasions when driven back by the Germans because it was impossible to withdraw the equipment farther to the rear than the narrow-gauge track extended.

In the final stages of the war the Germans suffered similar losses on a very large scale, and there is no doubt that their operations were greatly handicapped by these losses, because they had become so heavily dependent on their narrow gauge for the final distribution of all supplies and ammunition.

Had these systems been standard gauge, not only could the equipment have been withdrawn for subsequent use, but it could have been used to great advantage in assisting the movement of withdrawal.

The use of the narrow gauge entails the construction of large and expensive transfer yards and the rehandling of

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all supplies and materials coming in to these yards at the expense of a great amount of labor.

It will probably always be necessary to rehandle the regular divisional supplies of food, forage, and clothing at a divisional rail head, but there are tremendous quantities of ammunition and engineer material, especially road material, that can be sent direct to forward dumps, or to points where it is to be used without rehandling if standard gauge is used instead of narrow gauge. Anyone who has had experience in the supply of an army in action will appreciate the desirability of such a saving in manpower on rehandling.

If standard gauge is used, it will be possible to design the system for its ready extension in case of an advance. The main lines going to the front can be designed to carry standard equipment and to be extended into the enemy's territory as the advance progresses, whereas the narrow-gauge system is incapable of extension beyond a limited extent.

At best, trains can not keep a schedule much faster than 3 miles per hour over narrow gauge, and this means that the standard gauge must be extended and new transfer yards built nearer to the front, with every advance of 10 to 15 miles.

In the Toul sector the American narrow-gauge system reached its highest development. While the lines remained fixed, this system was very satisfactory, but even with the moderate advance accomplished in the St. Mihiel operation it was rendered entirely useless for nearly two weeks and then began to operate under great handicap on account of the length of haul. It had been planned to extend this system very promptly after the advance by joining it with the German system at a number of points, but it was found that the advance German lines of railway were all of very light construction and unballasted, which meant that they must be carefully rebuilt to carry the American equipment. The troops engaged on these extensions did wonders to get the lines opened as soon as they did, and the only criticism that can be leveled at the service was that the traffic manager was over zealous and accepted large quantities of freight for shipment before the lines were opened, with the result that the shippers were disappointed in deliveries, and the construction gangs were handicapped in getting ballast up for their work by the congestion on the lines in rear.

It is certain that if this system had been standard gauge instead of 60 centimeter, the rail heads could have been promptly advanced much nearer to the front with a great saving in truck haul and that the temporary lines in extension could have been operated with light equipment without waiting to completely ballast them. The German 60-centimeter system could have been operated with captured German equipment to help out till our own system was developed, but the main need after all was means to get material hauled and delivered on the German side of the old trench systems; from there distribution could have been easily handled by the regular transportation of the organizations.

To conclude, the narrow-gauge railroad system is capable of being satisfactorily developed for position warfare, but breaks down completely as soon as the positions are changed. No war was ever won or ever will be won by position warfare, and such warfare can never be more than a temporary expedient which will end as soon as either side is strong enough to take the offensive.

Light railroads of standard gauge can be built and operated more economically and expeditiously for position warfare than the narrow-gauge system and have the great added advantage of ready adaptation to an advance or a retreat. It seems obvious, therefore, that the narrow-gauge systems should have no place in our future plans, but should be replaced by a light railway equipment on standard gauge.

Discussion

E. Jadwin
Colonel, Corps of Engineers
Formerly Brigadier General, Director of Light Railways, and Director of Construction and Forestry, A. E. F.

Colonel Kelly's article suggests a new and definite idea for the improvement of a useful service whose usefulness has heretofore had some undesirable limitations.

Taking up the more debatable points in the order in which he has presented them, the following remarks are submitted:

The equipment of the 60-centimeter railways, particularly the large locomotives, was certainly top-heavy. Its stability will manifestly be considerably increased if the gauge can be brought to standard without including compensating disadvantages.

There need not be any great increase in the weight or bulk of track materials, excepting ties. The use of longer ties will increase the amount of work required for preparing the road bed where the surface of the ground is not already clear and smooth. In case any large embankments are necessary, the amount of earth fill will be greatly increased. There may be greater difficulty in making a location along roads and other places of restricted width. These are not believed to be a sufficient objection to the proposed change.

It is doubted whether the use of transfer terminals can be entirely eliminated. More study and experiments, possibly trial in actual warfare, may be needed to settle this point. If all the ammunition and engineer material arriving at the rail heads can come in cars light enough to run on the light railways, the function of transfer stations can be reduced, if not altogether eliminated with a corresponding saving in man power and rehandling.

With respect to curves, it is understood that the light railways used curves with as short a radius as 100 feet approximately, or about 56-degree curves. I operated for several years a standard-gauge track entering a machine shop area with approximately a 30-degree curve, over which heavy standard-gauge cars were handled by a short switch engine. I also installed one curve about 33 degrees, around which standard-gauge dump cars were dragged by Porter and Belgian locomotives. This latter was only an expedient for a few months until a flatter curve could be provided. There is understood to be in the yards at Omaha a curve about as sharp as this, over which standard-gauge cars are handled by a switch engine with a short wheel base. Four-foot-gauge street cars in San Antonio round some corners with radii less than 50 feet. This gives a greater degree of curvature than was used on the light railways in France. It would seem, therefore, that curves as sharp as needed can be negotiated by specially designed locomotives and by cars whose trucks pivot freely.

Grades, as Colonel Kelly points out, depend primarily on the weight and design of equipment, and, as steep grades can be used with a standard gauge as with a narrow, provided no greater loads are hauled and the same weight locomotives are employed.

The 60-centimeter track can probably be made up in handier sections, ready for laying, than standard gauge. On the whole the technical advantages of the two gauges seem to fairly well offset each other for prolonged service

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in a given area in trench warfare. If the standard gauge replaces the narrow gauge as the standard in such warfare, it may still be that the use of a limited amount of the narrow gauge will be advisable in special cases.

The loss of equipment and material due to inability to evacuate it on the standard-gauge track was a severe blow at different times both to the British and the Germans. The point that had these systems been standard gauge, not only could the equipment have been withdrawn for subsequent use, but could have been used to advantage in assisting the movement of withdrawal, and the further point that the standard gauge can be moved forward on its own wheels in an advance sufficient to reach the enemy's standard gauge are tactical advantages of importance. The narrow gauge can be connected across the enemy's narrow-gauge area and utilize his installation, if he will be considerate and strong enough to retreat only so far. The standard gauge can follow him as far as he may retreat, haul its own materiel and thereby make possible prompt start on the new installation.

Coming to Colonel Kelly's conclusion, while I doubt whether the light railways of standard gauge can be built more economically and expeditiously than those of narow gauge, I do not think the difference in cost and labor will be sufficient to determine a decision. Partly because they can probably be operated more economically, safely and expeditiously, but above all, because they have the added tactical advantage of greater adaptation to an advance or a retreat, standard-gauge railways are advantageous.

In conclusion, it is believed that many of the points he has raised can be determined with reasonable definiteness by peace-time experiments and that the advantage to the service of such experiments would be fully justified. An added reason for investigating the proposition closely, is that while it is new and offers advantages which seem obvious, now that Colonel Kelly has mentioned them, neither the allies nor Germans, so far as known, tried it at any time in their four years of trench warfare. And that is significant.

Wm. Barclay Parsons
Colonel, Engineer Reserve Corps; formerly Colonel 11th Engineers, A. E. F.

Colonel Kelly has made a very valuable contribution in his article on light railways. He is quite right that standard-gauge lines can be built almost as cheaply as narrow-gauge lines, and that standard-gauge equipment can be designed to pass curves with very short radii. The most striking instance of short radii curves on standard-gauge track is on the elevated railways in New York, where curves are found on the main line with a radius of only 90 feet. In my own practice, I have always opposed the construction of narrow-gauge lines as not being justified by economy.

In military work there are, however, other considerations than economy. In open warfare there is but one kind of railway to consider and that is one of the same gauge as the main lines of the country in which the operations are being conducted, whether that gauge be 3 feet, 3 feet 6 inches, 4 feet 8½ inches or 5 feet. Under such conditions there will probably be no time to construct new lines. The army commander will be obliged to take what he finds in existence and adapt it as best he can to meet his requirements. The question of gauge will, therefore, come up only in the case of warfare that is more or less stabilized, in which there will be involved the problem of distributing supplies beyond the fighting front. The factors that would influence if not control a decision in this case will be other than economy in first construction. Railway lines within, say, 3 miles of the actual front, will always be in poor physical condition, arising from either original light construction or frequent reconstruction of breaks caused by shell fire. To run heavy standard-gauge cars over such lines would result in more wrecks than locomotives with a high center of gravity would cause. It is useless to argue that orders should be issued forbidding heavy loads on forward railways. The people who have the directing of shipments are not engineers, and if the gauge will be such as to permit the running of heavy loads, heavy loads will at times be run. The writer had some experience in France with lightly built standard-gauge railways in the forward area in following up army advance, especially in the St. Mihiel and Argonne offensives, an experience in which, unfortunately, wrecks were not lacking. He knows, therefore, of the pressure from those in higher authority to run heavy loads over tracks unfit to carry them. A break in gauge is the only sure preventive.

The second reason in favor of light railways is that loads in the extreme front area are handled in small lots, and there is rarely any demand for a whole carload of, say, 30 tons. In practice, therefore, it is convenient, if not actually necessary that materiel arriving in standard-gauge cars should be unloaded at an advance rail head, and thence distributed in small lots to a number of points. It is also found that at times cars at the front must be pushed by hand, in which case a car with its load weighing 33,000 pounds is more easily handled than one weighing 99,000 pounds.

In short, the question of light railways is one that will be answered by practical and local conditions rather than engineering considerations of construction. The writer would deem it unwise to abandon the idea of light railways with a narrow gauge, although he is not wedded to the gauge of 60 centimeters (1 foot 11½ inches), as used in France. The gauge of 2 feet 6 inches might be better.

In open warfare such light railways would have no application, but in stabilized warfare the writer believes that they will be found highly useful. When they are used the rule should be laid down that the transfer rail head should be as near the front as local conditions permit, which in France was about 5 miles. Whenever a change in front occurs the rail head should be carried forward with the advance. This would keep the minimum amount of light railway in use and only between the advance rail head and the fighting front.

The impression is gathered from Colonel Kelly's paper that the light railways of 60-centimeter gauge were one of the outcomes of the war. Is this justified? That gauge had been adopted by the General Staff of both France and Germany prior to the war, and was the same as that used by Japan, following German tuition, in the Russo-Japanese war of 1905.

H. Deakyne
Colonel, Engineers; formerly Brigadier General Chief Engineer, 2nd Army, A. E. F.

I agree with Colonel Kelly that the use of the 60-centimeter railway in France should not commit us to the policy of considering it a necessary part of our equipment for warfare under all conditions. We fell heir to the narrow-gauge railway as one of the many features of the war that had already become settled facts before we entered.

The 60-centimeter track is undoubtedly a very narrow affair on which to handle locomotives or cars of any considerable weight. The meter gauge always appeared to be a much more satisfactory system for the purpose.

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Some of the defects of the narrow-gauge railways pointed out by Colonel Kelly are not without remedy. For example, the loss of equipment in case of a retreat can be avoided by the provision of main stems running directly to the rear at proper intervals. The Division of Light Railways and Roads had plans in the summer of 1918 for the construction of such stems for this purpose, and one such was constructed from Abainville to Sorcy. Another way of saving light railway equipment is to run it back to a standard-gauge rail head and then load it on standard-gauge rolling stock, provided the standard-gauge lines are free to handle it.

The advantages claimed for the narrow-gauge railway are those stated by Colonel Kelly, and one other, which is the use of light bridges. In the line from Abainville to Sorcy, it was necessary to cross a canal at Void. The crossing was made with a very simple bridge, which would have been totally inadequate for standard-gauge equipment capable of carrying standard-gauge loads.

The basic economic advantage of a narrow-gauge railway is that it can be laid almost on the natural surface of the ground. This means, however, that steep grades and sharp curves must be used to prevent undue lengthening of the line. There is no reason why a standard-gauge railway can not be laid in practically the same manner, but it is an error to assume that a line so constructed can be adapted to use as a main line by simply improving the ballast. The grades and curves would have to be entirely different for a main line, and this would mean a complete relocation.

The use of the narrow-gauge does entail the construction of expensive transfer yards and the rehandling of supplies, but the use of a light standard gauge would not evade similar yards and similar rehandling. If the light system is to be used strictly as a light railway, the heavy rolling stock bringing the heavy loads from the base can not be allowed upon it. The supposed advantage of a standard-gauge light railway system that would permit ammunition and road material to be sent on toward the front without rehandling, implies that the grades, curves and bridges of the light railway line are suitable for heavy equipment. If this is the case, it is no longer a light railway line, but a regular standard gauge.

A standard-gauge light railway line was used in the latter part of 1918 and the early part of 1919 between Commercy and Woinville. It was made by relaying the rails of a meter-gauge line, using longer ties. Considerable difficulty was found in securing light locomotives for use on this line, and the line was a source of uneasiness, because the bridges were not designed for heavy rolling stock. There was always the danger that the transportation department would send over the line a heavy locomotive or a car loaded beyond proper limit, causing a disaster at one of the bridges. This is an inherent defect in the plan for using a standard-gauge light railway. The change in gauge has, at least, the merit of making certain that no heavy rolling stock is going to find its way by mistake to the light railway system.

In open warfare, the supplies will follow the troops primarily in trucks, and the standard gauge will be brought forward as rapidly as possible to the limit of safety for a rail head. If the warfare becomes stabilized, as it was in France, there is a field for a narrow-gauge line. However, I should consider a gauge of 36 or 40 inches as more satisfactory than the 60 centimeter used in France.

Jno. P. Hogan
Lieutenant Colonel, Engineer Reserve Corps; formerly Lieutenant Colonel, 11th Engineers, and General Staff, A. E. F.

The first general use of 60-centimeter lines in military operations was during the Russo-Japanese war, and the motive power was largely man or horse. It was so successful that both the French and Germans adopted them as standard practice. Whether mechanical traction was contemplated is not known by the writer, but it is certain that the 60-centimeter line first made its appearance in the Great War with men and horses as motive power. The Germans were the first to employ light mechanical traction, and it is noteworthy that they always kept their equipment light, while the allies gradually introduced heavier equipment. This necessitated the use of intermediate wooden ties on the "Decauville" and of more or less ballast.

The Germans, by force of necessity, came to rely more and more on the 60-centimeter lines as their horse and automobile transport declined. At the time of the armistice they had been driven out of their narrow-gauge belt, with the loss of most of their track and equipment, and it is believed that their collapse was imminent from this cause alone unless they had been able to retreat and re-form behind the Rhine.

Their situation emphasizes the need of a well-balanced army and equipment to permit of meeting all the varying phases of warfare. This immediately brings up the question, whether the phase of warfare seen on the western front is apt to be repeated; *i. e.*, a situation where the forces engaged are too large for the theater of operations. The answer is yes for that theater of operations, but in general not necessarily so, for any other, though locally analogous situations may arise.

It is believed that the United States Army should be prepared primarily for operations on this continent and, secondarily, for operations abroad, which will probably be in conjunction with an ally or allies *now unknown*. If operating in conjunction with an ally or allies, the American army *being the last in the field* must conform as far as possible to their equipment, in order to permit intimate cooperation. (The Italics are *ours*.—Ed.)

For operations in this country or for open warfare anywhere, the principle set forth by Colonel Kelly of using light equipment on hastily laid standard-gauge track, is believed to be so correct that it does not need discussion. It is not believed that this would obviate the necessity of rehandling, since in this country, more than any other, the standard railroad car is increasing in size and could not be taken off standard main-line track. It would permit, however, the rehandling and classification depots to be located farther in the rear. Rigid discipline in keeping standard equipment off of hastily built tracks would have to be enforced. Its real advantage is in flexibility in a war movement.

Before adoption of Colonel Kelly's proposal there is one question that must be considered; *i. e.*, What is the present equipment available in the United States? The modern army can not have on hand sufficient mechanical equipment for its purposes and must rely on an industrial mobilization. The writer is aware that there is in existence in this country a considerable amount of 24-inch and 30-inch gauge equipment. How much light-weight standard-gauge equipment is there, capable of running on such tracks as Colonel Kelly proposes?

While the principles advanced are, therefore, thought to be sound, it is believed that a census should be taken of the equipment available, and that the final decision should be based on the industrial situation and tendencies.

F. G. Jonah
Formerly Colonel, Engineers (Light Rys.) A. E. F.

The writer desires to say at the outset that he does not regard the proposals of Colonel Kelly as offering any im-

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provement on the existing type of light railway track, material and equipment.

The light railway was developed by the French. The Decauville plant was manufacturing track and equipment for commercial purposes as early as 1882. It was shortly thereafter adopted by the French Army, and the German Army adopted it in 1892. Its extensive use by the Germans in the late war was due to the fact that they were short of rubber and gasoline, two essentials for motor transport, but having the steel plants and coal mines of France and Belgium in their possession, were enabled to make the utmost use of steam transportation, both standard and narrow gauge.

It does not seem that light railway track and equipment built to standard gauge would serve any useful purpose, unless the track was strong enough to carry the usual standard-gauge equipment operating in the rear, in which case it would at once cease to be a light railway track. The advantage of standard gauge, assuming that it could be built up to the trenches and battery positions, would be the saving of labor in transferring supplies at the rail head, but this saving of transfer labor would be much more than offset by the increased labor required to construct a standard-gauge track, no matter how crude the construction might be. There will be twice as much work involved in the grading of a standard-gauge track as a 60-centimeter line, and twice as much ballast required for its maintenance, and when it is recalled that 25 per cent of the labor employed in the construction of our light railways in France were engaged in making and applying ballast, this becomes a matter of great importance.

A light railway can be fitted to contours of the ground, can go through gorges, narrow passes, streets, or alleys, where it would be impossible to carry a standard gauge. When it is remembered that the equipment of a light railway is 5½ feet wide, and a standard gauge 9½, it will not be hard to recall places where the one could be used quickly and the other not at all. Apart from the question of grading or ballast, if the track is standard gauge, it is absolutely certain that it can never be assembled or laid with anything like the speed that can be made with the 60-centimeter gauge.

Colonel Kelly's conclusions as to the desirability of standard-gauge railway extenstions in forward areas are correct, and everyone will agree that we failed to carry our standard-gauge construction forward as rapidly as it might have been done, after the St. Mihiel drive and also during the Meuse-Argonne battle. Take the case of the conversion of the metre gauge to standard gauge running north from Commercy, this work dragged along, and was completed only as far as Woinville; had it been extended a few miles farther to Vigneulles, it would have connected with a standard gauge leading from there to Chambley, thus making connection with the German standard-gauge system west of Metz.

It is a mistake to say that the light railways ceased to function after position warfare ceased. They were in constant use, as it was only a short time before connections were made between our advanced lines and the most westwardly extension of the German light railway lines, which were well built and ballasted; at least in the St. Mihiel sector—the writer saw many of them and has talked with the officers of the 12th Engineers (Railway), who operated these lines after the St. Mihiel drive, and until March, 1919. These officers state that, after "No Man's Land" was passed, the German lines were all in good condition, and a plentiful supply of good ballast was distributed along the tracks for repairs. This regiment hauled supplies from the Sorcy railroad to Conflans over light railways. To be sure, this was too long a haul for that kind of equipment, but there was not sufficient motor transport available, and as the army failed to extend the standard gauge from Woinville to Vigneulles, there was nothing else to do but haul on the narrow gauge. On this long haul a schedule of 5 miles an hour was maintained instead of 3, and on many of the short hauls a speed of 8 miles an hour was regularly maintained.

Colonel Kelly refers to delays in connecting up our lines to the German track. The 12th Engineers have written a history of their operations, from which I quote:

> Order from G. H. Q. of November 11 forbade anyone going north of the positions of the front line of November 11 until the 3d Army units had started forward. These restrictions ceased at 5:30 a. m. of the 16th . . . and by November 20 American light railway trains were operating into Conflans. Beyond "No Man's Land" the track was found to be, on the whole, in fair condition. There had been some damage in the back areas caused by bombs and few instances of deliberate demolition were encountered. The enemy had, however, accumulated adequate ballast and track material, and had distributed these at points along the line.

As to what can be done with a light railway after position warfare ceases, I quote from this history:

> The connections and new track being in condition, the operating forces were faced with the problem of handling large amounts of all kinds of army stores as far north as Conflans and Saint Jean. Rations constituted a large part of these supplies, and it is true that the 12th Engineers fed the Third Army until it passed into Belgium. This tonnage for the Conflans area originated chiefly in the old railroads—Sorcy, Belleville, Bernécourt, Manonville, Leonval, and Trondes. A glance at the map is sufficient to make clear to anyone familiar with the limitations of the "Soixante" just what a problem this was for the operating forces. This Trans-Siberian haul, as it was known around headquarters, amounted to approximately 70 kilometers, or 44 miles—a large contract it is true, but the goods were delivered and delivered promptly. . . .

After the highways were repaired and the motor transport restored, this regiment was turned over to salvage operation—bringing back ammunition and engineering material from the forward areas. This tonnage became very heavy, and on January 3, 1919, the greatest volume hauled in any one day was 5,112 tons, which could not have been taken off the battlefields as economically or as quickly by any other means.

The writer is not unmindful of the fact that many of these valuable uses to which the light railways were put was after hostilities ceased, but believes a much greater use could have been made of them prior thereto, and is firmly convinced that a light railway can be built in less time than a highway on which motor trucks could operate, and certainly in much less time than any kind of a standard-gauge railway could be built.

E. M. Markham

Lieutenant Colonel, Corps of Engineers; formerly Colonel, Chief Engineer, 3rd Army, A. E. F.

The writer disagrees with Colonel Kelly's conclusion "that the narrow-gauge systems should have no place in our future plans;" but, on the other hand, accepts as sound the desideratum of broad-gauge extension with such rapidity and to such forward points as is consistent with conditions *de facto*. He views as hazardous, in this and many other matters pertaining to American operation in France, deductions arrived at upon the exclusive, or nearly exclusive, foundation of American performance in the particular event. He hopes that deliberate planning for the future may reckon with a better measure of preparedness, with a better and more business-like understanding of the issues, and with a clearer staff conception of its functions, all of

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which have important relation to the value of narrow-gauge railways.

The writer's observation of narrow gauge mainly concerned a period with the British, and duty with the Division of Light Railways at American General Headquarters.

In the former case, the British (Canadian) system behind Arras was noted to be operating in manner and location such that it could not possibly have been replaced by broad gauge. Road bed and rolling stock were substantially consistent with the necessities of the case; operations were scheduled, well balanced and controlled; speed capacity and radius of activity were well understood and respected. The system was performing its functions with great efficiency, relieving truck transportation to an invaluable extent.

In the American sector, narrow gauge appeared to the writer to have been both constructed and operated under what may well be described as "slap-dash" American methods, stimulated largely by urgency for premature operation, the inevitable result of which, at times, could be none other than confusion and derailment. The situation was additionally complicated by the frequent mania for speed, first, by the impulse and lack of judgment of the operator, and, second, by the staff demand for delivery. Again, the compulsory taking of business by staff direction over essentially absurd lengths of haul in the Toul sector, and generally throughout the American area after the armistice (to which Colonel Kelly refers), could give no other impression than that narrow gauge was not "up to the job." A street car ordered to transcontinental business is a not too impertinent simile. The fact was, however, that broad gauge did not exist, or, where existing, would not take the business, and that new construction was impossible. The efficient operating radius of narrow gauge is probably 25 to 30 kilometers. The futility of directing greatly extended performance, for whatever reason, detracts nothing from the usefulness and value of the facility within its proper sphere.

Narrow gauge is strictly a local agency—a mere community collector and distributor, so to speak, to and from broad gauge. It should not be considered, much less utilized, in replacement of the latter to any degree whatsoever. The functions of the two, short of emergency, must be regarded as wholly distinctive. Narrow gauge should not be regarded as abortive because of derailment or confusion occasioned by particular defect or insufficiency, any more than motor-truck transportation should be similarly classified because of individual mismanagement, distribution, failure of maintenance, or what not.

The fundamental of narrow-gauge employment upon proper occasion, is believed to be sound, and until a different view is deliberately adopted, incidental deficiencies of rolling-stock design, troubles resultant from premature operation over inadequate road bed, and similar matters should not be overweighted.

No sufficient reason is known to accept the proposition that the 60-centimeter locomotive "is an abortion." It would be unusual if its stability could not be improved upon; but, granting that desideratum, it should be remembered that the type made many thousand miles without trouble or derailment, and that where such occurred something was in all likelihood involved other than fundamental unsuitability because of gauge.

The loss of British and German equipment is viewed simply as one of the fortunes of war, the agencies responsible for the installations presumably having sufficient justification for their original conceptions. Broad gauge could probably not have been adopted in any of the localities served by light railway, and the abandonment of the latter was unquestionably occasioned by a debacle which neither side could have conceived to be possible, short of the event itself.

The writer is unable to follow the idea, whether for position warfare or for advance, that broad gauge, however lightly constructed and loaded, can replace narrow gauge; and he is especially confused by the suggestion of a hybrid, and unavoidably flimsy, broad gauge, taking standard equipment and standard cargo in avoidance of rehandling. The extent of necessary side hill cutting, sharpness of curves, steepness of grades, weight and volume of trestles, bridges, ties and ballast, all reflected in time and man-power requirements of original construction and maintenance, are believed to be more important elements of the equation than implied by Colonel Kelly, and to be prohibitive of the employment of broad gauge toward the extreme front, or in any manner or situation other than of deliberate layout, thorough-going construction, and minimum hazard of traffic interruption.

In the writer's judgment, narrow-gauge equipment should be redesigned to the end of lowering to the limit the center of gravity of the power unit, and of similarly treating all rolling stock. He is unprepared to say what is such limit. Redesign was, in fact, under way at the time of the armistice. If combined with redesign, there is balanced discretion from the top, and especially upon the part of the staff, regarding physical conditions, the limitations of frequently untried operators, the folly of impossible expectations as to speed and capacity, and if further, also from the top, demands be intelligently restrained to a radius of operation consistent with efficiency, narrow-gauge railroads will perform a most valuable service whenever there is a stabilized condition of such likely duration as to supply the fundamental occasion for their use at all. Even for a reasonable speed of advance, figures compiled at Chaumont suggest the great value of narrow gauge, impossible of substitution within acceptable limits of time, materials and labor, by any similar advance of broad gauge.

The writer shies at conclusions of the kind expressed in Colonel Kelly's article as determinative of requirements for "our future wars." He can not imagine more than incidental light railway provision for advance into Mexico, just as he can not conceive of a repetition of the European event without its use upon a generous scale. He would avoid, as well, a too comprehensive application of the conclusion that "no war was ever won, or ever will be won, by position warfare"; certainly "future plans" should not be inflexibly formulated upon any theory that casts out the possibility of temporary, and wholly unavoidable, position warfare. He believes that the amount and character of narrow-gauge reserve stock, personnel and instruction, should be determined upon without the use of superlatives.

The writer is confident of the truth of the following propositions: That narrow gauge should be reckoned with for any campaign of a character involving great forces and uncertainty of predetermined rate of advance with reference to existing distribution properties; that narrow-gauge facilities should be in hand in reasonable volume and at proper location, ready for installation in forward areas during any static period of duration; that, totally without regard to the existence of narrow gauge, broad gauge should be pushed forward as fast as practicable, and as far as consistent with not too destructive operation—narrow gauge overlapped by such construction to be at once thrown out, and its salvage suitably disposed in storage. Upon advance of greater or less depth, and presuming upon a further static period, light railways should be extended from their existing situation, or should be installed *de novo,* retaining to the rear only tentacle connections with central shops and

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depots for purposes of repair and replacement. In complete disregard of this advance of narrow gauge, broad gauge should again be extended to the limit of reasonably safe construction and operation as fast as material and men can be supplied, eliminating anew whatever light railway becomes possible of displacement.

In the writer's judgment, the use of narrow gauge, or the contrary, its field extension or displacement, can not be predetermined as broadly as Colonel Kelly suggests, nor in fact command intelligent discussion except as the elements of individual events, having to do with objectives, forces, terrain and similar matters, are scrutinized and the necessities of the case appropriately determined. Pending such opportunity of justifiable conclusion, reasonable provision for narrow-gauge instruction and reserve should be made, with a persistent eye to the better stability of its rolling stock.

Marshall R. Pugh
Formerly Major, 21st Engineers (Light Ry.), A. E. F.

Colonel Kelly in a few words has raised a question of the greatest moment: Shall the light railways of the future be standard or narrow gauge?

In 1916 or early 1917 Maj. Guy Boyer, of the Canadian Army, in a report to Gen. Sir Henry Jacob said, "The section of rail now employed for track is much too light, and I would suggest that nothing under a 36-pound section be used. With this heavier section, I propose that the gauge of all trackage be reconstructed to the standard gauge of 4 feet 8½ inches, which, I submit, would, in the event of advancement allow the existing mechanical powered lines to advance accordingly without delay . . . another advantage of standardizing the gauge of the train lines, is that the trucks, once filled at the base, will proceed direct to their objective without having to be unloaded as at present, owing to the difference in gauge of the tracks." His suggestion was not looked on with favor, and the narrow-gauge continued to be employed.

The British and Germans both lost large amounts of equipment during enemy drives that could have been withdrawn in time had the gauge been standard. It is a fact that the narrow-gauge railroad system is capable of being satisfactorily developed for position warfare, and that it has broken down in a warfare of movement, which, as Colonel Kelly points out, is the only way in which a war ever was or ever will be won.

Admitting all this, the writer can nevertheless not fully concur in Colonel Kelly's conclusion that light railroads of standard gauge can be built and operated more economically and expeditiously for position warfare than the narrow gauge and have the great added advantage of ready adaptation to an advance or a retreat.

In France the extension of standard-gauge railways was not able to keep up in any way with the advance of the 60-centimeter track. No railroad engineer would undertake to keep track construction of any gauge up with an army on even a fairly rapid advance, and with standard gauge the difficulty would be increased at least threefold. In the first place the writer has always taken exception to those who argued for the use of wooden ties throughout. They are undoubtedly desirable from the fact that surface and line can be more readily kept, but in forward areas the superior speed with which sectional track can be laid, especially at night, the lessened demand for skilled labor, and the avoidance of noise due to spiking, make the bolted sections preferable. When opportunity occurs they can be replaced by ordinary rail on wood ties, as was done in places in the light railway in the Toul sector. A revision of design of the standard American track as used in the A. E. F. appears desirable. The sections were 5 m. (16 feet 5 inches) long, and had eight ties, with a total bearing area of 13.76 square feet per section. The German sections were not all alike, but in general had ten ties to the section. One type of these German sections had ties 4 feet long by 7 inches wide as compared with our ties 3 feet 7 inches long and 5½ inches wide, which gave a bearing area of 23.2 square feet or 176 percent of that of the American section. Furthermore, recent investigations* indicate that "with jarring" the increased width of the German tie would enable it to support a load of approximately 160 per cent of that of the American tie. Therefore a section of German track would support a load 100 per cent greater than the American track, a most important advantage on poor soil. Such track with 20-pound rail would weigh about 550 pounds per section.

Remembering that ballast was the great bugbear and cause of delay in light railway construction in France, and that from a tenth to a quarter of all the traffic on our light railways was ballast, it is interesting to note that whereas a standard-gauge road, thinly ballasted, would take about 1,800 cubic yards per mile, a 24-inch gauge track would take 1,026 cubic yards per mile with wood ties or 520 cubic yards per mile with steel ties. A 30-inch gauge would take 624 cubic yards ballast per mile. The ties alone for a standard-gauge track would weigh at least 165 tons per mile, while the entire sectional track of a 30-inch gauge, rail and ties included, would weigh but 88 tons per mile.

Since heavy equipment could not well be employed on a "light" standard-gauge road bed, and since it would scarcely be feasible to run light equipment far to the rear, a transfer yard and rehandling would still be necessary, not only for divisional food, forage and clothing, but ammunition and engineer material as well.

Standard-gauge locomotives have been built of as light a weight as 7 tons. A number of such locomotives were successfully operated in the New York subways hauling track material.

The writer is informed by Lt. Harvey W. Bell that the stability of the rolling stock is not a matter of gauge but of design; that if correct design is used, the stability is practically the same for 24-inch, 30-inch or 36-inch gauge. His wide experience in design, manufacture and operation of light railway rolling stock entitle his opinions to great weight.

A 2-foot gauge (60 centimeters) was doubtless desirable in France to conform to that of all the combatants. Elsewhere a 30-inch gauge would be far preferable and would eliminate many troubles experienced on the *soixante*. It would involve no additional cost or additional weight of either rolling stock or track, and much greater stability would be afforded.

One marked advantage of the narrow gauge in the neighborhood of the enemy is its immunity from injury by shell fire, and the 30-inch gauge would be practically equal to the 24-inch in this respect. So narrow a target is seldom hit, whereas experience has shown that the standard gauge is quite vulnerable and far more difficult to repair quickly.

The description of an American steam locomotive is highly original and absolutely correct. The writer agrees fully with it, but would suggest a different remedy.

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*Second Progress Report, Special Committee to Report on Stresses in Railroad Track: Proceedings Am. Soc. C. E., February, 1920—page 133.

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Colonel Kelly admits that so long as the cars are pushed by hand or hauled by animals the narrow gauge has three points of advantage—permits use of lighter track material; permits use of sharper curves and steeper grades; permits use of sectional track. He maintains, however, that the minute mechanical traction is introduced these advantages disappear. The writer is not prepared to coincide fully with this opinion, but the locomotives and cars must be properly designed, with low centers of gravity. The French had a car that was excellently designed for keeping the rails, and their double-end steam locomotive was a marvel. It is at least questionable, however, whether it would not be better to employ gasoline exclusively. In the recent war locomotives had at times to remain for days away from water, coal and pit tracks. Some of the mechanical experts of the 21st Engineers are of opinion that a double-truck gasoline locomotive with all the weight on the drivers, a motor of about 75 horsepower and a four-speed transmission would be a most desirable type of tractor. Our steam locomotives were all that Colonel Kelly says, and then some. One captain in the 21st Engineers re-railed 65 locomotives in one month. I never saw a French steam or gasoline locomotive off the track. The Germans had a dense network of light railways opposite the American front, and when these were captured "it was found that the lines of the German system contained many sharp curves and heavy grades, which called for reduction before American equipment could be successfully operated." (From "Historical Report of the Chief Engineer," A. E. F.) It is American equipment that is thus by inference indicted. Instead of 24-foot cars of 22,000 pounds capacity, a four-wheel car of half that capacity and a third the weight should be tried out. It would keep the track better and could be readily re-railed.

Our light railways were miniature standard-gauge roads, whereas one should look to the logging road or contractor's construction railway for suggestions. To completely fulfill the functions of light railways they should be capable of quick extension; of the rapid construction of a dense network of tracks at certain points, and ability to run sidings and spurs to all kinds of inaccessible battery positions, machine-gun nests and trenches. There is a wide variation between a warfare of position, such as for four years existed in France, and an expedition chasing guerrilla bands in the mountains of northern Mexico. A careful study should therefore be made to determine where the light railway is advisable and where not. Experiments should be carried out to test the merits of different types of track and rolling stock; these to include rush emergency construction under adverse conditions to determine practically with what speed a line can be extended; how it will hold up under traffic, and how well adapted the rolling stock is to its purpose. Bring the track up to good condition as opportunity permits, but bear in mind that under battle conditions and in rush construction poor track is inevitable; therefore have rolling stock that can run on the poorest track.

E. D. Peek

Major, Corps of Engineers; formerly Colonel, Engineers, in Charge of Railroad Construction and Maintenance in the 1st Army, A. E. F.

It must be admitted that, granting the success of our light railway operations, they were fraught with many handicaps which we brought upon ourselves inadvertently. The American light railway equipment, both locomotives and cars, is much heavier and has a higher center of gravity than either the French or the British materiel. This type of construction, with the same width of gauge, demands a better and more stable road bed, and as a matter of fact, our experience in the war amply demonstrated that our light railway equipment demanded a better road bed than would be required for a light standard-gauge railroad.

The heavy equipment and high center of gravity, with an American personnel demanding higher speed and heavier loads than the French, resulted in increased derailments and increased demand for track maintenance.

The German lines, which fell into our hands in the vicinity of "No Man's Land," were all of the character upon which the Germans operated only short, light, push cars or tram cars and which could not be used by the American materiel, both on account of the weight of the rail and the degree of curvature.

It is believed that light railways or narrow-gauge railways were not thoroughly developed. When the World War began, a 60-centimeter light railway system was universally used in most of the industries in both Germany and France. In France it was also used in the fortified towns for the distribution of the heavy and bulky Engineer and Ordnance material. In this latter construction, during peace there was opportunity for obtaining good road beds as ample time was available. War brought on the necessity for a narrow gauge in the field, and we found that the French made great developments, especially in the vicinity of fortified towns, as Verdun, Toul and Epinal. In the vicinity of these towns the fortification systems for heavy artillery were extended into the field, and a standard commercial light railway project was utilized.

The narrow gauge, to be a successful light railway, should be developed in and under field conditions. It requires light equipment which means the minimum of preparation for the laying of the road bed and for prompt operation. It requires the utilization of light cars and engines properly built.

These conditions can be brought about only by experiments under actual field conditions, and it is thought that these tests will develop improvements along the following lines:

(*a*) Lower center of gravity of engines.

(*b*) Engines with double movable trucks in order to take sharper curves.

(*c*) Engines equipped with chain or gear drive in order to insure uniform power, permitting movements over rougher track and preventing derailments.

(*d*) Lighter rails.

(*e*) Lighter cars with lower center of gravity.

Even if all of these experiments are made—and there is a marked advance in the probable use of the light railway along these lines—it is still believed that the use of the equipment for defense will not be as easily and profitably accomplished as was the case with our light-weight standard-gauge equipment.

The experience in our Northern States upon logging roads, in which the ties are laid upon the ground without ballast and with little or no grading, gives rapid and efficient results. The equipment for the light railways now designed precludes even the remotest possibility of a similar use.

In large depots, storehouses, yards, fortifications and stabilized warfare, the narrow-gauge undoubtedly has its place. However, the character of war we are to wage on our borders must never be other than an offensive campaign in which the light standard railroad equipment has its pronounced advantage and should undoubtedly be used.

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Paul McGeehan
Major, Engineer Reserve Corps; formerly
Major, 12th Engineers (Ry.)

Colonel Kelly's article leads one far into the realm of speculation as to the character of future wars. It may be true that position warfare will have no place in future military operations, but it seems to the writer that our military authorities should so plan for the future, as to prepare us to meet an antagonist of at least equal strength to our own. With such an enemy any extensive land campaign must pass through a stage of deadlock where position warfare will be a necessity. If we are always fortunate enough to have wars where our victories are easy and our advances rapid, of course we will have no use for light railways. For they will only come into play when desperate resistance makes enormous concentration of men and artillery necessary on narrow fronts.

Granting the possibility of our becoming again involved in such a conflict, the question of what kind of light railways are to be used is very much in order.

In such a war the main standard-gauge railways will be advanced as far to the front as possible. The terminals of these main lines must be far enough to the rear, however, to avoid destruction, and to avoid too much annoyance from the enemy's heavy artillery. The zone of greater danger in front of these terminals must be served by the wagon roads and light railways. These will radiate out in fan-shaped systems toward the front from the rail heads. So if you make a small advance and capture the enemy's light railway system, you will find that his tracks are not designed well for your use, and that the fans all point in the wrong direction. And you are also liable to find that your new construction connecting your tracks with his can not be used for some time on account of soft embankments and lack of ballast.

This brings up a big question which an army commander must consider, whether an advance of less than the depth of the enemy's light railway system is really worth while at all. Such an advance is sure to disarrange ones own supply and transportation systems about as much as it does that of the enemy.

The 2d Army on the Toul front had this experience. The dumps were all established, and where the advance, after the St. Mihiel push, was only a few miles these were not moved forward, thus there resulted an excessively long haul for the light railways between the old rail heads and the new fighting front, requiring the operation of much new soft track, and the maintenance of long stretches of track at the rear. which it would have been much better to have abandoned. A young officer of the 11th Engineers from New York, aptly summed up the situation when he said that the 2d Army dumps were just "two battles behind."

In retreat it is obvious that the fan-shaped plan of the light railways will soon be wiped out if the retreat is at all extensive. It is also apparent that on account of the expense, organization of these tracks in depth is not practicable. If a retreat is among the possibilities, occasional lines running straight to the rear should be provided in order to save the rolling stock, and not leave a defeated army in what the British described as a "ghastly situation," when they found that practically all of their light railway equipment had been captured. The British had provided these stems to the rear, but they were so imperfectly supplied with watering stations and were in such a poor state of maintenance that the withdrawal had to be made at a snail's pace, and no time was availble when the ends of the tracks were reached, to load the locomotives on the standard-gauge trains.

So the writer is in entire accord with Colonel Kelly in his statement that light railways are not of much aid to an army either in advance or retreat, and is of the opinion that this fact should be accepted as an axiom in military engineering.

A discussion of the article therefore settles down to a question of gauge of the tracks. Again the writer agrees that the *soixante* gauge is too narrow. This 60-centimeter or 2-foot gauge may have been suitable in the early stages of the war, but the large American cars and the Baldwin locomotive have undoubtedly made it obsolete. The writer has previously advocated a wider gauge. Anyone who has ever ridden on the top of a water tank ahead of a locomotive and has watched this little narrow track move out from under him, first on one side and then on the other, with the swaying of the train, is liable to come to the conclusion that he is riding on a monorail rather than a railroad. It used to seem almost miraculous that cars loaded with baled hay 10 or 12 feet high ever stayed on the track. Many derailments and the constant slow speed of trains can be laid directly at the door of too narrow a gauge.

While the writer agrees that 2 feet is too narrow, he is not inclined to the belief that it should be increased to as much as 4′ 8½″, the standard gauge. In the first place, the narrow-gauge railways are cheap in money and in what is much more important under war conditions, require less human effort in their construction. The rails are not over a third as heavy as those of the standard gauge, and one man can handle a rail or a tie with ease.

Light railways should reach the front at intervals of a mile or so, and thus must follow up most of the small valleys which extend in that direction. This means that they must be adapted at small cost to the meanderings of small creeks. Narrow-gauge railways can be successfully operated on very sharp curves, of less than 100 feet radius, and by the use of this curvature all heavy cutting in earth and rock can be eliminated. One must remember that practically all of the grading at the front must be done by hand with pick and shovel, and that the labor available is usually both scarce and inexpert. And besides the writer has never noticed that the morale of troops was ever improved by requiring them to perform such labor.

It is granted that electric railways use even sharper curvature than that mentioned here for light railways, but the standard-gauge equipment of this country, on which we must depend in war, will not pass around such sharp curves. So the advantage mentioned by Colonel Kelly of turning these light railways into trunk lines later in case of an advance, disappears. Besides only the larger valleys can be utilized for the trunk lines, for long trains can be hauled only on tracks with light grades and easy curves. Usually the larger valleys will already have been occupied by the railways of peace time.

So generally the only railways suitable for advances will be the main lines in use before the war. These with their solidified road bed and their bed of ballast, can be utilized in a minimum length of time, even when their bridges have been destroyed.

If the narrow gauge is to be abandoned and the standard substituted, it would be found that it would be no easier to advance such a system than it is to advance the narrow-gauge tracks; because neither is designed for through business, and their usefulness as light railways would be decreased if they were so designed.

Then the standard-gauge tracks would be more conspicu-

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ous and would be sure to attract artillery fire. The enemy doesn't bother the 2-foot gauge tracks because they can be repaired with such ease after they are hit. And they are harder to hit because they are more crooked.

Another objection to the standard-gauge track would be that of having all ones eggs in one basket, and one shell would put it out of business. Whereas if the cost be divided amongst several narrow-gauge tracks at a distance from each other, the enemy would be put to more trouble and expense in annoying us.

The greater ease of concealment of narrow-gauge railways is another advantage. Narrow-gauge tracks can be built in a forest and so wound around among the larger trees that the skyline is not broken, and the tracks remain hidden from airplane observation.

The writer is of the opinion that the American light railway equipment of the latter stages of the war was ideal. The 10-ton gondola cars are as large as necessary and so are the locomotives. In his opinion the gauge ought to be increased to 30 inches. This gauge with the same rolling stock, built to negotiate sharp curves will enable the light railways to double their speed and greatly reduce delays from derailments. This widening of the gauge (6 inches) would not lose any of the advantages possessed by the 2-foot gauge. And coupled with the use of wooden ties it would materially reduce the amount of ballast and track labor required to keep the trains moving. Usually ballast is scarce on the battlefield, and inferior in quality. Anything tending to reduce the amount of ballast required furnishes a distinct advantage to light railway operations.

The writer was greatly impressed with the experience of the British in the first battle of Cambrai in November, 1917. In this push they concentrated all of the troops and artillery on the front to be attacked, that could be supplied by the wagon roads and light railways. In other words, if the excellent French wagon roads would have allowed them to haul up more food and ammunition, they would have employed more troops on this sector for their attack. Light railways located at a distance from the wagon roads materially augmented the British lorries in delivering supplies to the front.

In a great campaign in a country like America where good wagon roads are so scarce, concentration of men and materiel for offensive purposes, comparable to those in France, would be impossible without light railways. Perhaps the railways would be more highly developed than those of France because of the scarcity of good roads, which would throw a greater burden upon them. And such a campaign might develop a new rule of warfare, for victory may actually go to the belligerent having the most light railways, rather than to the one having the most artillery.

Harry L. Hodges
Formerly Colonel, General Staff (Cavalry) A. E. F.
Member Military Board of Allied Supply

The writer hopes that Colonel Kelly's article will serve the useful purpose of provoking a discussion of the efficiency of narrow-gauge railways. (It did.—Ed.)

His conclusion is, "that it seems obvious, therefore, that the narrow-gauge systems have no place in our future plans, but should be replaced by a light railway equipment on standard gauge."

Considering this statement from its purely engineering side, the writer does not deem himself qualified to express an opinion.

The American tendency in the use of light railways was to demand of them greater loads and greater speed than they were designed to accommodate. Should there be no change of gauge, there will be undoubtedly an endeavor, following this practice, to utilize the standard-gauge heavy equipment on the light standard-gauge lines, which use would probably cause as great a number of difficulties as occurred in the use of the narrow-gauge lines.

Perhaps the loss of narrow-gauge equipment, to which reference is made in the article under review, was due rather to the fact that army systems of light railway were not connected at that time, and so the equipment could not be shifted to the flank when occasion demanded it.

Should it be necessary to transfer shipments from a heavy standard-gauge line to a light railway equipment on the light standard-gauge line, there will be a necessity for transfer points, which Colonel Kelly cites as one of the weaknesses of a change in gauge, and as an advantage in light standard gauge.

Economy of construction, administration and maintenance are undoubtedly the reasons for the existence in peace times of the narrow-gauge systems, in the United States, France and Germany and of the "Vicinal" system in Belgium. These same reasons demanded their use in war. But there is an additional reason for the use of a peace-time gauge in war—the fact that it is capable of immediate quantity production.

The choice of gauge is largely the result of the conditions under which narrow-gauge lines are to be used, mechanically the wider the gauge the better so long as fabricated sections can be used.

The gauge employed by the British was chosen by them largely due to the fact that the German military narrow-gauge lines were all 60-centimeter gauge, and when captured could be immediately utilized.

It is accepted that there is a necessity for the utilization of light railway lines during stabilized warfare.

In any operations in which conditions exact intensive use of the highways, or where the capacity of the highways, due to their construction and condition, is reduced, steps were taken during the great war and will be taken under similar conditions in future wars to relieve them of all possible traffic, and to relieve motor and horse transport from the necessity of transporting such articles as can be otherwise transported, leaving them for a more mobile use. Light railways and standard-gauge railways perform in common these duties, but they have two essentially different functions; the standard-gauge railway is in great part an organ of procurement and storage; the light railway divides with the motor, horse and man transport the duty of distribution of supplies. It is a tactical rather than a strategic agency. It was decided daily in the French Direction de L'Arriere what proportion of the duty of distribution should be handled by light railways and what by motor and horse transport.

A doubt is expressed as to whether light railways can be utilized in a war of movement. In a war all of movement and in which the daily advance of the armies exceeds the possible rate of construction of light railways, there is room for serious doubt as to the possibility of their continuous use, but in a war in which there are periods of stabilization light railways can be and were used by both the French and British for a period during the break from a war of stabilization to a war of movement. Even in a war all of movement they can be used where an army holds a position for any length of time while other forces accomplish a strategic envelopment, thus relieving motor transport for more mobile use.

In fact their use in the break from a war of stabilization

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to a war of movement was contemplated by the Supreme High Command, who caused this subject to be studied by the Military Board of Allied Supply, which as a result of this study organized, for this purpose, an inter-allied reserve of light railway equipment. At the meeting of the Board, held on August 11, the French member, Marshal Foch's Chief of Supply and Transport, presented a note dealing with the problem of transportation on the front and the use which narrow-gauge railways could be put to in order to meet the increasing difficulties. He laid stress upon the fact that in the probable event of the enemy's retreat the Allied Armies would have to follow him up through devastated regions. Past experience gained during the war showed that this devastation comprised systematic destruction of all lines of communication, including the taking away of all material, thus rendering the re-establishment of railway lines a lengthy matter. It also greatly limited the number of immediately usable roads. Light railways could be used to form a link between standard-gauge rail heads and the troops on the front, thereby reducing the strain put upon the motor transport services and releasing a portion of same for more urgent or efficient use at other points. They could be constructed also with less difficulty and delay.

It is of interest to note the policy of light railways in each of the Allied Armies:

In the British the policy of light railways generally was based on the stabilized front. It is not found desirable to attempt to push broad-gauge rail heads nearer the front than 7 miles, and the average distance behind the front lines of these rail heads may be put at about 10 miles. Light railways are definitely regarded as essentially providing means of transport from the line beyond which broad gauge can not normally and regularly pass, and this interpretation of the scope of light railways has been strictly adhered to. The early policy laid down was that, in the event of a small advance, the light railways system would be deepened by approximately the depth of the advance. If the advance were strictly limited, broad-gauge rail heads might not be advanced, but in the event of successive advances the broad-gauge railheads would be moved forward to a position relative to the front similar to that occupied before the advance. It was considered in view of the difficulty of constructing suitable broad-gauge rail heads, that the light railway system should be allowed to grow considerably in depth before the broad-gauge rail head was advanced. A separate policy was, however, laid down for a considerable advance, and it was definitely decided that broad-gauge railways were to be the means of supplying the armies in such a case, light railways as *feeders to the armies* dropping out with an advance of great depth.

In the French, established at first as a remedy for insufficient ground communications, they developed into a regular system for the relief of the horse and motor transport for the hauling of ammunition, particularly where intensive fire was necessary. They were utilized, however, for field artillery, engineer and road supplies.

During the advance it was found that between the new positions of the enemy and those that he had abandoned there was a devastated zone in which the roads and normal-gauge railways could not be put into immediate use.

If the roads could be quickly enough repaired, the same was not the case with the normal-gauge railways for which one could not count on a daily advance in excess of 800 meters.

On the other hand, the relatively small power of motor transport made it necessary to use the latter for the transportation of personnel and food. It became necessary, therefore, to carry on, at the same time as the repair of roads and the normal-gauge railways, the construction of 60-centimeter lines.

In the Belgian the object of the 60-centimeter railway was chiefly to reduce wagon traffic on the roads as much as possible. Its need was felt more and more as the roads in the rear of the Belgian front were often in bad condition, very narrow and crowded (their width being hardly sufficient for the passage of an automobile) and muddy in rainy seasons.

The 60 centimeter was the only means of assuring the supply of ammunition to guns of large caliber; of transporting large quantities of stone material for repairing roads and for concrete works.

Finally in case of an advance the 60-centimeter was used in crossing shell-torn terrain and aiding in the reconstruction of the standard-gauge railways by the transport of men and material.

In the Italian the following policy was adopted in the construction of narrow-gauge railways:

To construct with 75-centimeter gauge railways where they might be used after the war, and to build 60-centimeter gauge railways when exclusively for war purposes and therefore temporary.

For the use of these railways the following policies were adopted:

1. To open up new lines of communication in places where railways did not exist, as they were easy to operate and could be built quickly.
2. To carry materials and ammunition to those places where the normal railways could not reach, saving in this way, mechanical and horse transportation.
3. To assist the railways in the zone of operations in supplying the troops operating in that zone.

F. W. Green

Formerly Lieutenant Colonel, Transportation Corps, A. E. F.

The writer considers Colonel Kelly's article to be a very interesting and timely contribution to any consideration of the practicability of narrow-gauge or light railways in war. In the summer and fall of 1917 he was engaged, while an officer in the 12th Engineers, in the operation of 60-centimeter light railways, serving the 3d British Army in the Cambrai sector. At that time the front was thoroughly stabilized, and, in general, conditions were most favorable for light railway operation.

The design of the light railway steam locomotives was not satisfactory. Water tanks of the saddle type were carried upon the locomotive boiler, which, considered with the narrow gauge, produced a high center of gravity, and consequent overturning moment. The driving wheels were only about 24 inches in diameter, and the angularity of the main rods consequently excessive. The ratio of grate area to heating surface was too small, and there was too much overhang at each end of the locomotives, rendering them particularly susceptible to derailment on poorly surfaced track. The design of the cars in use by the 3d British Army was, on the whole, satisfactory. The writer believes, however, that by carrying the water and coal in a tender attached to the locomotive, by altering the design of the boiler and frames, and by the use of an underframe system of spring suspension, that even with the 60-centimeter gauge, the light railway lines could be made a very serviceable and practicable utility.

The gas and gas-electric tractors, used immediately behind the front lines, where the use of steam locomotives was impracticable, were also susceptible of material improvements in design. In order that these units may properly function, it is necessary that either the gauge be widened and the resisting moment to overturning correspondingly increased, or that the center of gravity be lower. It is believed that a careful revision of the design of these units could develop material improvements. The light railway ought to be considered merely as an adjunct to the standard-gauge railway. It is usually considered impracticable, from a tactical standpoint, to undertake the operation of standard-gauge railways closer than from 5 to 8 miles from the location of the enemy's artillery. Light railways may be operated in comparative safety up to within 2 miles, or sometimes even less, except in the case where a line of the light railway is directly enfiladed by the enemy's guns.

Considered as an auxiliary service, the light railway, under ordinary conditions, ought never to be called upon to furnish transportation for more than one division, or, in extremely favorable cases, more than an army corps. The writer recommends that in all cases units larger than a corps should be served by standard-gauge railways, using the light railways at the standard-gauge rail head for distributing materials and supplies from the railroad to the divisions. With proper plans and a proper organization

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of the personnel, it ought to be entirely practicable to follow up an advance in open warfare with light railways, provided the advance does not progress at a rate faster than 6 or 8 miles per day. At the same time, dispositions should be so made as to insure that the standard-gauge railroad construction will progress at the same rate. The writer advocates the construction of duplicate light railway lines from the rail head to the front, using one line entirely for supplies, under normal conditions, and the duplicate line for transporting railway material for the next day's advance. As the broad-gauge construction progresses, the light railway track can be taken up and moved forward on this duplicate construction track, and ballast and other repair material for the operating line can be brought up to the place where needed, unloaded and applied without interference with the trains performing transportation service for the troops. Moreover, in case of tactical reverses, the duplicate track could be used in moving back material, personnel, and at the same time provide a means for withdrawing equipment and salvaged railway track. In case a need should arise for large reinforcements, the double track could be used for forward movement, or as a double-track line, as circumstances might require.

It has been the writer's observation that the failure of the light railways to properly function, aside from the difficulties in design, above pointed out, has been due to imperfect organization of the light railway service and imperfect staff co-ordination of the light railway service with other services. It is believed that the attempt to move supplies for an army, for a distance of 50 or more kilometers, over a light railway, is a serious error, and that the failure of the light railway service grew out of the expectation that the light railway could successfully function for such long distances.

The writer seriously doubts the wisdom of definitely abandoning the light narrow-gauge railway in favor of a light standard-gauge railway. The expense of construction and maintenance would be enormously greater, and the difficulties of distribution at the front vastly increased. It must be remembered that the primary reason for the use of the light railway was the large economies resulting therefrom, as compared with the distributing from standard-gauge rail head of material and supplies by motor truck. Where large concentrations of troops occurred, as in the late war, the wear and tear upon highways by motor trucks, in some instances, was so great as to require as many trucks to haul road material as for the hauling of other supplies. In its place it is believed that the light railway is an important auxiliary service, but there is a limit to its capacity, as above pointed out. In the case of a relatively small expeditionary force, for example, the Pershing Expedition into Mexico in 1916, it is believed that the light railway would prove a more economical means of transportation than the use of either horse or motor drawn vehicles for such long distances.

H. W. Durham

Major, Engineer Reserve Corps; formerly Major 41st Engineers, A. E. F.

At a recent meeting of the American Society of Civil Engineers, there developed considerable discussion on the question raised by Col. Kelly—the value of 60-centimeter gauge railways as developed in the war in France—and there was much agreement expressed with his points of criticism.

It is doubtful, however, whether the reasons given for the adoption of this type of equipment are correct. It is true that German manufacturers made large quantities of light industrial railway equipment before the war, but so did British and French manufacturers. In particular the Decauville 60-centimeter portable track and rolling stock was much used in France and her colonies for a generation before the war. When the Isthmian Canal Commission took over the French Panama Canal plant in 1904, there were great quantities of this stock on the Isthmus, and the writer, who was there during the first three years of construction, made much use of the old French equipment of this type. Several 60-centimeter railways were constructed for the supplying of materials to reservoir sites, distant from standard-gauge track, while locomotives and other rolling stock were put into service after twenty years' idleness in the jungle—a service very satisfactorily performed. To the pioneers at Panama these little railways were no strangers when met in France. For the first year of canal construction this track also formed the most available reinforcing material for concrete construction; in particular Ancon reservoir and the Caledonia highway bridge over the track near the Panama railroad station.

Others have already drawn attention to the fact that there were two main reasons for German dependence on these light railways. First, the shortage of rubber for motor tires, and, second, their inferior highway lines of communication. The latter were neither as extensive, as well located nor as well built as those behind our lines. Our army fought in a country supplied with the most comprehensive highway system in the world, and may not always be so well provided, as those who have been on the Mexican border well know. It is the writer's belief then, that good highways when available are infinitely superior and capable of much more elastic use than light railways; but if the question is one of the latter's use as compared with standard gauge, it seems as if our army experience with them in France was too brief and limited by which to determine the question, and that it would be better to do this with reference to the experience along the British front. Our army probably built and used more new light railway lines in its forestry operations than with the armies. During the early part of 1918 the writer was in charge of lumbering operations near St. Dizier and built over 10 miles of this light track for logging railways to reach the standard-gauge line at the mill. Several French Decauville locomotives were used, and it was found necessary to ballast all track to reduce the number of derailments which caused frequent delays. A French line on an adjoining project took as much track work as a standard-gauge line. More satisfactory results were obtained by extending the standard-gauge lines and using teams for motive power on the 60-centimeter track.

From his experience, both at Panama and in France, the writer agrees with Colonel Kelly in preferring standard-gauge track wherever possible, but does not think he has made a case for the absolute elimination of gauges other than standard. More consideration should be given to British and German experience before ruling out the portable lines from war use. The author also does not make it clear what would be the "light" standard-gauge equipment to which he refers. It could hardly possess the quality of portability. If we are to fight all over the world, we can not adopt any inflexible standard equipment good for all regions, for if we try to, we shall but repeat our experience with the ponton material so abundantly provided at Washington for crossing the Rhine.

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T. D. Sterling
Major, Engineers; formerly 21st Engineers (Light Railways), A.E.F.

Primarily light railways belong to a war of position and are comparatively of little use in a war of movement, as the normal-gauge lines can generally be utilized if proper preparations are made. The primary function of the 60-centimeter railway is to deliver ammunition, troops, rations, supplies and army and engineer material from standard-gauge rail-heads to points near the front. In other words, the field of construction and operation of the 60-centimeter railway is within the enemy's field of fire. It was considered impracticable, during the world war, to use standard-gauge lines in any sector within the field of fire.

Assuming that it is decided to build standard-gauge lines within the field of fire and to use on these lines light railway equipment altered to suit the gauge, there are many good reasons why it would be impracticable to build such lines, with the expectation of using on them light railway equipment altered to fit the standard gauge:

1. Assuming that the standard-gauge track would afterward be in use by standard-gauge equipment, it will be found that the located line of a 60-centimeter railway, with its sharp curves and steeper grades, can not be used successfully by standard-gauge equipment.

2. The amount of clearing, grubbing and grading for a standard-gauge line will require from one-third to one-half more man-days of labor than a 60-centimeter line.

3. *Track laying.*—Ties for the standard-gauge track will be the usual standard-gauge railroad ties, 8 feet in length and require for expeditious handling four men per tie. Ties for a 60-centimeter railway are 5 to 6 feet in length and never require more than two men per tie. If rails suitable for 60-centimeter railway are proposed for use on the standard-gauge ties, it will be found that standard-gauge equipment on which the track material will probably be loaded can not be brought forward on the light rails without serious damage to the track. If heavier rails are used, suitable for standard-gauge equipment, there will be a large increase in the force of men required. If track material is not brought forward on the standard-gauge equipment, on which it is most likely to be shipped, then it will be necessary to reload it onto the altered light railway equipment at the rail head. It is this rehandling of material at rail heads which it is proposed to avoid by the use of standard-gauge track directly to the front.

4. Assuming that the proposed lines are built to standard gauge, with a rail which will sustain standard-gauge equipment, it will be found, in case of a retreat, that the lost track material will represent many times the cost of a 60-centimeter railway.

5. *Rail-heads.*—It will always be necessary to have a certain amount of yard tracks and storage room at divisional rail-heads. (There will be a certain amount of truck haul at all times.) There is very little additional expense necessary to provide 60-centimeter trackage for such material as will be handled by the narrow-gauge lines.

Objections to the construction of standard-gauge lines close to the front may be briefly summed up as follows:

(*a*) Impossibility of locating a standard-gauge line in all places where a 60-centimeter line could be located.

(*b*) Greater amount of labor required for construction.

(*c*) Greater cost of material used.

(*d*) Greater difficulty of concealment from enemy view. (Standard-gauge lines show up very plainly in aerial photographs, whereas 60-centimeter lines may be easily concealed.)

(*e*) Because of greater cost of material and labor for construction there would be a consequent greater loss in case of retreat. There is bound to be loss in a retreat, but it is hardly good military policy to plan equipment on the supposition that a retrograde movement will predominate.

(*f*) No noticeable advantage in reduction of transfer yards, as such yards will always be required at some places.

In reply to the statement that light railways were rendered entirely useless for nearly two weeks after the beginning of the St. Mihiel drive, this can not be strictly true, as 60-centimeter lines were continually in operation from the day of the drive. It is admitted that there was much congestion and delay to traffic. This was due to insufficient labor and material being provided for the work to be done. There was also much trouble with the motive power.

The narrow-gauge railway admittedly can not replace the standard gauge, but equally so a standard gauge can not replace, to advantage, a narrow gauge. While the 60-centimeter railway has its limitations, it is the only practicable means of transportation in any sector which is lacking in good roads, and is the best means of aiding transportation by trucks and teams. Many of the objections to the use of the 60-centimeter railway are based on the performance of those lines in France, where the motive power and equipment were found to be incorrect in design, of poor construction and unsuited to the requirements of the campaign. The highway, the standard-gauge railway and the narrow-gauge railway each appears to have its own field which can not be filled satisfactorily by either of the others.

Aerial Mapping with the Tri-Lens Camera

By

M. P. Taylor
Captain, Engineers

One of the most important phases of work yet developed by the Bagley 3-Lens Camera is the mapping of large and, heretofore, unmapped sections of territory. There is much of this territory in the United States, of which no maps of any usable degree of accuracy are available, and the Bagley camera offers a solution for supplying, in minimum time, maps which are fairly accurate.

Up to the present time, a great question for debate seems to be whether the required amount of accuracy for present-day maps can be secured by aerial photographic methods. Aside from this question, there is no doubt but that a fairly accurate map is much better than none at all, for such a map allows a working basis and can be corrected as occasion permits.

In connection with the military mapping operations in the Southern Department, work is under way for mapping, by aerial methods, a large area in Southern Arizona. This territory extends from Nogales to Yuma, and from the Mexican Border northward to the Southern Pacific Railroad, comprising in all some 16,000 square miles of territory. The field work, or photographic operations, in this section is near completion.

For the area under consideration, there are no available maps that show the territory with even a fair degree of accuracy. Before starting the field work, the best possible maps were acquired. After starting operations it was found that these maps were so inaccurate and incomplete, for the most part, that they would not even serve as a base on which to plat the result of the photographic work. The country in this vicinity is a combination of desert and

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mountains, with few towns, railroads or other artificial markings on the topography. The available maps show the mountain ranges, but inaccurately, omitting many of the smaller mountains altogether. There is scarcely any drainage shown, and the roads and trails are shown incorrectly.

The work was laid out so as to be handled from three stations successfully, beginning at Yuma, the most western point; then from Ajo, in about the middle of the section; and finishing up at Tucson, on the east. The area to be covered from Yuma was about 4,000 square miles, and from each of the other places about 6,000. It was planned to fly the photographic courses in due east and west directions as nearly as possible, with a north and south course every 20 miles, for use as a control. This plan was adhered to throughout the work. It must be understood that there is a certain amount of variation from any outlined plan for this work, due to the physical impossibilities of flying courses exactly as laid out. This is especially true when there are no good maps to fly by, but at any time cross winds may interfere so as to make it almost impossible to fly a correct course.

All photography on this work is conducted from an altitude of 11,000 feet above the base of operations. The distance above sea level then may be secured by adding 11,000 to the altitude of the various stations; 200 for Yuma, 1,700 for Ajo, and 2,200 for Tucson. The elevation for carrying on operations was chosen arbitrarily, the necessary facts to consider being amount of detail to be shown and relative costs of carrying on work from different altitudes. The amount of film used, and therefore the amount of flying time necessary, varies inversely as the square of the altitude above the ground. At 11,000 feet the photographs give an approximate scale of 1: 20,000, and each exposure covers an area of some 1½ by 6½ miles.

Due to the rough nature of the country, the distance from the ground to the camera is a variable quantity, and the scale of the photographs changes accordingly. This is a condition incident to work in country of this nature. It cannot be eliminated in the field work, but can be corrected in the office preparation of maps from the photographs, provided sufficient ground control has been secured.

An overlap of about 50 per cent is used between consecutive photographs, and about 25 per cent between consecutive strips. This allows a sufficient amount for the variation in courses as flown, and also permits of using the central part of all photographs, which is of course the most accurate.

The field work was started April 5, 1920, and will be completed about July 5, 1920. To date about 13,000 feet of film have been used on this work, and the amount will be 16,000 before the work is complete. It can be readily seen that an unusual amount of work must be expended before this amount of film can be transformed into maps. All film developing is done in the field but no endeavor is made to handle the printing there. The exposures made with oblique lenses must be put through the transforming camera, and this is perhaps the longest part of the process.

It is estimated that it will take a year for the photographs of this territory to be worked up into map form, the force consisting of three laboratory men and six draftsmen. That would make fifteen months from the beginning of field work to the completion of the map. Considering the speed of ordinary mapping methods, this is remarkable.

Were ordinary mapping methods applied to the territory under discussion, progress would be much slower than in most places. The country is sparsely settled, water is scarce and, what there is, often of poor quality. The desert roads are very poor and impassable in many places. Survey parties can operate only under great difficulty, and with a small degree of efficiency. It is likely that the cost of mapping this region by ground methods would be twice the usual cost of such work.

The completed photographic map will show all horizontal detail, mountains, drainage, roads, trails and settlements. It is impossible to state now what the limits of accuracy will be as the ground control is unfinished, but a reasonable amount of accuracy is expected. At any rate the map will give correctly the general topography of the region, and be an effective basis for future operations.

Much has been said of the cost of aerial photographic mapping as compared to ordinary methods. This would seem to be rather unimportant, at least as far as the field costs go. It would undoubtedly be out of the question for any commercial organization to make maps economically by aerial methods. But the government has the equipment and the personnel, and moreover photographic mapping should be a part of all airplane pilots' training, as they will be fitted for it in war time. There is no apparent reason why this work should not occupy a prominent position in the aviation calendar.

Infantry Howitzer.—The Infantry accompanying guns, which were tested at Aberdeen Proving Ground, were manufactured by the Ordnance Department, the two types being copies of Italian designs examined by the Caliber Board in Europe. The first design completed was a 70-millimeter gun, firing a 6-pound projectile; the second design was a 75-millimeter gun, firing an 8.5-pound projectile. The object of manufacturing these two types was to provide models at an early date, in order to crystallize ideas and opinions on what characteristics this type of weapon should embody. The tests have clearly shown that these two models are not satisfactory to fulfill the specifications which have been proposed; *i. e.*, that this weapon shall be suitable as a substitute for both the 37-millimeter gun and the 3-inch trench mortar.

The Ordnance Department is now preparing designs of a weapon that will fire a 6-pound shell for direct fire, and a 10-pound shell for indirect plunging fire. The tests of the two Italian types have been suspended pending a metallurgical investigation which was found necessary.

Railway Artillery.—The outstanding features in the development of railway artillery in the United States during the last two years lies in the construction and test of the 14-inch gun railway mount, model "E." This gun and mount were designed in the Ordnance Office; the gun was built at Watervliet Arsenal, N. Y., and the mount at Watertown Arsenal, Mass. Gun and carriage tests at the Army Proving Grounds, and service tests at one of the seacoast fortifications have proven this mount to be one of the most serviceable pieces of railway artillery that we have.

The mount may be fired as a sliding mount from any well-ballasted track, but without any specially prepared foundations; it is provided with several degrees of traverse, so that a curved track is not necessary, as in the case of the usual type of sliding mount where no traverse is provided. The carriage is equipped with a base plate suitable for setting on bare ground or on a concrete plug, from either of which the gun can be fired in any azimuth. In target practice, at both long and short ranges, where moving targets giving the extreme rate of change in direction were employed, the practical use of this mount was well established, the general operation, rate of fire and percentage of hits being most gratifying.

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The Methods of Construction in War

By

E. Graves

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[*Note.* Engineering construction of all classes is one of the chief features of modern war. During the late conflict the engineers of the American Army covered the theatre of war from the base ports to the battle line with structures of every conceivable variety. Hundreds of thousands of men, including many of the ablest engineers in America, were engaged in this great work, so vital to the success of our arms.

Of the many men who directed this mighty undertaking none was better equipped by ability and training, none enjoyed a wider experience or achieved more conspicuous success than the distinguished author of this article, which we are glad to present to the engineering profession.

Colonel Graves lays down in clear and convincing language the basic economic principles which govern military construction. He then shows in detail the application of these principles to the various classes of work.

This treatise will be of value not alone as a guide to the military engineer of the future. Many of the principles and methods discussed by the author are quite applicable to many civil works, when prompt results adequate to the needs of the case and no more than adequate, are desired; and when the returns must justify the outlay.

The engineer of the future must be more than a mere builder of structures, a mere technician. He must understand the basic principles on which the success of construction enterprises whether in war or commerce are based, otherwise he cannot justly assume the title "engineer." Herein are some beacon lights to guide him in his future course.—ED.]

Fundamental economic principles

Bare necessities alone. Construction, both in the theatre of operations and out of it, is one of the functions of warfare that is susceptible of great mismanagement and incorrect judgment, if the fundamental economic principles of war are not continually heeded and applied. When warfare is started in any locality, the struggle of opposing forces means that there will be great scarcity of materials, supplies and transportation. It is inevitable that there should be a scarcity of all supplies, and that food, ammunition and men will have priority in transportation. It is therefore certain that construction will be done under most difficult conditions. That only bare necessities should be provided is axiomatic. A reserve engineer officer in the Great War said that when he went back to civil life, he might not be able to make a living because every time any one sought to employ him to construct anything he might follow his war-time training and persuade his client that he didn't need what he asked. So bear in mind, the principle of *bare necessities only* is of primary importance. Of course the decision as to what constitutes bare necessities rests with the military authorities.

Safety and durability of minor importance. While in civil construction great weight is properly given to safety, permanence, cost, etc., in military construction these features are of much less importance. Factors of safety need not be so great, although they are somewhat dependent upon the nature and purpose of the structure and other circumstances. For instance, if a military force is entirely dependent on *one* wharf for its supplies, it is necessary for that structure to have as great a factor of safety as in civil practice, but if, on the other hand, many buildings are being constructed for storehouses and personnel, it matters little if one or two of these houses fall down.* The saving of materials by building all the houses with a factor of safety of less than two, more than overbalances the loss of one or two structures. Also, the length of time a structure for military purposes will be required is always short and generally uncertain, so that it does not pay to build except for the present.

Planning, procedure and order of importance. In planning construction, where large expansion may develop, it is proper that structures should be so laid out that expansion is feasible. However, it is essential that the building program should be so carried out that each usable unit is completed in succession, in such a way that it can be used immediately. Thus the construction will lend itself continuously and progressively to the military necessity, and a change in the military situation which stops all the construction will not leave such a large proportion unused and useless as in civil practice where ultimate completion of the whole is generally the aim. It sometimes happens that work carried on in this way is more costly of labor and material, than if parts requiring similar construction methods are built at the same time. However, the satisfying of the immediate military requirements is usually the first consideration, and should rule. For instance it is wrong to start a number of storehouses when one house is needed, and all labor and material could be devoted to providing this necessity immediately. Similarly, it is wrong to lay ten railroad tracks in a yard before aligning and ballasting any, when perhaps only three tracks are needed immediately, and the available labor could be devoted to laying, aligning and ballasting these first. When electric power is required it is generally better to use a small gasoline unit to fulfill immediate needs and to add units as the demand increases, rather than start a large power house which may never operate at all. The loss of efficiency due to using small units is insignificant compared to the importance of fulfilling the requirements of the military situation. Intelligent supervision and planning will keep construction ahead of military necessities, while blind and senseless adherence to plans will not provide necessities in time.

Administration, organization, and control. In the administration of construction work over an extended territory two things are quite essential; 1st, there should be an engineer in each locality in charge of all engineering work, including buildings, railroads, electricity, water supply, and every other kind of construction, and, 2d, responsibility and authority should be decentralized as much as possible. The only way in which limited materials and labor can be most usefully applied is for one head to decide which feature of construction is most in demand, and to apply all available means to the job most necessary. This is in accordance with the principle stated above that a usable unit must be

*An amusing story illustrating this idea is related of Colonel Graves. While he was engaged in the construction of a large storage depot in France, one of his subordinates, greatly disturbed, entered his office and reported, "Colonel, two of your storehouses have fallen down." Far from reflecting the perturbation of his aid, Colonel Graves smiled and replied: "Good. I have been waiting for this. I now know how far I can reduce my factor of safety."

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rushed to completion, before parts of other units are started. Thus is avoided the spectacle heretofore too often presented, of several construction agencies, each obsessed with the supreme importance of its own task, vying with each other for the exclusive control of all available facilities. The head which supervises all engineering work in a theatre of operations must have similar heads in various localities. The work should not divide into specialties until it is small enough to be supervised in detail by one man. This is true of control, but does not mean that higher supervising heads should not have advisers in specialties. However, these advisers should not be permitted to interfere with the supervision of local heads over the various specialties.

Higher supervisers should delegate as much authority and responsibility to subordinates as is possible, because in war communication is slow, and local necessities are best known by the local man.

Plans should be considered only as guides to keep the local man informed of general policies, and should be changed at will to meet local conditions, and to conform to available materials and labor.

Simplicity. The maxim of Napoleon that simplicity should characterize all the operations of war, is as applicable to construction as to any other feature. All designs should be of the simplest nature, requiring only the most common construction materials, and supplies. For instance, water supply equipment should be of a few standard sizes of pipe and fittings with simple pumps. Electrical installations should be made with simple machines that do not require extraordinary personnel to install and repair, etc., etc.

Construction for personnel

The construction necessities are cover, water and latrines.

Cover in general. Men require protection from the weather according to climate, season of the year, etc. The nature of this protection is dependent upon the probable time of occupancy. Soldiers on the march rest and sleep in the shelter tents which they carry on their backs. If they are to stop in one locality for several weeks, it is desirable that large tents be provided. If occupancy seems fairly certain for an extended period, barracks may be advisable, and economical from the standpoint of transportation, materials, and health. In the World War the use of barracks rather than large tents in many cases was a mistake. Stationary and trench warfare created a false impression as to the advisability of barracks, which was not fully realized. It was useless for the first American Army to attempt a large barrack program in the front line area, because movements were too rapid for barrack erection. Transportation facilities were acute and were growing more so every day. Large tentage could have moved with a small percentage of the freight cars which were required for barracks. It is believed that large tentage should be kept on hand for about 40 per cent of any military force so as to avoid unnecessary barrack construction, and that barracks should be used only when occupancy for long periods is assured, since the wear of tents makes the use of lumber advisable only when long occupation is contemplated.

Layout and location. In locating a camp of any kind, either of tents or barracks, care should be exercised to take advantage of all local facilities to avoid unnecessary construction. If tents are likely to be changed to barracks, space allowances should be sufficient to permit of the change. Any existing roads should be taken advantage of in order to avoid road construction which is most expensive in labor, materials, and transportation. Kitchens should be placed adjacent to the road and latrines on the opposite side. Fire risk should be reduced by proper spacing. Layouts shown in Field Service Regulations should be followed in principle, local conditions as to roads and railroads, visibility, drainage, water, direction of prevailing winds, etc., being duly considered.

Space allowances. Military necessity often takes precedence over sanitary requirement in the matter of space allowances. Medical authorities say that a man should have about 600 cubic feet of space. Sometimes they prescribe even more. Generally they say, certainly not less than 400 cubic feet. In discussing barrack space, this is usually spoken of in square feet, the barrack being assumed to have an average height of 10 feet, which may or may not be so. The decision in this matter is made by the tactical military authorities, since the medical authority can not carry the responsibility incident to the necessary reduction in his recommendation for air space. In the World War, the foreign armies allowed about 40 square feet of barrack space per man, but the American Army operated and increased its personnel so fast that by necessity its allowances were about half of this. Men were placed in double tiered 4 and 8-men bunks, and received an allowance of not over 20 square feet per man. The following quotation from orders of G. H. Q., A. E. F., shows what military necessity brought about in the World War:

3. The following allowances of floor space will govern officers charged with constructing shelter for our troops:

(*a*) Enlisted men. Bunks 2′ 8″ by 6′ 6″, double tier, in sets of four, 2′ 8″ apart, giving one linear foot of Adrian barrack (20 sq. ft.) per man. For company (250 men) kitchen and store room, 12 linear feet of Adrian barrack (240 sq. ft.), and one additional linear foot (20 sq. ft.) for each three men of the organization as dining room.

(*b*) Nurses. One room 10′ x 14′ for each two nurses. Kitchen allowance same as for enlisted men.

Dining room allowance, 2 linear feet of barrack (40 sq ft.) for each three nurses.

Where nurses are now accommodated in Adrian or other similar type barracks, their quarters will be altered to conform to the above.

(*c*) Officers. One room 10′ x 14′ for each colonel; one similar room for each lieutenant colonel or major. For officers below the grade of major, rooms will be provided for use in common on a basis of not less than 70 sq. ft. of floor space for each officer. When officers are quartered in an Adrian or similar barrack 14 sq. ft. of space allowed for each officer will be taken for a common assembly room, which will be separated from the balance of the building by a full height partition. For kitchen and store room for officers 10 linear feet of barrack (200 sq. ft.) will be allowed, and for dining room 2 linear feet of barrack for each three officers (13 1-3 sq. ft. per officer).

(*d*) Hospitals. One bed for each 3 linear (*) (60 sq ft.) of Adrian barrack. Kitchen allowance, 18 linear feet (360 sq. ft.) of Adrian barrack for 300 men, and 24 linear feet (480 sq. ft.) for 500 men. Dining room allowance, 2 linear feet (40 sq. ft.) of Adrian barrack for each 3 men of hospital capacity.

4. Lower bunk frames should clear the floor by 18″ and there should be room enough between the upper and lower bunks to allow a person to sit upright in the lower bunk. Company barracks, kitchen and dining rooms will not be floored.

5. The stove allowance is amended to give one stove for each 33 linear feet (660 sq. ft.) of Adrian barrack, or one stove to each room.

Types of barracks. In determining upon the type of house to use, it is well to consider local practice. In France designs were used which could be made from the short lengths of lumber used in that country. Demountable buildings were used to a large extent, because they could be made up in shops with machinery and economy in labor and in lumber. In the Punitive Expedition into Mexico huts were made of "Dobe" brick which could be made on the site and sun dried. Where the barrack has to be transported any distance, it is certain that wood or wood and corrugated iron are best, because more cover can be obtained for the

*Instructions to provide equipment for 1,200 patients in a 1,000 bed unit modify this to about 40 sq. ft. per patient.

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same amount of transportation than with any other materials.

In general, except where special conditions obtain, barracks for personnel about 20′ x 100′ are best on account of simplicity of construction. Where space is limited, a two-story barrack may be advisable, but this is exceptional. A larger barrack may be more economical in the materiel used per man, but complications in roof trusses, and the inadvisability of putting too many men in one building make the smaller building best in general. The use of corrugated iron brings quicker results, and takes less transportation to bring the material to the site, but the house is not so comfortable as wood, it being colder in winter and warmer in summer. On the other hand, the fire risk is less for iron than for wood. At Bordeaux some two-story barracks were constructed because ground space was not available for single-story buildings and at Brest some large corrugated iron barracks were erected because needs were so urgent that time overruled every other consideration.

Dining rooms and kitchens. As stated in the order quoted, a building 20′ x 100′ was made to serve one company of 250 men for dining room and kitchen in Europe in the World War. This was supposed to be equipped with rough lumber tables and benches but was not always so fixed. This kind of dining room was provided in divisional areas, and in certain large depots with more or less permanent personnel. In replacement camps, rest camps, and debarkation camps where large numbers of men were fed rapidly from one kitchen, other special types of dining rooms were developed. These did not provide seats, but stands on which the men can place their mess kits, and shelter from the weather should always be provided.

Screening. In France there were few flies, comparatively speaking, and it was prescribed that screening would not be used except for operating rooms and kitchens in hospitals. After the Armistice this was modified by screening being prescribed for kitchens and dining rooms at some of the ports, or where the warm climate made flies more prevalent. At the debarkation camp at St. Nazaire screens were not used, because, according to the Commanding Officer, flies could be controlled by cleanliness. Such large numbers of men were fed continuously that it was impossible to keep either the kitchens or dining places closed to flies, and screening was useless. At this place there were almost no flies. In warmer climates in America screening will always be demanded although with rough construction it is very difficult to keep a house fly-proof.

Windows. In the World War, glass could not be obtained. In addition, its transportation is always difficult. Various types of window substitute have been developed, consisting either of some kind of transparent cloth or tough paper, or of wire netting coated with a transparent film of gelatin substance, which may be inflammable or not and soluble in water or not, preferably *not*, of course. Window substitute in rolls provides a large amount of window material requiring little transportation space.

Water allowances. The amount of water men use, depends chiefly upon what they can get. While European cities use from 20 to 30 gallons per inhabitant, per diem, American cities use from 60 to 250 gallons per inhabitant. Men in camp will get along for cooking and drinking purposes alone (not including washing) on about one gallon per man per day. One camp in France, of about 20,000 men, had wash water two or three feet below the ground surface, and hauled for several months drinking and cooking water, getting along very nicely by hauling one gallon or less per man, per day. The large debarkation camps in France had water supplies providing a maximum of 10 gallons per man. So 10 gallons or less per man or animal, per day, will take care of a camp quite nicely although, of course, it will not provide for street sprinkling and such uses. Where water is piped to separate companies, one faucet per company can be made to serve and no provision for washing faces and hands is *necessary*, although it is sometimes made.

Bath houses. In the divisional areas in France, one bath house per battalion area was provided. It had a "bain douche" of 8 showers, and was a house 12′ x 23′ with a partition giving a room 8′ x 12′ for the shower, and a room 12′ x 15′ for dressing. When practicable a four-inch concrete floor was put in the shower room and a wooden floor in the dressing room. The "bain douche," a French affair, is a most economical device in material and in water used. The above mentioned allowance is quite small and requires good administration and supervision in the use of a bath house by a company, and bathing by squad. Somewhat better facilities were provided in some large camps, but the above represents *bare necessity*.

Drainage. In camps, drainage should be by open ditches, and piping should not be used.

Latrines. Latrines should be of the simplest type. About one seat to 20 men is desirable, although one seat to 40 men can be made to serve. No floor or concrete is necessary around a latrine. A roof with enough siding for a screen is desirable although by no means an absolute necessity. The French squat latrine is economical but does not conform to American standards of comfort like the American seat latrine. Whether a latrine has sides, roof, and seats depends upon availability of material. No sides or roof at all, or simply pieces of canvas or brush are frequently made to serve. In war, flush water, septic tanks, and other sewage disposal devices should be avoided as there are never materials or labor available for such purposes.

Electric lights. Where electric power and materials for lighting are available, it is a convenience to have electric lights in a camp, and they may be installed. However, such installations are made only when the facilities for their construction are easily available. When camps are lighted there need not be over four 25 watt lights per barrack (20′ x 100′) and one 25 watt light per officer. Ordinarily in war only divisional headquarters and other higher headquarters have electric lights. A divisional headquarters require about 3 kilowatts for lights.

Laundries. The use of laundries in the A. E. F., except for troops going in and out of the front line and for hospital patients, was forbidden, for reasons of economy.

Hospitalization

Percentage of hospitalization for a military force. In the beginning, hospital provision to accommodate 7 or 8 per cent of the personnel in France was authorized by G. H. Q., A. E. F. This was to be obtained by renting existing buildings and by new construction. Later this percentage was increased until it became 15 per cent. Just before the Armistice the sick and wounded increased rapidly and became 12 or 13 per cent. The combination of flu and desperate fighting accounts for such a high percentage of hospital patients. It is believed that it must be a most desperate war in which hospital provision of over 10 per cent is necessary. When fighting is not severe and not continuous, 5 to 7 per cent ought to be an ample allowance. A divisional training area in France was allowed a camp hos-

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pital of 300 beds, *i. e.*, 300 beds to 28,000 men or a little over 1 per cent.

Base hospitals were constructed in 1,000 bed units. As mentioned above, the space allowance per patient as prescribed was 60 square feet, but later instructions to provide for 1,200 beds in the so-called 1,000 bed units made the actual allowance from 46 to 54 square feet per patient.

There was provided for the actual use of a patient from 55 to 76 sq. ft. of space. This figure corresponds to the figure of 28 sq. ft. which was provided for the ordinary soldier. The overhead space in the base hospital units varied from 13 to 17 sq. ft. per patient and the total space per patient including space of attending personnel, was from 88 to 117 sq. ft. For the camp hospital these figures were 46 to 77 sq. ft. for actual use of each patient, and 65 to 108 sq. ft. total allowance per patient.

Water supply and sewerage. In France water supplies for base hospitals were designed on the basis of 25 gallons per patient, per diem, but not always was so much water available. Latrines with cans were used, the contents from the cans being generally burned. Drainage pipes for wash water and urine were laid. This is believed to have been a mistake. Piping for drain water and not for sewage is not worth the labor and material involved, and there was not enough water to permit of sewage being carried into the drains. An enormous amount of labor and material would have been conserved if no such drainage had been attempted. Stationary wash basins could have been dispensed with, and tin basins on a bench substituted. Sinks can be improvised from any materials available.

Electricity. The electric lights placed in each ward should not exceed six. The power provided has to be suitable in voltage and sufficient to meet the requirements of the apparatus in the operating rooms.

Remount depots and veterinary hospitals

A large program of remount depots and veterinary hospitals was carried out in France, although the scarcity of animals hardly warranted so much construction. For horse shelters and other buildings round poles can be used for posts when squared timber is scarce. Also hay racks and horse troughs can be placed on the ground and made of corrugated iron, where lumber is scarce. Disinfecting or sulphur chambers are constructed with any material available. They are nothing more than fume-tight houses in which animals are backed into stalls, and the doors closed, with the heads of the animals projecting outside. Horse dips made of concrete were constructed at veterinary hospitals.

Air service construction

The Air Service may require special construction at assembly plants, training centers, depots and landing fields in addition to provisions for personnel.

Assembly plants. If aeroplanes are delivered unassembled as they were in France, an assembly plant will be necessary. In France this plant was located where parts arriving at all ports could be collected. It was laid out on a very large scale and constructed progressively by unit, so that it could function to meet immediate needs. The units used were assembly shed with motor testing adjunct, salvage shed, shop, store sheds, hangars, and landing field.

One assembly shed was composed of three houses, 50 feet wide by 500 feet long placed side by side and five houses placed perpendicular to these from 50 to 110 feet wide and about 350 feet long. In the three sheds first mentioned the planes were unpacked and partially assembled. They were then moved into the perpendicular sheds where the wings were put on. The width of these sheds varies to suit different sized planes, and it was expected that planes might finally be received having a width of 100 feet. It was claimed that floors were necessary in these sheds, but the planes were assembled without floors, although certain parts of the sheds were finally floored with concrete to facilitate work. Between the sheds forming the unit, the valleys in the roof were covered and water was carried off by simple wooden troughs. The sheds were generally steel frames covered with corrugated iron, although some were made of wood.

The salvage shed was identical with the assembly shed.

The shop was a building about the same size as the assembly shed. On account of machinery being used, concrete floors were greatly desired, and were partially laid, although they were done without for awhile. Power was furnished by a 50-horsepower gasoline unit at first. More power was to be added.

Store sheds about 50′ x 500′ were used to store parts in. They were simple sheds without floors, containing certain racks to fit special parts.

A landing field adjacent to the plant was used on which to test planes before they were sent to the front. Hangars were placed on the side of this field.

Training centers. The training centers in France contained provisions for personnel (which were supposed to be the same as for all Army personnel), landing fields, with hangars, and shops for minor repairs.

Depots. Air depots in France were located away from general depots, because the air supplies did not follow the same lines of travel as other supplies. The depots had store sheds without floors the same as general depots.

Landing fields. Landing fields were constructed at assembly plants, at training centers, and behind the front. Some of these were located where weeds had to be cut down and grubbed; others were more properly located on open ground, where smoothing only was necessary.

These fields have to be made smooth, and planted in grass. Preparing a field is a long job, and should be carefully considered and found necessary before being started. Plows, scrapers, graders, rollers and tractors are used. A large 75-horsepower tractor, with a grader having a 12-foot blade will do such work, or it can be done with smaller apparatus. Small Grey tractors were used to a great extent in France.

Hangars. Hangars can be made of steel, wood, or canvas. Canvas, of course, is most expedient, but where long use is assured, or where extremely wide spans are required wood or steel is used. The Bessenau hangar, used in France, consisted of a light wooden truss covered with canvas. It had widths as great as 23 meters. This type of hangar is the most economical in material and in transportation, and it can be easily moved. Spans under 70 feet can be made with wooden trusses. Greater spans than this make steel almost essential and even smaller spans may make steel more expedient.

Motor transport construction

Motor transport facilities include assembly plants, shops and parks. Each port in France had an assembly plant. There was one large shop in the Intermediate Section, and parks with shops were scattered throughout the Advance Section behind the front. All these layouts contained similar structures varying in size. The construction work was building sheds, roads, and storage parks.

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Sheds. The sheds were made of both wood and steel. Sometimes they had concrete floors. Sheds were permitted only for work and for storage of spare parts.

Roads. Heavy traffic around motor facilities requires much road work. It has to be done with dirt, gravel, or rock, whichever is most available. Drainage is exceedingly important, because with good drainage almost any material will do well. Road work for any purpose is drainage and rock, and in war whatever is available must be used, with drainage always in mind.

Parks. Storage ground for motor vehicles in France was sometimes graded and drained, but it was rarely surfaced with rock or gravel. Generally grading for drainage will keep the ground firm enough to permit storage of motor vehicles; and only those portions of a park which are subjected to traffic have to be surfaced with rock. However, at places in France mud became so bad that tractors had to be used to move motor vehicles.

Supply

The British found the requirements for their Army in France varied from 28 to 30 lbs. per man per day. The experience of our Army indicated a larger figure than this (about 36 lbs.), but we were storing up a large 90-day reserve all the time and were constructing storage therefor. In addition, we never had a regular basis of supply for a fixed number of men. It is considered that 30 lbs. per man per day is an ample allowance for planning for an ordinary expedition and that 40 lbs. per man is sufficient for any contingency. The figure, of course, depends upon the reserve planned for.

The plan of storage for our expeditionary force in the World War was first to have a reserve supply of 90 days for 2,000,000 men. Later this was changed to 45 days supply for 4,000,000 men. One-half of this was to be stored in the Base Sections near the ports; one-third in the Intermediate Section; and one-sixth in the Advance Section. In order to handle and care for such a large supply, extensive port, railroad and storage plans were necessary.

Port construction

Dock requirements. Experience of the British and American Armies showed that there could be unloaded 1.25 tons per day per lineal foot of dock. On the basis of 40 lbs. per man, 1,600 feet of dock length would supply 100,000 men, and 16,000 feet would supply 1,000,000 men.

Freight handling apparatus. In France there was great difference of opinion as to the advisability of installing cargo handling apparatus, and the kind of such apparatus most expedient. Large Gantry cranes straddling three tracks were advocated by some; smaller cranes straddling only one track were advocated by others; and others advocated only ships tackle. At first only ships tackle was available. On the large dock at Bordeaux, large Gantry cranes were later partially installed. Other derrick devices lighter than Gantry cranes were tried with differences of opinion as to results. It is fairly certain that military necessities will have to be first met with no dock handling devices at all, and if civil practices come in later, when tonnage is sufficient to supply them in addition to necessities, they can be designed according to existing conditions. In France, the railroads never succeeded in removing all the supplies from the docks, so the unloading of the ships was not the critical requirement.

At Antwerp, Belgium, a wharf used by the A. E. F. after the war had unloading equipment that is considered reasonable if devices other than ships tackle are possible. This wharf had a space 55 feet wide between the classification shed and the front of the wharf, with three railroad tracks on it. The outer track was spanned by a crane, so materials such as rail, iron and steel could be loaded direct from ship to flat cars. A cargo requiring classification could be deposited on a one-horse truck, which would carry it into the large classification shed on the rear of the dock, and deposit it, where it was desired. Railroad tracks were located also on the far side of the classification shed, so cars could be loaded therefrom. The principle of this dock by which, in addition to railroad cars, liberal use can be made of horses, trucks or men to move stuff away from the ship's side, is good.

The questions of ballast for ships, coaling, unloading exceptionally heavy pieces, etc., are problems which require special solutions, depending upon existing local conditions.

Dock construction. Any rapid wharf construction, and rapidity of construction will certainly always be necessary in military operations, must be wood construction and probably it will be pile construction. A pile wharf is the quickest and most economical in materials. The Montoir Pier is considered the best type of work of this kind done in France from a military standpoint.

Railroad facilities

General requirements. In any theatre of operations, the main lines of communication will utilize existing railroads and these will ordinarily be found adequate, insofar as main line tracks are concerned, but, as in France, extra facilities may be found necessary. Ordinarily, construction necessary will be included in one of the following classes:

Passing tracks.
Tracks on docks and from docks to yards.
Receiving, classification, and departure yards, near docks at engine terminals, at depots, or at any place where trains are made up.
Engine terminals.
Water tanks.
Railroad shops.
Regulating stations.
Railhead sidings.

Weight of rail. In France practically all the railroad laid was in the form of yards and sidings. Although several lines ten or fifteen miles long were constructed to connect wharves with storage yards, or aviation centers with main lines, this was the exception rather than the rule. Since in yards and on sidings trains move slowly, it is not necessary to have as heavy rail as on main lines. In France 80-lb. rail, and 14 ties to the rail were used. It would have brought about a great saving in tonnage if about a 60-lb. rail had been used, and rail of this weight would have served the purpose. Perhaps 16 or 18 ties to the rail would have been advisable for the lighter rail, but nevertheless the resulting saving in tonnage and transportation would have been enormous.

Tracks on docks and from docks to yards. There are usually at least three tracks used on a dock in front of the classification shed, to take the cargo direct from ship. With three tracks, cars can stand on one to receive loads and be moving on and off, on the other two. If rails are laid at floor level, supplies can more easily be moved by animal, by truck or by hand truck, off the dock into the classification shed. Back of the classification shed there should be two or more tracks to receive cargo from this shed. Two or more tracks should be laid from the dock to receiving, classification and departure yards.

Railroad yards. At places where trains are made up and at depots, receiving, classification and departure yards with

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tracks from 1,500 to 2,000 feet long are necessary. Tracks in France were spaced first with 14 ft. centers, then with 16 ft. centers to permit locomotive cranes on hand to be used. While plans should be made providing for ultimate expansion into elaborate yards, the construction should be carried on progressively to fit immediate and urgent needs. In France plans were never completed entirely. Supplies moved eastward only, and all types of cars were used for any and all purposes, indiscriminately, so the need for classification westward did not exist, since only empties traveled in that direction.

The layout used at Gievres, France, served the Intermediate Depot; served as an engine terminal; and during the German attacks near Chateau Thierry, served as an advance depot and regulating station for the Paris Group of American Forces. In other words, these yards were made to serve every requirement under most difficult conditions. One track (about 1,700 feet long) along one side of the storehouses was found sufficient. The yard was designated with the idea that each storehouse was similar to a freight storehouse in New York, Chicago or San Francisco. In such a storehouse freight comes in for Jones, Smith, etc., at the same time that it is going out for Thompson, Jackson, etc., so the facilities for handling into the house from cars and out of the house into cars at the same time are necessary. At Gievres it was different. Everything that came in was for Uncle Sam and everything that went out was for Uncle Sam, and practically everything that came in on the railroad went out on the railroad. One house generally carried only one article, and if that article was to be shipped to Uncle Sam, the same article, if in cars, would simply be reconsigned in the same cars without unloading. The entire yard of about 125 storehouses was just as if it were one house with many tracks through it. Unloading and loading from the same tracks was never necessary because each particular item was always stored on more than one track. Items coming in would be unloaded on entirely different tracks from the one on which loading was necessary. In the area where wagons were unloaded, assembled and then reloaded for the front, three adjacent tracks and a locomotive crane were used. Of course such a layout as this is constructed in order as the facilities are needed, and where topography makes construction difficult, that part of the yard is simply omitted and extensions are made where construction is easy and rapid. Ballasting was not done here at all, and is never done until it is demonstrated to be necessary.

Engine terminals. On a main line engine terminals are placed about 75 or 100 miles apart. These terminals consist of receiving yard, turntable or Y, ash pit, inspection pit, water tank, coaling facility, engine house, boiler house, oil house, standing tracks and departure yard. A classification yard is necessary only if trains are broken and made up anew at the terminal. The yards are constructed only as needed. Ash pits and inspection pits may be constructed of concrete or of old ties. Coaling was from a pit, by locomotive crane.

Engine house construction in France followed civil practice. It should have consisted of simple sheds, containing each about two tracks. Thus there would have been light from the sides, and complicated sawtooth construction requiring glass would have been avoided.

Water tanks. Water tanks have to be placed on main lines about every ten or fifteen miles, at engine terminals and at places where switching is necessary. Tanks can be improvised from any lumber available. A plank 3″ thick is desirable. When a tank must be improvised, 25,000 gallons is a convenient size. Posts for such a tank can be 8″ x 8″ resting on wooden blocks instead of concrete. Any available iron rods can be used for bands. If turnbuckles are not available a substitute can be improvised by taking a piece of pipe, mashing it together in the middle longitudinally, passing the rods through the two tubes thus formed, and securing them with nuts on opposite ends. If regular crane and large pipe is not available, 4″ or 6″ pipe and fittings can be used.

Regulating stations. A regulating station is nothing more than yards to receive, classify and make up trains for serving troops with a daily automatic supply. Cars containing complete rations are made up into trains, so that cars for one unit, generally a division, can be easily shifted out of a train. Supplies for a division for one day, other than ammunition, generally require cars carrying from 50 to 80 tons. The regulating officer receives requisitions from troops, and supervises the making up of trains. A regulating station may or may not be at the same place as the advance depot.

Rail head sidings. Where a division receives its supplies, sidings and storehouse space are necessary to only a limited extent. As the supply is automatic and daily, usually store space for one or two days' supply, with corresponding sidings is sufficient.

Ammunition depots

Depots for ammunition other than small arms ammunition, are constructed separately from General Depots.

Layout. In France, advance ammunition depots were so laid out that each storehouse (about 50 x 500) was located apart from other storehouses. Intermediate and base depots were first laid out with the storehouses in groups of eight houses, each 50′ x 1000′. Later, the depots in the rear were designed on the same principle as the advance depots. Although yards of eleven or more tracks were planned in France, five tracks filled every need which developed. A water tank near the yard was found necessary.

The sheds for ammunition are the same as the sheds for general stores. Designs of sheds, with earth protection on the sides and overhead, were made in France but there was never material and labor for such construction. Such a storehouse would simply make an explosion more disastrous, as the earthen walls and roof would act as tamping for the explosive. Safety is obtained by separating the ammunition, so as to localize any explosion. Intermediate and base depots are located beyond the range of hostile aeroplanes, so protection for them is not logical. Separation of storehouses gives a certain amount of concealment from aeroplanes. As a matter of fact, a great deal of the ammunition in the World War was stored outside, and this can be done in any war, if materials and labor are too scarce to permit of the construction of store-sheds. If sheds are constructed, it is not necessary to build the ground up to car level, since in war man power for operations is always more plentiful than building facilities. It is important to get something that can be used quickly and to give little consideration to the number of men necessary for operation.

Electric lighting. At the advance depot in France, electric lights were installed in the sheds, and power units were placed on push cars so that they could be placed on tracks adjacent to shed and connection made to lighting wires. It is rare that loading is going on from more than one or two sheds at the same time at night. At intermediate and base depots night work will rarely be necessary, so electric lights are not essential.

Personnel. The operating personnel for an ammunition depot in France was about one thousand men, and camps for

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them were located on existing roads nearby. It is better to locate men in separate small camps, if possible, so that there are workmen near all parts of the depot.

General storage depots

Plans and development. All supplies other than ammunition, aeroplanes and motor vehicles will ordinarily be stored in general storage depots, whose location will depend upon conditions. The storage depot at Gievres, France, in the intermediate section was most used, and was successful. It was constructed progressively according to immediate and urgent needs, and was never completed according to plan. This is, or should be, typical of storage depots for military purposes.

The storehouse area is laid out in sections, each section having a ladder track on each side connected by house tracks about 1,700 feet long, there being one of these to each three warehouses. These tracks are about 150 feet apart, which gives space enough for open storage on the opposite side of the track from the houses, as well as space for fire breaks. A section can be started with a ladder track on one side, the ladder on the other side added later. Running tracks are added when found necessary.

In constructing a storage depot, in the beginning the space should be laid out in separate areas for each department of the army, in the necessary proportion, and the construction should proceed so that each department can begin storing supplies, and expand without mixing up its supplies with those of other departments. At Montierchaume all the railroad sections were started at the same time, so each department could have its own expansion area.

In addition different types of storehouses should be distributed on separate tracks so that any one commodity can be stored on separate tracks, this so that if desirable the same commodity may be loaded from one track while it is being received on another.

In constructing the yards no existing roads should be closed by warehouses or tracks, as roads are almost impossible to construct with the means at hand, and available roads should be used.

Each department will desire one or more storehouses from which shipments can be made by truck. These warehouses should be selected adjacent to existing roads so that each department has one warehouse on a road. At Montierchaume wagon yards, and open engineer storage were distributed throughout the depot to make fire breaks between the storehouses.

Fire protection. In the layout of the depots, the warehouses are intentionally spaced far enough apart so that fire can not spread from one to another, and groups of warehouses are separated by open storage spaces. In addition, much of the contents of the warehouses is not inflammable, and generally the warehouses are built of corrugated iron, and are not extremely inflammable. No artificial fire protection is necessary. The cost of such a system in material far exceeds any probable loss from fire. Fire should be prevented from spreading by keeping the areas between the warehouses clear of rubbish and inflammable material. To lower the fire risk, all offices and facilities which use fire should, when practicable, be located outside of the sections which contain warehouses. At Montierchaume, wagon yards, and open engineer storage were distributed throughout the depot to make fire breaks between storehouses. Sidings or spurs far removed from other stores are laid for the storage of hay, and dynamite, for localizing fire risk.

Coal pile. A reserve coal pile in addition to the coaling facility for locomotives may be necessary. Such a pile is formed by unloading by hand from two or more tracks. As the coal increases, the tracks are raised until the pile gets about 10 feet high at the higher end, then a new pile is started. Cars, standing on tracks laid on level ground alongside such a coal pile, can be loaded with coal when it is desired for use. Coal piles such as described may catch on fire inside. For this reason, their height should be limited to about ten feet, and they should have spaces between them. If fire develops, it has to be stopped by digging around the fire, and localizing it.

Types of warehouses. The storehouse most used in France was 50 feet wide and 400 or 500 feet long. It was made with wooden frame and corrugated iron roof and sides. Designs used in France had very small factors of safety, and would have to be strengthened if used where large wind or snow loads are expected. In France frequently no sides were put on these houses, and they were used as open sheds. Sides were placed only on houses which carried perishable supplies, such as flour or sugar. In place of windows, siding was simply carried up to within about a foot or eighteen inches of the roof, and a continuous opening was left at the top which was protected by the eaves. Doors were generally not used, canvas being placed over openings where it was necessary to close them. Of course this did not contemplate protection from theft except by guards. The frames of buildings were made with round posts and rough lumber. Mostly no floors at all were placed. Dunnage was used to keep supplies off the damp ground. Supplies very sensitive to water, such as flour and sugar, were placed on a floor or dunnage consisting of wood poles with rough edged plank laid on them. Economy in labor of operations is of minor importance in war, so floors at car level do not warrant the labor, materials and time necessary to construct them.

In addition to the flimsy structures described, there were used in France some all metal warehouses of the same sizes as the wooden framed ones. One type of steel building came from America, and another type from England. The two types illustrated the difference in proper construction methods in peace and in war. The American building was perfectly safe and was good for many years. The English building had a very small factor of safety and was good for only one or two years. The American building consisted of many different and non-interchangeable parts, while the English building had more simple parts. One hundred such American buildings were received in France and they were of different designs. It proved exceedingly difficult to get the parts of any one building together. In addition some parts were so heavy that handling was very difficult. These buildings should all have been of the same design, their parts should have been as nearly interchangeable as possible, and there should have been as few parts as possible. The parts should have been light, and the entire building could have been much lighter, and less durable, thereby saving labor, material, time and money.

In war, materials are necessarily scarce, and just as no labor saving construction is warranted, likewise, absolute safety from fire, theft, and weather is not as important as in peace time, since everything is more or less temporary, and chances must be taken. Forty per cent of the rations and a large proportion of other stores can be stored outside for periods of two or three months without any appreciable loss. It is foolish for the supply departments in war to play a perfectly safe game and pay heavily for it, when at the front large losses are a mere incident.

Cold storage. Where soldiers are to have fresh meat,

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cold storage plants may be necessary. These are used only to freeze or store meat between shipments, and not to store a reserve supply. Reserve rations are kept in the form of canned meats. In France some plants of this kind were built. The one at Gievres with rated capacity of 5,000 tons, stored at times 6,500 tons of meat, it being piled in quarters with 2″ x 4″ strips between. The floor space used was 896′ x 110′, with about 11′ head room. This makes the area occupied from 15 to 20 sq. ft. per ton stored. These plants were first designed in the same way that they are designed in civil practice. Later they were modified, and when built, the ice freezing feature, spare boilers and water for condensing purposes were omitted. While such a structure, on account of its technical nature must be most carefully constructed, a designer having in mind the military requirements of simplicity, economy of materials and time, and the lack of durability, can modify for the better the structures designed from civil experience.

Bakeries. If the depot is required to make automatic shipments of rations to the front, bakeries may be necessary. It is necessary to carefully consider their location with reference to water since the water requirements of a bakery are very large. In war where simplicity is the rule, a corrugated iron house for each bakery company is better than any complicated mechanical bakery. The house can be constructed to fit the bakery organization. Sometimes it is difficult to obtain fire brick for use with the field bakeries, but as they are supposed to operate in the field, the lack of such brick should not be serious.

Freight house for small shipments. The depot will probably have to make a large number of less than carload shipments from the various departments, and it will probably be necessary to use about 15,000 sq. ft. for a shipping warehouse for L. C. L. This warehouse should be located near a connection to the mainline outgoing railroad.

Camps for operating personnel should be located on existing roads, and should be distributed around the depot, so that personnel belonging to each department is within walking distance of its work. Such distribution lends itself also to sanitation and reduced fire risk. The total operating personnel at Gievres, which carried 30 days supply for one million men, was about 22,000.

Electric lights. The working of labor at night is an uneconomical procedure, and is avoided as much as possible. Experience has shown that in the intermediate and base depots very little night work is necessary, so it is unnecessary to install electric lights in the warehouses. On the rare occasions when night work is necessary, acetylene flares can be used.

Mapping Northern Russia for the Archangel Expedition

An interesting article under the above title by Robert C. Johnson, appears in *The Wisconsin Engineer* for April, 1920. The article points out the absolute need for maps in a military expedition, no matter how great the difficulties of obtaining them. Some of the difficulties are well expressed by the author, who was a member of the American engineer battalion which took part in the Archangel expedition (1st Bn., 310th Engrs.).

A few days before we sailed from England for Archangel the colonel checked up the British pioneer equipment which had been issued in place of our own, and discovered a shortage of topographical supplies. Upon requisitioning additional material from the War Office, in London, he was informed *that Russia was too vast a country to be mapped during operations*, so no further equipment would be necessary. In spite of this careless disposition of the matter, we purchased a few antiquated supplies, which had been passed over by the British Army, and hopefully ordered a great many more from France.

When we arrived in Archangel, which is a city of 40,000 inhabitants with many fine buildings, we found the British trying to revise a Russian survey made in 1880. Because they were not prepared to do this work, they assigned it to us. As the only map we had was on a scale of 1: 1,000,000 and covered the area from the North Pole to Petrograd, no one knew the exact location of the front or of the separate units.

A search through the government offices in Archangel revealed a map of 800 sheets, printed in Russian, and of such a large scale as to be of little use for reproduction or distribution. There was only one copy of this map. Our problem then was to make an operations map showing the location of roads, villages and rivers—this to be done in the dead of winter and through a densely wooded area of 120,000 square miles.

We immediately organized a mapping section consisting of twenty Russian civilians and five Russian soldiers (none of whom could read, write or speak a word of English), three British officers, six British N. C. O's, and twenty American engineers—all under the command of an American engineer officer.

As no mapping section was specifically authorized for our campaign, everyone in G. H. Q. felt, when one was created, that it belonged to his particular department. At least that was the feeling when there was any work to be unloaded on the section, even to the painting of door signs; but when the section needed men or equipment, it was only a poor orphan.

The cheerful alacrity with which this tiny party attacked the task of mapping the huge area is characteristic of the American engineer under all conditions.

Strategy was resorted to to keep down drafting and painting demands irrelevant to the mapping.

Existing Russian maps were pantographed and translated for use as the base, and field parties made plane table check of the roads to give a map of sufficient accuracy for the plotting of artillery ranges. The writer describes in full the office methods used.

Thirty men were in the office, twenty-two of whom were Russians. The latter were very slow and careless, although their work was neat. A careful check had to be made of all their lettering as none of them understood English. They struck periodically for higher wages or shorter hours; but were usually bluffed into returning when fired. They did not realize that we couldn't get along without them.

The gravest question was one of sufficient supplies with which to carry on the work. Our stock was estimated to last only six weeks, and there was a general shortage of pens, pencils, erasers, thumb tacks and other things which are so plentiful in our own country. Our only methods of reproduction were by blue printing and hectographing. The latter method is always unsatisfactory and can be used efficiently only up to twenty-five copies. Our supply of blue-print paper was not sufficient to make one complete copy of the entire map. Nevertheless, work was pushed ahead, and cablegrams were sent to rush supplies.

Difficulties were encountered in making the various Russian maps join.

This was due to two causes: First, the forty years (since it was made); and, second, working in from the edges of the map (the method adopted) made all errors cumulative toward the center (where they became very noticeable and embarrassing.—Ed.). A chart was made of the magnetic variations during the forty years and corrections were applied to the respective surveys. The residual error was then distributed uniformly over the entire area so that only a small variation

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occurred at any one point. (One of the original forms of "Camouflage." —Ed.)

Paper tracings of the territory along the front were blue printed. Our print paper was slow, and as the sun shines there only four hours a day during the winter this blue printing was an arduous job. Daylight prints required a full hour of exposure. Finally, an old arc-light machine was discovered at the shipyards; but, as the current was on only eight hours a day, the printing ran way behind the drawing. However, by the 1st of January, the field parties were furnished with enough material to keep them busy.

Each field party was commanded by a Royal Engineer officer, and consisted of Russian forestry men and British or American N. C. O's.

The detailed methods and difficulties of carrying out the field work are described in full by the author.

Not a single day was lost because of cold weather, although the Russians had to stay out when the temperature stuck around 30 degrees below zero. One field party of three American N. C. O.'s and six Russians made 1,200 miles of road traverses in the six weeks from January 1 to February 12. No attempt was made to run out a base line or make solar observations, so that the work was unquestionably in error, but was sufficiently accurate for our purposes.

All through December and January the supply officer met every boat arriving in Archangel so as to be sure no one else obtained our supplies, should any arrive. Every department acted as a free lance whenever ships came in, because they all needed everything aboard. One of the last ships to arrive was met by the usual battalion of supply officers, only to find that the thoughtful War Office had sent up telephone poles. Archangel is a lumber city with forty saw mills. (This strikes a familiar chord in all our breasts.—Ed.)

Finally a shipment of lithographic supplies was received and unpacked; but the gasoline engine was minus everything but the flywheel and muffler, the press had no bolts with which to assemble it, and the circular glass of the arc-light machine was broken. These would have been trivial matters anywhere except in Archangel, where the nearest replacements are two thousand miles away. After much work the press was set up and an electric motor attached. All of the lithographers and pressmen swore they had never seen such a machine, as their oldest acquaintance dates back only to 1880. Modern presses are adjusted to print about 1,200 sheets an hour, so the motor had been geared for this speed. The first time the switch was closed the 2-ton plate carrier developed so much energy that it forgot to come back at the end of its run and kept going until a wall interfered. This caused a two weeks' delay while the blacksmiths made repairs and adjusting pulleys were erected for the motor.

When the mapping section was first organized two lithographers were placed in a Russian lithographic shop to become familiar with the local machinery. This was done so they would be ready to go ahead in case our own equipment failed to come. On the arrival of the press from England an inventory showed that no chemicals were included, so lists were made up and the materials purchased locally. This was a difficult task, as the Russians were very jealous of their supplies and concealed them in barns, attics and warehouses. Finally enough were gathered so that the plates could be made.

Contact printing from tracings onto sensitized zinc plates was first used in plate preparation, and although first appearing to be the most desirable method it was abandoned in favor of the method by drawing directly on the zinc by use of carbon paper. Maps were prepared in three colors—lettering, rivers, lakes and villages in black, roads and trails in red, and co-ordinate lines in yellow. The paper was very poor.

The scale of the main map was 1 inch=10 versts or .66 mile (very close to 1/40,000) and some 500 sheets (28 inches by 18 inches) were required to cover the area held by the allies. About 100 sheets covering the front and lines of communication were prepared by lithography before the departure of the American troops, lack of time preventing the preparation of all of the sheets.

In June, when the 1st Battalion, 310th Engineers, left Archangel, the British Expedition had been furnished by us with a complete series of Army maps. As the London War Office was not yet convinced that Russia *could* be mapped, no English Sections or equipment were sent to replace us. Therefore, on our way home we left our originals at the War Office in London for reproduction on heavy paper and transmittal back to Archangel.

Note.—The desire of most officers to have colored maps for facility in reading is a considerable handicap in reproducing maps in the field. The reproduction problem is greatly simplified if officers can be induced to use maps in black. Each color used requires the preparation of a separate plate and then considerable time is taken up in setting the different color plates on the press to obtain proper register. Much time is also lost in "washing up" the press between colors. Aside from these items the time of press running to produce any given map is directly proportional to the number of colors used. So in the problem of the topographical section of the Archangel force, instead of producing but 100 map sheets in the time available, at least



A familiar figure in unfamiliar surroundings. American soldier sketching in the frozen northland of Russia

300 maps sheets and in all probability the entire 500 map sheets could have been completed if those in charge could have been induced to accept maps in black only.

Life of cast-iron pipe in Philadelphia.—The first cast-iron water pipe in Philadelphia was laid in 1817. It was flange pipe, imported from England. It was in continuous service until 1914, a period of 97 years, when it was replaced by larger pipes, in anticipation of street repavement. It was in good condition when taken up and had evidently by no means reached the limit of its useful life, except through obsolescence. Soon after a transition from flange to bell and spigot pipe occurred, and in 1915 a line of this old pipe laid in 1827 was removed during subway construction. It was in excellent condition after 88 years service, but was not relaid, as a main of larger capacity was desirable.

Several hundred feet of 30 inch pipe laid in 1850 was taken up in 1918 to facilitate parkway construction, and was found to be in such satisfactory condition that after being cleaned it was relaid.—*Eng. and Cont.*

Water power act regulations being drafted.—Regulations to be used in carrying the Water Power Act into effect are being drafted by Oscar C. Merrill, the executive secretary of the Federal Power Commission; Gen. Enoch H. Crowder, representing the War Department, and Herman Stabler, representing the Interior Department. Applications for permits under the new act now approximate 1,000,000 horse power. Lt. Col. William Kelly, of the Engineer Corps, has been appointed by the President to serve with the Power Commission as Engineer Officer. Much of Colonel Kelly's experience in the Engineer Corps has been in California, where he has been brought in contact with water-power problems. He was in France with the 117th Engineers, and as Corps Engineer, 4th Corps.

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Death of General Marshall*

ON July 2d of this year there passed away a really notable and outstanding figure in the history of engineering, both civil and military. This was General William Louis Marshall, U. S. Army, Retired, formerly Chief of Engineers, and, at the time of his death, Consulting Engineer to the Secretary of the Interior in connection with the projects of the Reclamation Service. General Marshall was a strong man, a unique personality, an able, courageous and original engineer, and an American citizen of the very highest type.

His long career, characterized as it was by many well-known achievements as a constructing engineer, is familiar to those who have studied the development of the art in this country, for he led where others followed. Born in Kentucky on June 11, 1846, a member of the celebrated Virginia Marshall family, of which the most famous member was the Chief Justice, John Marshall, as a boy of 16 he left school and enlisted in the Union Army in the 10th Kentucky Cavalry, serving as a private and corporal from August 16, 1862, to September 17, 1863, when he was taken with typhoid, from which it took months to recover. In June, 1864, he entered the Military Academy, from which he was graduated, number seven in his class, on June 15, 1868, and assigned to the Corps of Engineers. Among his classmates were the late Gen. J. G. D. Knight, who was No. 2; Gen. R. L. Hoxie, who was No. 3; Prof. E. W. Bass, who was No. 4, and Richard Henry Savage, who was No. 6.

Following his graduation, Gen. Marshall served with the Engineer Battalion at Willets Point until July 5, 1872, with an interval of one year during which he was Assistant Professor of Philosophy at West Point. Thereafter he served as Assistant Engineer on Western explorations under Lieutenant Wheeler between July 5, 1872, and August 8, 1876. During this period, on horseback and on foot, he covered a very large part of the country west of the Rocky Mountains, riding and walking many thousands of miles. Perhaps one of his most notable achievements was the discovery of Marshall Pass, the lowest pass through the main ridge of the Rocky Mountains, now occupied by the main line of the Denver and Rio Grande Railroad.

After this he served on river improvements in Tennessee, Georgia, Alabama and on the Mississippi River until April 21, 1884, and he was then assigned to duty on the improvement of rivers and harbors in Wisconsin and Illinois, being stationed in succession at Milwaukee and Chicago until 1899. It was at this time that some of his most notable work was done, for amongst other important improvements he began and virtually completed the Illinois and Mississippi Canal, the so-called Hennepin Canal connecting the Illinois River at Big Bend just below La Salle with the Mississippi River near Rock Island. This canal, whose construction was ordered by Congress without any favorable recommendation on the part of the Corps of Engineers, was intended to form part of a through route between the Great Lakes and the Upper Mississippi River, but, unfortunately, Congress did not then provide, and has not since arranged, for the construction of the portion between Chicago and La Salle. While, therefore, the Hennepin Canal has not been a commercial success, it is remarkable as an example of skillful and original engineering. Begun in the early nineties before the art of concrete construction had become well known among engineers, all of its masonry is concrete. This courageous departure from the then existing practice was due entirely to General Marshall's sound judgment and bold initiative, and he then developed the details of methods which were subsequently adopted by the entire engineering profession and have continued in force practically unchanged to the present day. For this service to society, productive as it has been of great saving of time and money, the highest commendation and gratitude are due him.

The Hennepin Canal affords instances of practically every type of structure used by the canal engineer. It has more than 30 locks, there are 7 or 8 aqueducts, numerous bridges, a number of emergency gates or weirs and several dams, at one of which water power is developed. All of these structures are admirable examples of the art of engineering and remain to this day models of what should be done under similar circumstances. Some of them were patented by him —notably, an automatic lock gate and an automatic emergency weir, and these are ingenious, simple and dependable. All of his patents were freely placed at the disposal of the United States.

During his stay at Chicago, General Marshall acted also as Consulting Engineer for the Lincoln Park Board, and while in this service developed and patented a type of lake-shore revetment that is still in highly successful use and will probably continue to be used as long as the need for this kind of structure exists.

He was relieved from Chicago in 1899 and sent to New York, where he engaged in the local work of river and harbor improvement and, in addition, was assigned to the construction of fortifications in and near New York Harbor. Here, too, his bold and original genius found scope and expression. The Ambrose Channel, a most successful piece of work, was completed under him; his fortification work became the standard in details and methods for other similar work throughout the United States, and he planned and completed the enlargement of Governors Island. In 1908 he was promoted to be Chief of Engineers, and in 1910 by operation of law he retired from active service as an officer of the Army, after an honorable and distinguished career of 40 years.

He was a man of strong and decided views but of simple, unaffected manner, and the soul of good nature and geniality. Generous, sturdy and upright in all his relations, he was incapable of anything small or petty, and unwilling to suspect impropriety in others. So fine was his character as to attract the affection, confidence and admiration of all with whom he came in contact, in high places as well as in low.

Thus it was that on his retirement as Chief of Engineers, General Marshall was signally honored by President Taft, who, unwilling to permit the services of so brilliant an engineer and so splendid a man to be lost to the government, created for him the position of Consulting Engineer to the Secretary of the Interior. In this capacity General Marshall continued to serve until his lamented illness and death.

In him his country, his family, his friends and his profession have suffered the loss of a most upright, brilliant and accomplished and lovable personality.

"He was a man, take him for all in all
I shall not look upon his like again."

* See frontispiece. Memoir by Col. Chas. Keller, Corps of Engineers.

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Death of General Gorgas

WILLIAM CRAWFORD GORGAS, the noted sanitarian, the implacable foe of "Yellow Jack" and of all other diseases that afflict humanity, was not an engineer by profession; but his life work was so closely allied with engineering achievement, and in so large measure responsible for one of its noblest monuments, the Panama Canal, that in his death the engineering profession experiences a sense of personal loss.

General Gorgas died at London on July 4, 1920, following a stroke of apoplexy, He was born in Mobile, Alabama, October 3, 1854, the son of Gen. Josiah Gorgas, a graduate of West Point, and an officer of the Confederate Army. William C. Gorgas entered the U. S. Army in 1880 and rose to the rank of Major General and Surgeon General of the Army, which position he occupied during the World War.

His life history is a record of continuous achievement, which was recognized by every worth-while honor that might be conferred upon a scientist and a benefactor of his race.

His greatest service, which entitles him to foremost rank amongst the truly great saviors of mankind, was his long and successful fight against yellow fever. His methods of combating the dread disease were based on the epoch-making discovery of Major Walter Reed, U. S. A., that the mosquito is the means of transmission. Following the Spanish-American War General Gorgas rid the city of Havana of yellow fever, and subsequently he rendered possible the construction of the Panama Canal by holding "Yellow Jack" in check on the Isthmus.



Portrait by Harris & Ewing

But Gorgas was not satisfied with the defeat of this enemy of mankind. He knew that its total destruction was possible, by localizing and successively eradicating it from every center of infection. To this noble work he had pledged his life, and had he been spared for a few years he would have seen its consummation.

Under the direction of the Rockefeller Foundation the humanitarian work will be carried on by others, to whom the example of General Gorgas' unswerving devotion to a dangerous duty will ever serve as a guide and an inspiration—a pillar of cloud in the day of success and prosperity, and a pillar of fire in the night of trial and adversity.

Death came to this noted American at the pinnacle of his fame. His victory over disease was won, acknowledged and honored throughout the civilized world during his own life time—a happy and fitting tribute to a great man whose gentleness of heart and modesty of character formed so striking and pleasing a contrast to the wonder of his achievements. And he died, as he had lived, "in harness" in the service of mankind—en route to South Africa to ameliorate sanitary conditions there.

Christie Mount for 155-millimeter Gun.—The Christie self-propelled mount for the 155-millimeter gun, Model 1918 (Filloux), was designed for the Ordnance Department by Walter Christie, of the Front Drive Motor Co., Hoboken, N. J. The design embodies new features in this class of artillery, the principal one being that the vehicle is designed to travel on rubber-tired wheels on good roads and is convertible into a track-laying vehicle when desired. When traveling on wheels, the caterpillar track is carried on the vehicle, and is so arranged as to be easily dismounted from the shelves and wrapped on the same rubber-tired wheels, when it becomes a caterpillar vehicle. There are eight rubber-tired wheels, the two at the breech end of the mount arranged to steer the vehicle, and the two at the rear end geared to the transmission, so that they are the drivers under both conditions, while the four intermediate wheels are spring mounted in such a manner as to carry weight or not, as desired. The whole unit weighs 44,000 pounds and is capable of traveling over 15 miles an hour on the rubber tires. It can travel practically as fast on the caterpillar tracks, except that the steering slows down the progress to a certain extent. It can be run in either direction with ease, but normally it travels breech first. Firing tests have proved that this mount will be a very satisfactory vehicle, and the Ordnance Department is ordering three more in order to submit them to a service test.

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Future Coast Defense Artillery

Digest of an article, by Lt. Col. Sanderford Jarman, Coast Artillery Corps, in the U. S. Artillery Journal
Discussion by Col. C. O. Sherrill, Engineers, and Col. E. P. King, Field Artillery

[*Note.* The Great War did not upset the "eternal principles" of the art, but it has brought about notable modifications of the methods of applying those principles. Radical changes have been and are still to be made as a result of our late experiences. Important amongst these are the changes in permanent land fortification, with which this country is less concerned than is Europe; and changes in the methods of sea-coast defense, which is a matter of much concern to us. Radical and revolutionary ideas are being advanced, and this is well, for only thus can we make the rapid progress necessary to keep pace with the march of events. But we must not go to extremes. We must avoid the mistakes of those who declared, after the deadlock had set in on the Western Front, that mobile warfare would never again be seen, and who subsequently, when the deadlock was broken, as confidently asserted that there was now an end to trench warfare. The golden mean is nature's solution of most questions, and somewhere between the views of the ultra-radical and those of the ultra-conservative, the true answer is usually found. The following somewhat divergent views of exceptionally well informed officers of all the arms concerned with artillery defenses, both fixed and mobile, will be of special interest to all our readers as throwing light on the vital, fundamental problems of our coast defense.—*Ed.*]

COLONEL JARMAN classifies artillery materiel in accordance with its mission, as fixed or harbor, heavy tractor or self-propelled, pre-major caliber railway, and major caliber railway. All types of the fixed or harbor artillery now in existence are given a sub-classification, as follows:

Secondary Armament:
Minor caliber 3-inch
Intermediate caliber 6-inch
Primary Armament:
12, 14 and 16-inch guns and 12-inch mortars.

Considering the target against which harbor defense guns will be used, only two general divisions are made, which are armored and unarmored ships. The probable forms of attack are: in force to capture a port, long range bombardment, long range attack to cover a run-by.

Secondary armament.

As the 3-inch gun, primarily intended for attack on unarmored ships, is outranged by similar armament now carried by the latter, there is no place for this type, except for anti-aircraft defense and for augmenting the secondary armament.

The 6-inch gun mounted on a barbette type of mount is limited in range due to type of mount to combat unarmored warcraft. The development of this weapon should secure greater range. This country is well supplied with excellent 155 millimeter G. P. F.* mobile guns adequate for secondary armament in coast defenses.

Major caliber fixed armament.

While this armament now consists of 8, 10, 12, 14 and 16-inch guns and 12-inch mortars, a considerable number of the 8, 10 and 12 inch guns and 12-inch mortars were withdrawn to supply the demand of the American Expeditionary Forces for high-powered long-range artillery. All of this armament is the outcome of studies and designs laid down prior to the Spanish-American War.

The radical changes and development of naval construction caused attempts to bring the fixed armament up to date to meet such naval developments, but a point has been reached where further modifications and alterations are impossible, its main deficiency being its fixed position and inability to meet attacks from the rear or the flanks. The 12-inch mortar is limited to a range of less than 16,000 yards. The 12-inch guns in some instances have recently been mounted on a new type of barbette mount permitting an elevation of 35 degrees and consequent increase of range. But as modern ships are constantly adding more armor, they make a most unfavorable target for the long range guns. The attempt to combat with a 12-inch gun an enemy ship armed with 14, 15 or 16-inch guns and possibly 18-inch guns is believed unwarranted.

The short 14-inch and 16-inch guns now emplaced with low muzzle velocity and short range are inferior to modern naval guns. The development of naval guns to obtain an elevation of 40 degrees leads to the conclusion that it will be practicable to mount them to fire at any angle, which, together with aerial observation, will materially aid the accuracy of fire from ships. The mission of this general class of coast defense armament as it now exists is *only to prevent an enemy from using the port as a base of operations.*

The War Department, in view of these defects, in 1916 adopted the 16-inch rifle and 16-inch mortar as the new types of major caliber armament, in addition to which the 12-inch guns are now being remounted to permit a range of 27,000 yards and 360° traverse. This barbette type of mount permits the laying of the piece for range at maximum elevation in nine seconds.

The 16-inch 25-caliber howitzer and 16-inch 50-caliber gun are to be mounted "En barbette" giving firing positions from 0 to 65 degrees, with ranges of 22,000 and 40,000 yards, respectively.

Judging by past developments the trend of future developments will be toward longer range, higher powered weapons. Rumors even now mention recent installation of an 18-inch gun in a foreign navy.

The range of guns during the Nelsonian era was limited, gradually increasing to a decisive range of 17,000 yards in the battle of Jutland. The 16-inch gun is expected to obtain its maximum range at 53 degrees which will give it preponderance over foreign naval guns which do not permit an elevation of over 40 degrees. The general tendency analogous with the policies of the navies of the world is for the seacoast defenses to reduce the number of types to a minimum.

The proper mission of the major caliber armament is to protect our large seaboard centers of population, naval bases and public utilities. The 16-inch howitzer is outranged by guns of foreign navies and an immeasurably greater gain in power at long ranges would be had by retaining only the 16-inch gun, as the gun can perform the functions of the howitzer but also may be used as a direct fire gun within the range of the howitzer. Since the future calls for a cannon of 18-inch caliber, it is safe to say that the 16-inch howitzer is obsolescent.

*G. P. F.—*Grande Puissance Filloux*, the high-powered 155 millimeter gun designed by Filloux.

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Heavy tractor or self-propelled artillery.

There are now in existence several high powered tractor drawn guns. This class of armament is capable of attacking unarmored vessels and due to its mobility is superior to fixed secondary harbor defense. Its use would be to cover fields of fire in place of the armament recently declared obsolete or removed for use in the A. E. F.; to cover fields of fire where additional secondary armament is deemed necessary; and to support troops defending landing places.

The 240 millimeter howitzer will serve as reinforcing gun for troops defending landing places, holding transports too far out to debark troops. It will also serve as local protection for attacks from the landside.

The two types now under development, the 155 mm. G. P. F. gun and the 240 mm. howitzer, will fulfill all of the above requirements. This was made possible by the great development of gas engines and caterpillars. As an auxiliary, the 4.7-inch anti-aircraft gun with its ability to fire at 0 degrees and with an arc of 360 degrees will serve most efficiently.

Pre-major caliber railway artillery.

This covers certain cannon removed from harbor defenses and mounted on railway mounts for use in the A. E. F. The limit of range of these weapons is 22,000 yards for the 8-inch gun and 16,000 yards for the 12-inch mortar, effectively covering and making ineffective the secondary armament of a fleet at a range of 16,000 yards.

The projected development of this class is as follows:

8-inch 50 caliber gun, 240 pound projectile, 35,000 yard range.

12-inch 20 caliber howitzer, 700 pound projectile, 25,000 yard range, both with a traverse of 360 degrees.

They should be held in strategic location and used for unprotected landing places only.

Major caliber railway artillery.

There are a number of types of 10, 12 and 14-inch railway guns and a 16-inch howitzer now in the hands of the Army. Of these, only two are effective for seacoast defense, viz., the 14-inch gun and 16-inch howitzer, Type E, of which only one each has been made.

The Westervelt Board recommended the following two types:

14-inch 50 caliber gun, range 40,000 yards, 1,400 lb. projectile. 16-inch 25 caliber howitzer, range 30,000 yards, 1,600 lb. projectile, both with a 360 degree arc of fire.

This recommendation no doubt was based on the understanding that these two were the largest types possible to be mounted on barbette railway mounts, and also probably considered economic reasons.

The final type of mount should be a unit type with the gun on its mount at all times, incorporating all refinements found possible on fixed barbette mounts, giving it the advantages of rate of fire and accuracy of the latter in addition to mobility.

A full review must be made of seacoast defenses before considering the ideal weapon. The doctrine of all navies of the world is that shore guns cannot be effectively attacked by naval vessels and there is not going to be any attack unless it is felt there is a fair chance of success. Our major caliber railway mount will give an additional weapon producing doubt as to strength of the coast defense. Concrete to protect guns from ships' fire will not keep the enemy away but gun fire will perform this mission.

While it is hardly conceivable that we will be attacked on the Atlantic and the Pacific Coast at the same time, if the major caliber armament has mobility it can be moved from coast to coast. The proper use of this type will be as the primary armament in the protection of ports, naval bases, and public works from attack by armored ships.

There seem to be no insurmountable difficulties in placing a 16-inch 50-caliber gun on a railway mount even if of necessity transported in two units and assembled with the aid of a crane. This will permit its being used and supplant the present fixed armament of like caliber.

The present policy of coast defense makes the Department Commander responsible for his department except when an independent commander has been assigned. The Coast Guard Commander is independent of the Coast Defense Commander but must co-operate with him. There are also commanders of division and field armies holding strategic centers. There is lacking a complete and outlined plan of organization, dependence being placed on the expectation that there would be time for organizing an adequate defense. The development of railway, heavy tractor and self-propelled artillery will cause a revamping of the policy governing the defense of the seacoast.

The following seems a feasible system of defense. Considering the seaboard of the United States, the Canadian and Mexican Border as defense line divided into three army sectors, the first army should cover from North Dakota, exclusive, to Chespeake Bay, inclusive; second army from Chesapeake Bay to Pacific Ocean; third army from lower California to North Dakota, inclusive, each army to include a proper proportion of inland states. Each army sector is to be divided into Corps areas. The Corps staff should be charged with the duties of coast defense plans, which would primarily be based on the great mobility of railway artillery of today and the future.

With a plan based on concentration of responsibility for the defense of any sector in the Corps, there is no violation of the fundamental precept of the present policy of actually meeting the invaders at the water's edge; but it makes the principle more workable by concentrating all agencies under one control, and due to the extreme mobility and ranges possible with the tractor and pre-major caliber railway artillery, the total number of field army troops can be materially reduced.

Discussion

C. O. Sherrill
Colonel, Engineers

Colonel Jarman has presented a number of important conclusions as to the present status of seacoast defense and its desirable development, and states that a logical system of defense of the frontiers of the United States should consider the problem as a whole, placing upon territorial commanders under the War Department full responsibility for all defensive measures within their sectors. This principle has the official sanction of the War Department and is thoroughly sound. It cannot be gainsaid that the present defensive system, which contemplates entirely independent commanders for each of the separate agencies used in the defense, is entirely wrong.

As Col. Jarman well says, the adoption of this policy has been influenced undoubtedly by the fact that from a practical standpoint all means actually in existence for carrying out the defense of our seacoast consisted of fixed harbor defenses, but he is incorrect in assuming that the continuation of fixed harbor defenses necessarily prevents a logical

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assembling of the various elements necessary for an effective defense of the entire coast line; for, it is believed that the fixed armament should be considered as part of the general line of defense, exactly as redoubts are in mobile warfare, and that all artillery, both seacoast and mobile, should be under the territorial army commander.

With the conclusions arrived at in the paper under discussion, the undersigned is in general accord, but must take exception to certain views, especially with reference to railway artillery.

The principle which requires 360 degree traverse for all guns is generally sound, but each particular case should be decided on its own merits, as there are many locations where it is not only useless and needlessly expensive to provide fire over certain sectors, but positively dangerous in that an enemy having captured the gun could turn it on the city or other area defended by it.

It has not by any means been as yet demonstrated that mobile guns of any type are as effective against rapidly moving targets, even for direct fire at short ranges, as the highly accurate seacoast guns on fixed and carefully adjusted bases. This, however, is a question that can easily be determined, and if field guns prove able to do the work effectively, they should by all means replace fixed guns.

The following pages are devoted to a discussion of the entire subject of railway guns in seacoast defense and mobile warfare. These remarks are not made with the idea of condemning railway guns, if they can be shown to be a useful means of defense, but simply to point out the fact that up to the present time this utility has been assumed rather than demonstrated, and to suggest a line of action which will allow a correct conclusion to be arrived at on this subject, so important to the entire army. In the past, correct tactics of coast defense have been subordinated to fixed guns, and there appears to be danger that in the future the desire to use railway guns will be the controlling feature of coast defense plans.

As a result of the experience gained by the operation of railway guns in France, Coast Artillery officers are now generally beginning to feel that much simpler installations and improvised auxiliaries are sufficient unto results. If results can be thus secured against naval targets with railway guns, the same principle can be advantageously applied in the construction of fixed emplacements, for the installation of the gun itself on a fixed mount is an extremely small item as compared with the provision of bomb-proofed utilities and elaborate fire control installations heretofore required. The Chief of Engineer's office is now investigating this question of a simplified type of installation based upon the principles of dispersion and concealment.

As yet, but little consideration has been given to the powers and limitations of railway artillery in seacoast defense and mobile warfare. In arriving at conclusions as to the general applicability of this type of armament to both seacoast and mobile warfare, this important matter should be given full and careful consideration before opinion in the army becomes crystallized and an extensive and expensive program of construction of railway artillery carriages and the organization of railway artillery troops is undertaken.

As visualized by the paper under discussion, railway artillery is to form the important connecting link between the highly mobile artillery of minor calibers accompanying a field army and guns of the heaviest type on fixed emplacements installed for service against naval targets and as a protection to our more important harbors and naval stations.

Railway artillery, therefore, is assumed to fill two distinct roles:

(1) Defense against the rapidly moving targets presented by naval vessels in coast defense.

(2) Long range fire against fixed targets as an adjunct to the field army.

The value of railway artillery for these two uses should of course determine the extent to which it is to be used in our army.

Railway artillery in seacoast Defense

Relative merits of fixed and railway mounts.

Guns in fixed emplacements have the great advantage of being located just where they are needed, after careful study and investigation, and have a soothing psychological effect upon the local inhabitants, by the very fact of their presence alone. For each important harbor and naval base which, according to our theories of defense, requires complete protection from hostile navies, there is a certain minimum armament which must be permanently maintained and always available for its defense. For this minimum armament, therefore, only the most economical and effective type should be employed. If guns on railway mounts fulfill this condition, this type should be used.

For reinforcing armament which may be necessary in addition to the above mentioned minimum, railroad guns should be used if, after thorough study, they are found to be more desirable than guns on fixed emplacements.

Guns on railway mounts, it is claimed, have the advantage that they can be moved from place to place as needed, and they can likewise, theoretically at least, be temporarily withdrawn if the enemy's fire becomes too heavy, and can later be put back in position. Whatever type the portable mount takes, it can never be made mobile as the guns on an enemy's ship. Consequently, if an enemy makes a feint in strength at one place, say on the New England coast, and presses this feint with such vigor as to cause shipment to the New England coast of the available portable guns, he can suddenly shift his attack to the mouth of the Chesapeake with such rapidity that the portable guns can not be withdrawn from position and moved by land from the New England coast to the new region in time to meet the new attack. Therefore, if our sole, or even our main reliance, be placed upon portable guns, the number to be provided would probably have to be nearly or quite as great as the guns otherwise required to be mounted in fixed emplacements.

At the present time, the railroad mounts for heavy guns are of two classes, one of which fires from the car itself, the other from a prepared site. It is generally agreed at this time that only the latter is worthy of consideration for the major calibers in seacoast defense. With this type of mount, the cars are moved to a site prepared in advance, the mount is removed from its tracks and lowered upon a base prepared in advance. When once the gun has thus been placed in firing position, it has many of the disadvantages of a fixed mount and few of its advantages. Moreover, the process of placing it on its tracks and moving it away is necessarily too slow to prevent its being destroyed by a concentrated hostile fire once it is "spotted."

Fixed emplacements have the great advantage of providing solid horizontal immovable platforms, carefully adjusted and levelled so that the gun can easily and accurately be aimed both in azimuth and elevation. Where the gun is removed from its tracks and placed upon a base, such bases must either be prepared in advance of concrete and steel, at considerable cost, or else there will be more or less

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settling of the foundations during the process of firing, with resulting errors in level and consequently in the accuracy of fire.

As at present designed, fixed emplacements have the additional advantage of providing protected magazines fitted with carefully designed appliances for ammunition service, permitting the maximum rate of fire of the gun. To such an extent has this ammunition service been perfected that 12-inch guns have been fired at 19 second intervals. The recent 14-inch and 16-inch emplacements have been designed to permit a possible rate of fire of only 25 to 30 seconds between rounds and a rate of fire in action of one shot every 40 seconds, making it impossible to maneuver the ship out of the danger area of the next shot. As compared to this high rate of fire of fixed mounts, the results of the only tests yet held of the 14-inch railway mount rifle, viz., those at Fort Story, are cited, in which the average rate of fire was one shot every 3 minutes, the best record yet made by these guns. The speed of a modern battleship is at last 2,000 yards for the 3-minute interval between these shots. It can be readily seen that in this period it would be quite feasible to change the direction of the ship by zigzags so as to render spotting useless for determining the next position of the vessel.



7-inch siege howitzer on railway mount

This is a true railway mount. No special track or special installation of any kind required, other than the jacks shown. Can be fired from any locality (except a bridge). All-round traverse.

This deliberate rate of fire is sufficient in firing against a fixed land target, but where the target is moving at a rate of from 20 to 35 miles per hour, the question of rapidity of fire is of the greatest importance; consequently a gun on a fixed emplacement which can fire from 3 to 6 times as rapidly as a gun on a railway mount is for the time being at the very least more than 3 to 6 times as effective.

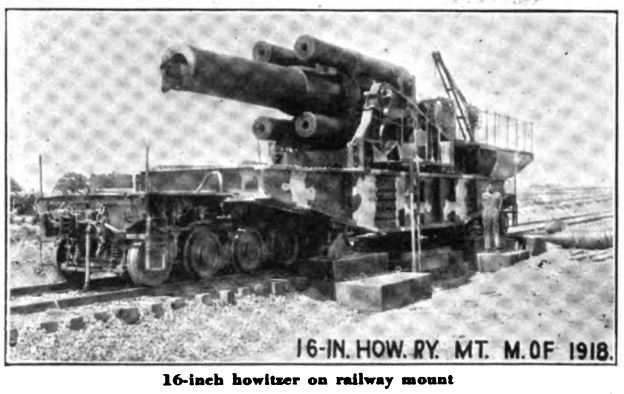
Relative Costs

Fixed emplacements, as now designed, have the disadvantage of costing more per gun than portable carriages on railways, moreover, the present type of fixed installations have extensive auxiliaries for increasing accuracy, rate of fire and protection to material and personnel. These cost several times more than the mere mounting of the gun. But it should be noted that, in addition to the railway cars carrying the guns, there must be supplied other cars of special design carrying ammunition and special appliances for handling the ammunition between the cars and the gun. The cost for the various bases prepared in advance must also be charged against the railway mounts as well as the cost of the necessary modifications of track, grades and alignment and extensions of track, firing spurs, sidings for auxiliary cars, etc. Also it is to be remarked that it is possible to simplify the designs and reduce the costs of our fixed emplacements without greatly reducing their efficiency. Cheaper emplacements and less elaborate provisions for range finding and other accessories are possible.

The railways along the seacoast are not suitably located for the effective use of railway guns except in a limited number of places, and even in these few places they are often of a light type not adapted to carrying the major caliber railway mounts. All of these light tracks would require strengthening to carry railway guns and the construction of extensions to provide adequate firing positions before they could be used. The methods proposed for handling these railways guns involve improvised facilities for ammunition service, fire control, command, and fire direction. It therefore would be highly instructive to compare the results under these conditions with those obtainable with the very efficient auxiliaries provided by fixed emplacements; also to make a comparison of cost and efficiency between the railway guns with improvised auxiliaries and fixed guns with similarly improvised auxiliaries.

Intermediate armament

For those localities where railways exist in proper position for effective use of railway guns against naval targets, many of the disadvantages of the major caliber railway guns do not apply to intermediate calibers which can be fired directly from the track; but, intermediate armament on wheel and tractor mounts are at least as effective as those on railway mounts in coast defense, so it would appear to to be inadvisable to consider railway guns for such use, as even the smaller caliber guns on such mounts will cost more and be of less general adaptability than those on wheel and fire; the other is that they must be placed in positions from which they can reach the classes of naval vessels against which their fire is efficacious. The armament considered



16-inch howitzer on railway mount

A semi-permanent installation. Requires a specially prepared track. The blocking shown is carried on railway cars and placed by a portable crane. It can be moved to another locality in a few hours. Limited traverse.

tractor mounts for both coast line defense and land warfare purposes.

For the provision of intermediate armament for the coast defenses, consideration should be given to the large number of 6, 8 and 10-inch guns on fixed mounts recently declared obsolete, and obsolete naval guns, for installation on gun blocks at vital locations, rather than the withdrawal of efficient mobile guns from the mobile army or the construction of additional intermediate caliber guns.

16-inch vs. 14-inch guns against battleships.

Two fundamental considerations must be satisfied by armament to be successfully used in seacoast defense. One is that the weapons must be capable of accurate and rapid necessary by all authorities for use in seacoast defense is

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divided into primary (major caliber) and secondary (intermediate and minor). The primary armament should consist of weapons capable of penetrating the most modern type of battleship, either through its deck or through its side. This can be accomplished effectively by the 16-inch guns and 16-inch howitzers now approved as the standard for major caliber fixed emplacements. The largest gun contemplated at the present time on railway mounts is the 14-inch with a penetrating power sufficient up to 7.5 miles, to pierce the 15-inch side armor of the latest designed type of battleship, and from 16.9 miles to 22.8 miles, capable of piercing the deck of this battleship. As compared with the 16-inch gun on fixed emplacement, this is relatively inefficient, inasmuch as the latter will pierce the side or deck armor effectively at all ranges up to 45,000 yards; the side armor as far as 12.8 miles and the deck from 6.2 miles to 25.5 miles range. It will be noted that the 14-inch gun leaves a zone 9.4 miles wide within which neither deck nor side armor can be penetrated, where the enemy could lie in



Foundation for 12-inch rifle on railway mount

This foundation can be installed at any locality after some preparation. The material is transported on railway carriages, and requires about 6 hours to put in place. The traverse is limited, hence the direction of the track must be such as to permit the gun to cover its assigned field of fire. This may require that spur tracks or turnouts be built, and in fact this would usually be necessary that traffic on the main line, including ammunition supply, be not interrupted.

relative safety and bring his concentrated fire on the coast defenses.

It is known that the latest types of battleship are being armed with 15-inch guns and at least one late British vessel with 18-inch guns is understood to be under design. In view of this high powered armament, the expenditure of large sums of money in providing railway mounts for the relatively more or less obsolescent 12 and 14-inch rifles in lieu of 16-inch guns seems of doubtful advisability.

Assuming, however, for the sake of argument, that the 14-inch guns are sufficiently powerful to justify their extensive use in seacoast defense it will be necessary to determine their hitting efficiency on railway mounts before accepting them for future construction. Up to the present time, so far as known, only 13 record shots have been fired by this type of armament against moving targets in the test firings at Fort Story in the fall of 1919. This limited number of shots appears to be insufficient to furnish the basis of sound deductions as to the accuracy of railway artillery. The efficiency of the following armament against rapidly moving naval targets has apparently been assumed by the author of the paper under discussion to have been demonstrated:

12-inch mortars, 14-inch rifles, 8-inch rifles.

With the present information available, the undersigned cannot subscribe to this view, and he is of the opinion that exhaustive tests should be made before such a conclusion is accepted.

Scope of investigations necessary

Assuming that tests will demonstrate the ability of railway guns to hit naval targets, there are many other questions to be determined before adopting them in place of fixed emplacements. Some of the subjects to be considered are the rate of fire and the possibility of predicting successive changes of position of the target with sufficient accuracy between shots to allow hits to be made; the efficiency of the improvised ammunition service used with these guns; the effectiveness of improvised range finding systems; the relative costs of coast defense by use of railway mounts as compared with fixed guns; the determination of the localities at which railways are available from which railway guns can bring effective fire upon dangerous naval targets; the relative merits of intermediate armament on wheel and tractor mount as compared with railway mount; the value of railway artillery with the mobile army, etc.

System of coast defense involving only a permanent nucleus of personnel.

The operation of railway guns requires a trained gun crew, able to function at various localities with which the members of the crew are more or less unfamiliar, using improvised auxiliaries for ammunition service, range finding and command. This operation is virtually equivalent to having guns of calibers suited to probable targets installed on simple gun blocks at salient points for the protection of our harbors with no permanent auxiliaries whatever, so that, from time to time, for drill, and in case of emergency, gun crews could be moved up to operate these guns. This presents the thought that the cheapest and most effective harbor defense may be secured *by installing guns on fixed blocks, but instead of permanently maintaining gun crews in the vicinity of each gun, as has been the custom in the past, to keep necessary gun crews mobilized at central points for use at positions threatened by an enemy.*

This might advantageously be carried a step further by maintaining only a nucleus of permanent personnel at these central stations, sufficient to train local reserves or militia living near the gun positions in the proper handling of the armament in their localities. In view of the fact that these guns are fixed in position and the militia gun crews would not be subject to withdrawal to remote and foreign fields of operation, there is no part of the system of national defense that can be so well handled entirely by local militia or reserves as the operation of our seacoast guns.

The principal item of expense incurred heretofore in connection with seacoast defense has been the maintenance of personnel to man the guns and auxiliaries; the cost of the gun itself and its emplacement is trifling in comparison with the continuing cost of the upkeep of the personnel for its operation. In fact, as elaborate as the fixed emplacements have heretofore been, *their cost is only about one-sixth of the cost of maintaining the battery personnel.* In the period since the World War, there has developed a decided change of view on the part of the Coast Artillery as to the necessity of elaborate emplacements provided with every facility for protection, convenience and comfort of personnel, and for rapidity and accuracy of fire. It was formerly considered essential to have full bombproof protection for all utilities, but now the tendency is toward the elimination of all protection, and reliance upon dispersion, concealment, and duplication of vital elements to insure

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that the armament will work under all reasonably probable conditions of engagement. If a system of defense could be evolved with only guns on gun blocks, without the expensive auxiliaries heretofore provided, and without permanent maintenance of full personnel at each gun, its cost would undoubtedly be found to be far less than an equally effective defense by the present system or railway artillery.

Railway guns in mobile warfare.

The next subject for consideration is the utility of railway artillery in mobile warefare. This use has many ardent advocates in the Coast Artillery, but, among those best qualified to speak on the use of railway guns, none is perhaps better equipped than Brigadier General Johnson Hagood, who, under date of January 27, 1920, in a report to The Adjutant General of the Army, makes the statement:

"For the benefit of those who do not care to be burdened with the details, I will state my conclusions first. They are as follows:

"Ninety-nine per cent of the value of railway artillery in the United States is in its use against water targets. * * *

"Stabilized warfare: The stablized character of warfare on the Western Front in Europe lent itself peculiarly to the use of railway artillery. These big guns, located from 5 to 10 miles back of the lines, were used with powerful effect to bombard cities, to destroy railway terminals, depots of supply, railway bridges and concrete fortifications of the enemy. The maximum range obtained by the Allies was less than 30 miles; but the Germans obtained a range of almost 70 miles.

"Practically all of the firing of the railway artillery was done by map. The penetration into enemy lines was so deep that it was always impossible to get terrestrial observation and generally impossible to get aerial observation. A similar use of railway artillery against land targets in a war in the United States *would require maps of the whole country very much more accurate than any now in existence, and a stabilized condition of warfare which it is impossible for any of us to imagine. Moreover, it would require that we should take as our targets our own cities, railway terminals, depots of supply, railway bridges and other public works.*

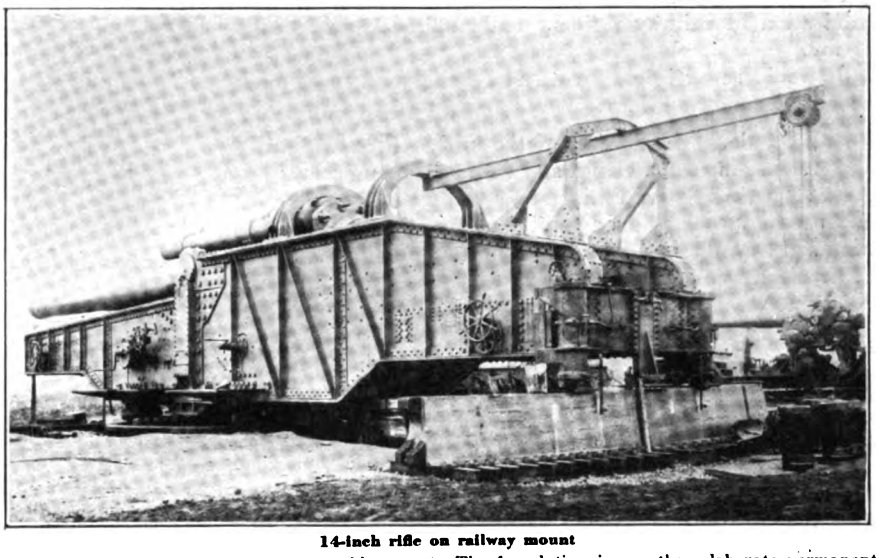
"It is hardly consistent with the principles of American military policy or the genius of the American people that we should plan war on any such basis."

It will be noted from these quotations that General Hagood asserts that 99 per cent of the value of railway artillery will be against water targets. This is equivalent to stating that unless railway artillery can be justified by its utility in coast defense against naval targets, it will be inadvisable to consider its use with the mobile army under the conditions existing in our country.

It is a principle of mobile warfare that the smallest caliber gun that will accomplish a certain result is the one that should be used for the purpose. This principle is so fundamental that it is believed unnecessary to do more than to call attention to a few principal reasons, such as, the greater rapidity of fire, greater mobility, greater rapidity of going into and out of action and in changing position, decrease of the transportation required to supply ammunition and the lower cost of construction and operation of the smaller guns. If this principle be accepted, then it follows that with a mobile army no guns should be furnished larger than essential for its purposes. On this subject, the Board of Artillery officers, appointed by Special Orders 289, War Department, 1918, recommended as follows:

It will be seen that the normal artillery missions of a field army can be accomplished by the assignment of six calibers, *i. e.*, two light weapons, two medium weapons, and two heavy weapons, a gun and a howitzer in each class, and a satisfactory anti-aircraft gun.

In accordance with the principle enunciated by the Artillery Board, these weapons would, therefore, be approximately 3-inch guns, 4-inch howitzers; 4.7-inch guns, 6-inch howitzers; 6-inch guns, 9.5-inch howitzers; all on wheel or tractor mounts. The ranges effectively and sufficiently covered by these weapons would include all those up to 25,000 yards. The railway guns with the mobile army of calibers larger than the 6-inch rifle and 9.5-inch howitzer would be unnecessary except for firing at ranges in excess of 25,000 yards. For the reasons enunciated by General Hagood it will be apparent that there is no probable use to be made of our field armies which would justify the construction of railway guns for use only at ranges greater than 25,000 yards. Fire of railway guns, as General Hagood says, must be almost entirely by map and must be directed at targets of such extent and nature as one not likely to be met in our operations. The attack of targets far in the rear of the lines should be bombing planes rather than by super-caliber railway guns.



14-inch rifle on railway mount

This is a movable rather than a portable mount. The foundation is a rather elaborate permanent installation involving the use of concrete. The gun carriage can be moved from one such foundation to another in a short time. The installation as here shown allows only limited traverse, but this may be increased to any desired amount by extending the foundation. Note chain block and trolley for handling shells. This is the highest development to date of railway artillery.

Camouflage

General Hagood states that big guns in the open, properly camouflaged, cannot readily be discovered, nor are such targets liable to serious damage by naval fire. This has been fully demonstrated by the results of naval bombardment of the defenses on the coast of Belgium and at the Dardanelles. Although the emplacements on the Belgian coast were only slightly camouflaged, they were located in

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the rear of the line of small sand dues and there were very few hits recorded out of a great number of shots fired, and of these few, only in isolated cases was any serious damage done to the guns or emplacements. Similar results were noted at the Dardanelles. My conclusion from a consideration of the experiences of the World War agrees with the view of General Hagood as to ease of camouflage. Moreover, it has been found that big guns unconnected by railway tracks are far more readily camouflaged than those located on railroads, which advertise the presence of the guns, with the cars, engines, and other adjuncts necessary for their operation. In other words, a major caliber gun, emplaced on a simple concrete gun block a few hundred yards from the shore, without bombproof magazines, and with ammunition and other auxiliaries distributed in small units, all suitably camouflaged, could be concealed, so as to be an almost impossible target for a hostile navy, more easily than railway mounts with their tell-tale tracks.

Conclusion

In view of all the considerations it is believed that the general utility of railway guns in seacoast defense and with the mobile army has not yet been sufficiently established to justify extensive construction of this armament or the organization of railway artillery units in the United States Army.

It would be advisable for a full investigation to be made along the following lines:

(*a*) On the entire subject of the utility of railway artillery for use in coast defense and with the mobile army;

(*b*) On the relative utility and cost of a system of coast defense by means of fixed emplacements alone and by railway artillery alone;

(*c*) By fixed emplacements supplemented by railway and other mobile artillery, taking into consideration the present elaborate types of emplacements and auxiliaries; also on the basis of a simplified type of emplacement with improvised auxiliaries;

(*d*) On the relative utility of the present system of permanently maintaining full personnel for all coast defense armament as compared with one involving the maintenance in peace of a nucleus to care for the armament and for training militia and reserves in the operation of the coast defenses in their locality.

E. P. King, Jr.
Colonel, Field Artillery

The first thought that occurs to the Field Artilleryman on reading Colonel Jarman's article is that he has not properly differentiated between the duties of the mobile army and those of the Coast Artillery, or rather, that he appears to have given the Coast Artillery two inconsistent missions to perform: The first, the protection of especially selected strong points and the second, co-operation with the mobile army at other threatened points along the coast. Doubtless Colonel Jarman's own ideas on this subject are clear and well defined, but the term "Coast Defense" has been so long applied to the defense of particular points of our coast line that most readers assign this meaning to that term and do not consider it as applying to the defense of the coast line as a whole. It would, perhaps, be well then to examine into the missions of the various parts of our military forces in defending the seacoast.

From the standpoint of defense, the coast line may be considered as being divided into two parts; first, certain strong points whose strategical and economical value require that they be held at all hazards, and second, other points which embrace all the coast line between the strong points and which are to be defended only in case an enemy attempts to make a landing. Ordinarily the points selected as strong points have been the seacoast cities and the harbors. These have been fortified and garrisoned by Coast Artillery troops. As long as these strong points are heavily fortified, armed and actively guarded by appropriate garrisons, it is highly improbable that an enemy will attack them. This is the intention in so fortifying, arming and guarding them. It must be realized, however, that if for any reason, such as to reinforce the mobile army, the troops charged with the duty of guarding the strong points are to any great extent withdrawn therefrom, these important places will be at the mercy of the enemy, and his attack, even though planned for elsewhere, will undoubtedly be diverted to these points which present every advantage for effecting a landing when not sufficiently guarded. It is not safe to assume that garrisons can be withdrawn from our strong points without the knowledge of the enemy, and consequently in case of a hostile effort against our coast line the garrisons of the strong points must necessarily be maintained at full strength.

The duty of protecting that part of the coast line which lies between the strong points inevitably falls upon the field army, and that organization alone should be charged with this duty. The field army for this purpose should be complete within itself so that it may function at maximum efficiency without requiring that the strong points of the coast line be left unguarded at the time of all times when they should be completely protected. An enemy in ships is more mobile than troops on shore, and his point of attack may be changed more quickly than the disposition of the defensive forces operating to prevent a landing.

According to all of our previous organization and ideas, the artillery which accompanies a field army is Field Artillery; that is to say, is a part of the Field Artillery arm of the service. The artillery which is charged with the defense of the strong points of the coast line is Coast Artillery. Hitherto, except in emergencies, the Coast Artillery has been charged with no other duty. The primary essential of Field Artillery is mobility; in other words, it must be able to accompany the army in the field. Apart from the field army, the Field Artillery has no function.

Colonel Jarman discusses at some length the use of mobile artillery materiel in the defense of the strong points of the coast line. It is not desired to attack such a use of mobile artillery materiel. It is immaterial whether the strong points are protected by guns on wheels or by guns on fixed mounts. The one essential is that the guns shall always be at the strong points so that the enemy may not take advantage of their absence and of the superior mobility of his ships in order to attack the strong points successfully. Whether the mobile artillery materiel fulfills the technical requirements of the defense of the strong points is a question for which there is no place in this discussion. The essential point is that if mobile artillery materiel is to be so employed, no advantage can safely be taken of its mobility until the situation has developed to such an extent that it has been definitely determined to be impossible for the enemy to attack the strong point. According to Colonel Jarman's statements, some of the mobile artillery materiel which he discusses is not suited to the defense of strong points, but nevertheless, he suggests its use by Coast Artillery in support of field army troops when repulsing landings.

The railway artillery which Colonel Jarman discusses at considerable length is subject to different considerations and rules from those affecting other classes of artillery. It is

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mobile only in a very limited sense of the word. It is movable rather than mobile. A position must be secured for it by the field army; railways must be built, or existing lines of railway strengthened or repaired and the necessary sidings and other auxiliaries provided before this artillery can be brought into position to support the field army. As the army moves and occupies new positions, these must be prepared for the railway artillery in the same manner. Really, the formalities are very great. Strictly speaking then, the railway artillery cannot accompany an army in the field but can only follow it under certain conditions. This means that the railway artillery is not true field artillery and would tend to confirm the statement by General Hagood that 99 per cent of the usefulness of railway artillery is in the coast defenses. The use of this class of artillery in the defenses of strong points is open to the objection previously mentioned in connection with the employment of mobile artillery; that is, it may be a satisfactory weapon in a strong point as long as no advantage is taken of its



Base ring of emplacement for 14-inch rifle

This is the base of the emplacement shown in the preceding illustration. It involves the use of concrete and hence requires a considerable time to install.

mobility, but as soon as it is moved out of its position, the strong point becomes relatively weak. If guns on fixed mounts are technically inferior to railway guns, then without question the latter are better adapted to the defense of strong points than are the former, but not otherwise.

It would seem then, that the field army should be as stated before, completely organized within itself, and provided with all needed artillery materiel and personnel organized into mobile units capable of rendering to other troops of the field army the support which they may properly expect from their artillery, without reinforcement from any forces outside of the field army. Or, to put it more briefly, all the artillery which accompanies the field army should be field artillery, organized, trained, employed, and commanded as such.

Emergencies have arisen in our past history in which garrisons for the strong points of our coast line were not required. Similar emergencies may arise in the future. If they do it would be criminal to leave the garrisons of our strong points unemployed when they were needed elsewhere, no matter in what capacity. No sane person can object to their reasonable employment elsewhere when they are not needed in the strong points of the coast line. But their employment elsewhere should be based upon absolute and definite knowledge that the strong points are secure against attack. If we assume the field army to be employed in preventing a landing upon our coast, we must necessarily also assume superior naval strength on the part of our enemy, in fact so superior, that he must have overcome our navy, else he could not attempt to effect a landing in any great force. Under these conditions it would certainly be impossible to withdraw from the strong points of the coast line the garrisons assigned to their defense, and if we have not supplied the field army with the necessary artillery, separate and distinct from the garrisons of the strong points, the field army will be needlessly weakened by this neglect. *The arms of the service should be organized in accordance with their normal missions.* The Coast Artillery should be organized to defend the points on the coast line selected and organized as strong points, and the Field Artillery should be organized to support the field army with all the artillery fire that it can properly demand or expect. This makes the distinction between these two arms a very plain and simple matter and strictly in accord with the definitions of Field Artillery and Coast Artillery enacted by Congress when these two arms of the service were established. Duties and tactical employment determine the arm, and not the materiel with which units are equipped.

Chemical Merger Expected.—Negotiations looking to the merger of several of the large by-product and chemical companies are said to be progressing satisfactorily. The plan involves the merger of the General Chemical Co., Barrett Co., Semet-Solvay Co. and National Aniline Co. It is possible that an announcement bearing upon the proposed merger may be made before the close of the month. Prices at which the shares of certain of the subsidiary companies will go into the merger have been agreed upon.

It is understood that the aggregate earnings of the companies to be embodied in the merger—Barrett, National Aniline, General Chemical and Semet-Solvay—are now runninge at rate of $30,000,000 annually of which National Aniline contributes about $12,000,000.

Range Tables for Machine Guns.—The Small Arms Ballistic Station was established at Miami, Fla., for the purpose of revision of range tables for the firing manuals was made as a result of these tests and of tests carried on in France. It was found that, for the Model 1906 ammunition, the data given in the handbooks was not reliable at the longer ranges, due principally to lack of adequate range facilities before the World War.

Muzzle-brake for Guns.—Tests were conducted at Government proving ground last fall of several types of muzzle-brakes or gas deflectors. These devices were in each case a series of discs or vanes of varying shapes attached to the muzzle of the gun. Against these vanes a portion of the powder gases impinged on leaving the muzzle, the effect of which was the reducing of both the length of recoil and the carriage stresses. These tests were made on the 2.95 and 3 inch guns. The greatest amount of energy of recoil absorbed by these brakes was obtained in the case of the 3-inch gun, which was about 80 per cent. The results of these tests on the whole are promising, and tests are being continued with muzzle brakes attached to guns of larger caliber.

Erosion of Machine-gun Barrels.—A great number of tests on erosion of machine-gun barrels have been made. Barrels of different kinds of steel and different types of riffling have been made and tested. In addition to this, a large number of routine tests have been conducted to determine the accuracy life of the standard machine-gun barrels with ammunition of different types. These tests are not yet completed.

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The Military Engineer

Dedicated to the National Defense

Lt. Col. P. S. Bond
Corps of Engineers: M. Am. Soc. C. E.
Managing Editor

Lt. Col. G. A. Youngberg
Corps of Engineers
Consulting Editor

VOL. XII SEPTEMBER-OCTOBER, 1920 No. 65

A Pilgrim's Progress

OUR predecessor and forebear, Professional Memoirs, was, during its entire career, a semi-official publication, which was printed at the Engineer School plant at Washington Barracks, D. C., at a very moderate cost to the journal. It led a quiet existence, shielded by circumstance from the vicissitudes of life.

Recent legislation has forbidden the publication of journals of this class in government plants. It is necessary that they be published commercially, paying all their own expenses.

Professional Memoirs faced a crisis. Its accumulated resources and current income did not permit its publication on a purely commercial basis. There were two alternatives open. One was to reduce the size and scope of the journal to something more modest and more in keeping with its financial resources. The other was the reverse of this, to enlarge and expand, to make our journal more interesting and more useful, and to appeal to a larger class of readers. It was decided that we had an important mission to fulfill, and the second alternative, to wit, expansion, was adopted. In this decision the Society of American Military Engineers and its journal The Military Engineer, had their origin.

Decision must be followed by action, and very prompt action was necessary in this case. In the apathy succeeding the war the subscription list of Professional Memoirs was approaching the vanishing point. Interest in the periodical was at its lowest ebb. There was only one thing to do, to issue a larger and better journal. If it aroused the interest and met the approval of the profession, success was assured. And no outcome, other than this, was ever considered.

To fulfill our mission of promoting the National Defense, an organization of some kind, a society, was essential. And to maintain a national society, whose membership is scattered from coast to coast, some organ of communication, a live and up-to-date journal, was likewise essential. Hence our magazine must be continued, it must be made more interesting and appealing than heretofore.

The first number of The Military Engineer was printed at a commercial plant in Washington. Conditions in the printing world were bad. They were especially unfavorable to a new periodical. The difficulties of getting work done were very great and prices were high. Moreover, the new magazine, different in form from the old, was to be designed, its details worked up as it was being printed. These difficulties caused the first number to appear fully two months late. Nevertheless our first number was favorably received, and our Society showed signs of growth that encouraged us to persevere in the face of difficulties.

It was decided to establish our own plant, but funds were not at the time available for the project. So it was carried out in part only. A "composing" plant was purchased and installed, and the second number was set up in our own establishment, but printed commercially. The difficulties of getting presswork done were as great as ever. We were unable to make up our lost time, and it was quite evident that satisfactory results could be obtained only by having a complete plant of our own. The process of acquiring the plant, installing it and putting it in operation, was slow and painful. Our old quarters were too small, and we were compelled to move elsewhere. Just at this difficult juncture our efficient business manager, Major Richards, was taken seriously ill and has not yet returned to duty.

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During the month of June the installation of our plant was finished. In April we had found ourselves several thousand dollars in debt, with our cash exhausted. But our Society was growing rapidly, and at present with our membership approaching 3,000, with a healthy growth in our advertising columns, and with a thoroughly equipped plant, we are independent of conditions in the printing business, except for the difficulty of obtaining supplies, and we are solvent financially.

This number of THE MILITARY ENGINEER is, from cover to cover, the product of our own plant. Many of our members have told us that, typographically, we need not fear comparison with any other professional journal. This result has been made possible by the loyal work of our business and circulation managers and our printer, and by the hearty support and encouragement of THE SOCIETY OF AMERICAN MILITARY ENGINEERS.

The crest of our difficulties appears to have been surmounted, and the outlook for the future is promising. By the first of the coming year our Society will be strong enough to support even so ambitious a journal as THE MILITARY ENGINEER. And the mission of our Society, the promotion of engineering preparedness for the defense of our country, we *can* and *will* accomplish.

Society of American Military Engineers initiates organization of Local Posts

BEGINNING in June there opened an important era in the history of our Society. In our May-June issue we announced our intention of organizing local posts in some of the larger communities. In June and July preliminary meetings looking to the organization of these posts were held in most of the large cities, and a number of smaller one.

The meetings were in most cases well attended, and in all cases very enthusiastic. Many eminent engineers, members of our Society, are backing the movement, local engineering societies and clubs and commercial organizations have lent their support.

In practically every case a number of charter members of the new post were enrolled, in the majority of cases an organization was effected and officers, or temporary officers, were elected, in a few cases preliminary details were discussed and future meetings schduled.

The influence of the local posts has already been strongly felt in a considerable increase in the membership of the parent society as a direct result of the local posts.

An excellent start has been made, and the outlook for the future is bright.

It is regarded as most important that the growth and activities of the local posts be given publicity, and THE MILITARY ENGINEER will devote whatever space is necessary to this purpose. The activities of each post will furnish valuable suggestions and stimulus to other posts. Our Society is co-operative, and only by working together can we accomplish our mission. It is urged, therefore, that all posts send to the Secretary of the Society, from time to time, reports of an informal nature concerning their activities, portraits of their officers, news items, membership, personal notes, plans for the future, etc.

Every member of the National Society should promptly join the post in his locality, if there be one.

Reports from the local posts are not as complete as we would desire, but the following summary will indicate how much progress has been made in a very short time.

CHICAGO, ILLINOIS.

Address: Mr. J. T. Montgomery, Secretary, 31 North State Street.

First Meeting: June 15, called by Col. W. V. Judson. Elected temporary officers: John deN. Macomb, President; G. B. McClary, Secretary-Treasurer. Recommended substitution of name "Section" for "Local Post."

Second Meeting: June 28, elected officers. Col. C. Vandeventer, President; Mr. J. T. Montgomery, Secretary-Treasurer.

CLEVELAND, OHIO.

Address: Capt. James H. Reding, Secretary, 13900 Savannah Avenue.

First Meeting: June 16, called by Col. R. R. Raymond. Elected temporary officers: Col. J. R. McQuigg, Temporary Chairman; Capt. J. H. Reding, Temporary Secretary.

DULUTH, MINNESOTA.
(Lake Superior Post.)

Address: Mr. William S. Morris, Secretary, Commercial Club.

First Meeting: June 12, called by Col. F. A. Pope. Temporary Officers elected. Col. F. A. Pope, President; Mr. Frank McComber, Vice President; Mr. William S. Morris, Secretary; Mr. A. G. Hatch, Treasurer; Mr. J. R. Rubey, Assistant Secretary.

JACKSONVILLE, FLORIDA.

Address: Mr. J. M. Braxton, U. S. Engineer Office, Masonic Temple.

First Meeting: June 15, called by Col. W. J. Barden. Temporary officers elected. Mr. J. M. Braxton, President.

Second Meeting: July 10 (no details).

LOS ANGELES, CALIFORNIA.

Address: Mr. Burt Harmon, Secretary, 745 West Ocean Avenue.

First Meeting: June 15, called by Col. F. B. Downing. Temporary officers elected: Mr. Charles T. Leeds, President; Mr. Carl B. Wirsching, 1st Vice President; Mr. John A. Griffin, 2d Vice President; Mr. Burt Harmon, Secretary; Mr. G. C. Fitzgerald, Treasurer.

MILWAUKEE, WISCONSIN.

Address: Maj. F. C. Best, Secretary, care of U. S. Engineer Officer.

First Meeting: June 25, called by Col. E. H. Schulz. Temporary officers elected. Col. Edward H. Schulz, Presi-

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dent; Mr. T. C. Hatton, Vice President; Maj. F. C. Best, Secretary.

Meetings July 2 and 9 (no details).

MONTGOMERY, ALABAMA.

Address: Mr. Dwight C. Trevarthen, Secretary, P. O. Box 763.

First Meeting: June 15, called by Maj. W. A. Johnson. Officers elected: Maj. W. A. McCalla, Vice-President; Mr. Dwight Trevarthen, Secretary-Treasurer.

NEW ORLEANS, LOUISIANA.

Address: Lt. Col. H. P. Ralston, Secretary, 2302 Prytania Street.

First Meeting: June 15, called by Maj. E. J. Dent. Temporary officers elected: Maj. E. J. Dent, President; Maj. A. M. Shaw, Vice President; Lt. Col. H. P. Ralston, Secretary; Capt. J. H. Carruth, 1st Director; Lt. Col. Pendleton Morris, 2d Director.

Second Meeting: June 22, application for charter.

NEW YORK CITY.

Address: Maj. Percy E. Barbour, Secretary, 29 West 39th Street.

First Meeting: June 15, called by Col. Edward Burr. Temporary officers elected: Col. F. A. Molitor, Chairman; Col. G. D. Snyder, Vice-Chairman; Maj. Percy E. Barbour, Secretary.

Second Meeting: June 29 (no details).

PHILADELPHIA, PENNSYLVANIA.

Address: Lt. Col. W. B. Ladue, 815 Witherspoon Building.

First Meeting: June 15, called by Col. W. B. Ladue. Maj. Marshall R. Pugh, presided (no details).

PITTSBURGH, PENNSYLVANIA.

Address: Mr. Wm. M. McKee, Secretary, 1708 Farmers Bank Building.

First Meeting: June 17, called by Col. H. B. Ferguson. Temporary officers elected: Mr. E. A. Gibbs, President; Mr. E. F. Archibald, Vice-President; Mr. William M. McKee, Secretary; Mr. F. W. Henrici, Treasurer; Mr. W. H. Horton, Jr., Assistant Treasurer.

PORTLAND, OREGON.

Address: Capt. P. Hetherton, Secretary, Chamber of Commerce.

First Meeting: June 15, called by Col. J. R. Slattery.

Second Meeting: June 28. Officers elected: Maj. Lyman Griswold, President; Maj. W. H. Emerick, Vice-President; Capt. P. Hetherton, Secretary; Capt. J. W. Morris, Treasurer; Capt. R. E. Kremers, Assistant Treasurer.

SAN FRANCISCO, CALIFORNIA.

Address: Capt. D. W. Dodge, Secretary, 733 Rialto Building.

First Meeting: June 29, called by Col. Thos. H. Rees. Elected temporary officers: Col. T. H. Rees, President; Lt. Col. Chas. B. Wing, Vice-President; Capt. D. W. Dodge, Secretary; Capt. J. D. Cleary, Treasurer; Col. J. W. Williams, Assistant Treasurer.

ST. LOUIS, MISSOURI.

Address: Lt. Col. John L. Buchanan, 7th and Clark Ave.

First Meeting: June 15, called by Maj. DeWitt C. Jones. Elected officers: Maj. DeWitt C. Jones, President; Lt. Col. F. G. Jonah, Vice-President; Lt. Col. J. L. Buchanan, Secretary; Maj. J. W. Skelly, Treasurer; Maj. W. W. Burden, Assistant Treasurer.

Second meeting: June 23, signed application for charter.

SEATTLE, WASHINGTON.

Address: Secretary, Seattle Post, Society of American Military Engineers, U. S. Engineer Office, Seattle.

First Meeting: June 15, called by Col. J. A. Woodruff. Committee appointed to organize: Col. J. A. Woodruff, Mr. J. M. Clapp, Capt. Bertram D. Dean, Capt. K. C. Bean, Maj. A. O. Piper.

WILMINGTON, DELAWARE.

Address: Mr. Pearson Winslow, Secretary, Engineering Department, DuPont Building.

First Meeting: June 15, called by Col. E. N. Johnston. Officers elected: Maj. W. F. Beyer, President; Mr. W. M. McIntosh, Vice President; Mr. Pearson Winslow, Secretary-Treasurer.

Morale in war and peace

IT was Napoleon who said "In war the moral is to the physical as three to one." His estimate was very conservative, especially perhaps as applied to his own people, the French.

Unquestionably, the best demonstration of moral power which history records, was given by Joan of Arc. Joan was a poor country maiden, totally ignorant in all things concerning state-craft and the art of war. She exercised no leadership, if by this we mean that the leader must know what he is doing and direct the operations of those under them. Yet she defeated the previously victorious army of a great nation and placed a King on the throne of France.

These results Joan achieved solely by the romantic stimulus she gave to the highly sensitive morale of the French people. Napoleon himself, while knowing the art of war better than any other man, owed his success quite as much to his power to influence the morale of his soldiers. This is well illustrated by the following anecdote:

In their assaults on the Borodino Redoubt (in the Russian campaign) the French had been several times repulsed with heavy losses. Without reinforcements, with their morale low as a result of defeat, it seemed useless to send the French army again to the assault. The last day happened to be the anniversary of the great French victory at Austerlitz. As noon approached, the French battalions were assembled for the final assault. The morning had been cloudy, but at noon the sun broke forth and gloriously illuminated the field of battle. The great commander, quick to take advantage of any favorable circumstances, pointed to the brilliant orb and exclaimed: "Soldiers, it is the sun of Austerlitz that shines upon you." With shouts of enthusiasm the excitable Frenchmen charged, and in the twinkling of an eye captured the stronghold which had resisted all their previous efforts.

We are prone to think of "morale" as a military term. But it is fully as applicable to the affairs of peace as to those of war. The most successful leaders both in war and peace are those who know best how

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to stimulate the enthusiasm of their followers. Warm enthusiasm wins the battles of peace, after cold reason has pronounced them lost.

We all realize, in a more or less academic way, the power of enthusiasm. Yet how frequently we neglect to take practical advantage of our knowledge, and of the thousand and one opportunities constantly afforded us to stimulate the enthusiasm of our "soldiers." A little stroll around the work or through the plant, just to let "the boss" be seen, a little show of interest, a cheery greeting, a word of approval and encouragement, a kindly inquiry, a reminder of good performances in the past—all these will work wonders in achieving results.

It has been said that such opportunities are no. presented in the great armies of the present day, the great "soulless" corporations in modern industry, where personal contact between the leader and his followers is impossible. This is not true. Through organization the leader directs and controls the acts of subordinates he never sees or knows. It is quite as easy to affect their morale, to stimulate or depress their enthusiasm, by the same means. The personality of an enthusiastic leader is a living force which pervades the entire organization, however large it ma be. Subordinates will take a pride in serving such a leader, and his personality becomes a power in their lives, even though he be unseen.

The Army Ordnance Association

EARLY in August the first issue of *Army Ordnance,* Journal of the Army Ordnance Association, made its appearance. We are convinced that no technical magazine ever made a more splendid showing from the beginning. The new journal is most handsome and attractive. Beautifully printed and illustrated, its contents from cover to cover are of absorbing interest. Amongst the leading articles are "Decentralized Production," by Gen. Guy E. Tripp, chairman of the Board of Directors of the Westinghouse Electric and Mfg. Co.; "The Ordnance Engineer," an appreciation of his services by Gen. William Crozier, late Chief of Ordnance, U. S. Army; "Motorized Artillery," by Col. L. B. Moody; "Government Nitrate Plants," by Col. J. H. Burns; "Manufacture of Tanks at Rock Island Arsenal," by Col. H. B. Jordan; "The Machine Gun of the Future," by Maj. J. S. Hatcher, etc.

The Army Ordnance Association, already a strong and flourishing society, is pledged to the promotion of industrial preparedness as one of the strongest guarantees of peace. All American citizens available to the government in connection with the design, production, inspection, purchase, etc., of ordnance material, are eligible to membership in the new society.

The offices of the new society are in the Munsey Building, Washington, D. C. Charter membership is now open, the annual dues are $5. Maj. J. L. Walsh is Secretary of the society and Editor of *Army Ordnance,* and Mr. Harry P. Taber is Consulting Editor.

The R.O.T.C. Camp

THOSE who favor universal training or universal education (it smells just as sweet or otherwise by either name), have consistently maintained that education, being the greatest national as well as personal need, should be a function of the supreme governing power of the land. Especially is this true in a *democracy,* whose success is dependent on the intelligence of its citizens, whereas in an autocracy success, or at least perpetuity of autocratic control, is too often dependent on their ignorance. According to this theory education and democracy go hand in hand, each is or should be at once both the cause and effect of the other.

The Army is devoting much of its energies at present to a practical demonstration of the power of the Federal Government to educate our citizenry. This mission of the Army is one of the great "new ideas" that are the aftermath of the war. Yet after all this idea is not so very new.

An important feature of this demonstration is the series of summer camps for the instruction of the Reserve Officers' Training Corps. In this issue we present an interesting article describing the Engineer Camp at Camp Humphreys, Va., its purpose and the methods by which it has sought to achieve this purpose. All those who believe that right training or education is a fundamental human need will find much to interest them in Captain Styer's entertaining story of what has been done at Camp Humphreys.

What is our mission?

A lively correspondent whose morale is manifestly still good, contributes the following:

In action whenever a commander becomes confused, when he seems to be getting lost, when all things seem to be going wrong, it is his duty to stop and think—What is my mission?

To-day in the Army when many things are going wrong, when hundreds of officers are leaving, when an amazingly small number of men are re-enlisting, when it costs hundreds if not thousands of dollars to get a recruit, when those officers who are not cowed by threats from above announce that morale is at a low ebb, is it not well for the Regular Army to ask itself, What is our Mission?

Is it the purpose of the Regular Army to increase the educational tone of the country; is it the mission of the Army to offer amazing educational opportunities to the youth of the land when it is being daily demonstrated that such offers cannot be carried out under the "voluntary" system without an expenditure out of proportion to the results attained; is it the mission of the Army to stand silently by and see some of its best material, both commissioned and enlisted, leaving the service; or is it the mission of the Army to insist that it remain a sound reliable military organization, capable of giving the last ounce of its strength to the country and to the best advantage, while so maintaining the true military character of the nation, so keeping abreast with military progress, so formulating military plans, as to guarantee a virile, healthy military body, capable of effective expansion in time of war?

Without question the mission of the Regular Army is to be fit, to be

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prepared, to be ready for any emergency. To do this it must first of all things maintain a strong, efficient personnel. It may be small but it must be good. Next, we must not be blind to the experiences of the great war but keen and alive to apply them to our problems of the present and future. We must look with suspicion and constructive criticism into all our habits which embarrassed us during the recent emergency. We must recognize that any method of training, administration or routine, which undermines soldierly efficiency and hampers progress in war should be eliminated. We must realize that in time of emergency when every member of the regular service should be capable of assuming tremendously increased responsibilities, his military character and training must be sound if he is to endoctrinate all the new men placed under him with proper military methods, practice, habits and ideals.

In the matter of discipline it is time we realized that in a democracy such as ours the only criterion for superior rank is superior worth and leadership; that no officer has any business holding a commission unless he is a better soldier than the men he commands, but that an officer does not have to pet and pamper new recruits in order to show his democratic spirit. We are thankful to realize that Americans are still sufficiently virile to admire a strong man who is efficient and capable, and to want to follow him. On the other hand, the day of the snarling martinet is past, as is the day of a privileged officer class. We must admit the fact that the army has no room for an officer who, while requiring the highest degree of smartness and courtesy from his men, remains seated, smoking in front of his tent, while his men come to "attention" and salute him.

We of the regular service must not quit the service nor must we desert our idea's. We see our true mission. As our vision has cleared and expanded during the war so must our courage and determination strengthen to stand four square and see it through.

The Engineer Emergency Officer in World War

By

C. O. Sherrill

Major, Corps of Engineers

[*Note.*—It gives us a peculiar pleasure to here record this tribute to the services of the "emergency" engineer officer, by a regular officer of high standing and wide experience. Colonel Sherrill voices the opinion of all his brother officers during the war. They have been weighed and not found wanting by those best qualified to judge the value of their services—the engineer officers of the Regular Establishment.—ED.]

AT the beginning of operations by the United States against the European Central powers, there were 256 officers in the Corps of Engineers of the United States Army.

The Corps of Engineers in time of war is charged with activities of such variety and magnitude that long before the war the necessity for a Reserve Corps of Engineers was recognized, and when war was declared there were approximately 364 civilian engineers commissioned in the Engineer Reserve Corps. Very few of these had any military training or had knowledge of the functions of the Engineers in war, but having been so commissioned, were supposed to have cognizance of the requirements—officers by Act of Congress.

In May, 1917, the first officers' training camps were started and, about a month later, special engineer officers' training camps were organized, to which all Engineer officers then in other training camps were transferred. Later, additional engineer officers' training courses were inaugurated, which covered a course of about 12 weeks; also, a great number of civilian engineers with special qualifications were commissioned and put on active service, till the total number of officers in the Engineers on November 26, 1918, reached 11,133; of which 449 were Regular Army Engineer Officers and the balance were commissioned only for the emergency, with the exception of 30 who, on account of being on inactive duty, retained their commissions as reserve officers. Including officers who had previously been on active duty at one time or another during the World War, there were altogether about 13,000 officers in the Engineers.

The training of Engineer reserve officers at training camps gave them a knowledge of military organization and routine, the latter a much abused term but essential to any organization which is to function smoothly and systematically. The Engineer reserve officers who served with combat engineer organizations found such training of the greatest value, but the civilian engineer on purely engineering work found that the training so acquired, by giving a broad view, was also a great help to him.

The emergency engineer officers were among the best of the engineering profession in the United States, ranging from young men just graduated or about to graduate from technical schools, to railroad presidents. Every conceivable specialty of technical endeavor was represented, and almost every one was needed and placed in his proper sphere as nearly as a qualification system devised by experienced specialists, and knowledge of the man by direct personal contact could place him. His surroundings were new and his contact with men somewhat different from that in time of peace and particularly so in France. It took time for many to get accustomed to it; most of them did it quickly, very few never; but the latter probably would not have fitted anywhere.

Engineering work in war is a service for the achievement of the common end—the conquering of the enemy. To arrive at this result, a co-ordination of all military services is a prime requisite and a co-ordination of the branches in each service a necessity. Engineers in civil life have held similar relations to industrial and commercial activities and their entrance into the military life probably was not so complete a transition as in other branches of the service After all, the military engineer service is not materially different from any other highly organized force, as railroad or large contracting organizations. The man who was a success in the latter was bound to be a very valuable member in the former, and such proved the case.

The limitations of law at first did not permit the appointment of officers above the grade of Major in the Engineer Reserve Corps, and too much praise cannot be given to the patriotism and self-abnegation of the men above draft age, holding positions of great responsibility, who volunteered for this service. Men of international reputation as engineers and some of the highest paid engineering executives entered the service, and while of course at first nearly all reserve officers were placed under Regular Army officers, as soon as adjustments could be made these able men were placed in positions commensurate with their ability and experience.

While rank in the Army in general established precedence, this, particularly in the engineering service in the S. O. S., was often set aside when the situation required it, until correction could be made by appropriate promotion, which later was authorized.

Most professions or trades have a language peculiar to such occupation, and one of the first difficulties, but of really minor importance and very soon overcome, was the lack of ability of the civilian engineer to understand the military vocabulary, not necessarily slang, but as different from the ordinary language as is the railroad man's professional vernacular. When this handicap was overcome, the common ground between the reserve officer and the army

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as a whole was found, and things commenced to move; he could now "speak the language" of the service.

Engineer reserve officers occupied every position in the Corps of Engineers from second lieutenant to brigadier general; they took charge of many organizations at the front and rendered excellent services of a purely military character; their specialized technical knowledge was taken advantage of in every way and seldom if ever did they fail to respond to any demand on them, whether it was a purely military or other specialized technical requirement; they gave the best that was in them.

The regular army officer could not and did not attempt to specialize to the extent required in this war, but his general knowledge of military affairs and engineering, and his trained executive powers were taken advantage of to the full. The combination of the broad outlook of the regular with the highly expert and specialized knowledge and aggressiveness of the emergency officer was a combination hard to beat, and Germany could not beat it.

While, of course, the regular army engineer had endeavored, through direction of public works and association with the civil engineering profession, to keep abreast of all modern improvements and new lines of thought in his profession, the close contact with the men from civil life during the war has given him opportunities to observe and learn, often even how not to do things. Similar experience was gained by the emergency officers, and should another emergency arise within their life-time the mutual experience gained will be of invaluable aid to the defense of this country.

The emergency engineer officer was an American and as such never willing to be a mere machine. Unfortunately, this was often his conception of military duty as laid down in regulations. When he found out that military organization may be likened to a machine, but that the human factor is never overlooked in the American Army, he became the valuable human part in the organization, to create which was the object of every one connected therewith, and who served with the one aim in view to defeat the enemy, not alone with brute force, but by the exercise of every faculty of the human brain.

The work done by the emergency officers of Engineers covered every conceivable engineering activity, and to enumerate these would show as many and probably more items than the Trade Index of the New York City directory. The Engineer reserve officers loyally followed the motto of the Corps of Engineers: "Essayons," "Let us try," and they succeeded. Lest the Corps of Engineers shall be thought to minimize the eminent services, it is desired here to render final acknowledgment to this self-sacrificing body of men, without whom the war could not have been won.

Still sliding at Panama

That the end of the slides at Panama is not yet and that the engineers charged with keeping open the "big ditch" still have their troubles, is indicated by the following extracts from a report by J. W. Pratt, Superintendent of Dredging on the Canal:

During October, 1919, a slide occurred at Cucharacha, which had remained quiet for three years, causing over 200,000 cubic yards of earth and rock to come into the canal. This was removed and everything was quiet until the 22d of last February, when another movement at the same place commenced, and since that time we have had four distinct movements besides a gradual creeping part of the time. Over 500,000 cubic yards have been brought into the canal by these latter movements. In one night the canal was closed to shipping, and it took four days to open a way for ships to pass. We fought every day for two months to keep sufficient channel open for ships to pass. One can walk to the center of the canal now. The trouble with removing the material is that it is largely composed of rock, some very large that have to be blasted. These rock are pushed out from the hills, and into the canal, some moving clear across to the opposite bank. Some of them are 150 feet long, 50 feet wide and 40 feet thick. They have to be drilled and blasted before being removed. We have three 15-yard dipper dredges, and these are the only kind that can successfully handle this material. The material is put in scows and towed about 15 miles to the dumping ground. So, of course, the work is very costly, and proceeds night and day, Sundays and holidays.

As to the magnitude of these slides, the area that moved covers 35 acres. The movement was primarily caused by the collapse of a rock ridge that had served as a retaining wall when the big slide occurred there four years ago. The collapse was due to the gradual deterioration of the rock in this wall. Material immediately behind this wall, a huge hill, pushed out, carrying everything before it, the high ground behind the hill settled 100 feet by pushing forward, and the movement extended to a distance of one-half mile from the canal. The hill there is 500 feet high, mostly rock. A huge piece, 1,000 feet by 400 feet, settled and broke up, pushing forward and causing everything before it to move. The movement is very deep—perhaps 200 feet. This movement is affecting a hill 600 feet high that is to one side of it and nearer the canal. The rock in these hills is slowly crumbling and falling into pieces as if struck by a series of blows. There must be very great vibration to cause it. There is considerably over 3,000,000 cubic yards of material in motion. To add to our troubles, a part of the movement is behind a huge rock hill that is on the bank of the canal. And the canal will be closed for a long time if this hill is pushed over. We are using large hydraulic graders in an effort to relieve the pressure from behind this hill and divert the material around it. It sometimes moves up to this hill at the rate of 2 feet an hour, and moves up the steep slope to within a few feet of the top. It would overflow it like water were it not for our efforts. It is strange to see huge rocks moved up the almost perpendicular slope. The earth is as dry as powder, dusty, and yet it flows like water with that pressure behind it.

The British battleship *Renown*, with the Prince of Wales on board, had to wait four hours while we blasted the top off a large bowlder in order to give sufficient depth. That was a very trying day. The Prince was much interested in our operations. He could see from the ship what we were doing. The work was highly praised by the Governor, who was naturally anxious to get the boat through on schedule time.

Autofrettage for Guns.—The Ordnance Department is investigating the so-called "autofrettage" method of constructing guns, with a view to comparing its merits with the built-up and wire-wrapped methods. The latter two forms of construction have hitherto been used in all modern guns. The principle involved has been the support of the tube of the gun by the shrinkage of hoops around it in the built-up construction, and the wrapping of wire under tension around the tube in the wire construction. The pressure of the hoops or wire reinforced the inner tube, enabling it to support a greater internal pressure than a single tube could withstand.

In the autofrettage method of gun construction, the gun may be constructed in one piece. Before the bore is finally completed, hydraulic pressure is applied, sufficient to cause an actual expansion of the gun. The elastic reaction which takes place after the hydraulic pressure is removed places the inner part of the walls of the gun under compression and the outer part under tension, which is the same general effect as is obtained in the built-up or wire construction. If this method of construction is otherwise satisfactory, it will probably be cheaper than either the built-up or wire method. Furthermore, the time required for manufacturing the gun will be reduced to a considerable extent, and it may be possible to obtain a gun of equal power and lighter weight.

Cost of American forces in France.—The average daily cost of maintaining the American forces in Germany varied from $1,271,000 in February, 1919, to $76,000 in May, 1920. This is paid by Germany.—*Statistics Br. G. S.*

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Chemical Warfare in Attack

By

Amos A. Fries

Brigadier General, Chief of Chemical Warfare Service, U. S. Army
formerly, Chief of Chemical Warfare Service, A. E. F.

[*Note.*—Gen. Amos A. Fries, the author of this article, at the outbreak of the war was a Lieutenant-Colonel of the Corps of Engineers. He was appointed Chief of the Chemical Warfare Service of the A. E. F. and subsequently promoted to the rank of Brigadier General. He served throughout the war in this capacity. On the reorganization of the Army following the war General Fries was appointed Chief of the Chemical Warfare Service, for which position he was the logical candidate. He is thus unquestionably the best qualified man in America to write with authority on the tactical use of poison gas in war. In his article General Fries sets forth in a singularly lucid and convincing manner the sound doctrine of chemical warfare as developed in the A. E. F. under his direction. He tells what has been accomplished and dissipates many popular misconceptions concerning the use of gas. But the most interesting and useful part of the article is his portrayal, based on fact and sound reasoning, of the possible future developments of this now important arm of warfare. These predictions by our leading authority cannot fail to be of absorbing interest to all our readers.—ED.]

What chemical warfare includes.

CHEMICAL warfare material includes all gas, smoke and incendiary materials and all defensive appliances, chief of which is the mask, used by the Army. Some of the items or materials in both offense and defense are used by the entire army, while a few are used only by Chemical Warfare Service troops.

Meaning of term "Gas."

The term "gas" is now taken to include all materials that are carried to the enemy by the air, after their liberation from cylinders, bombs or shells. It is necessary that this broad use of the term "gas" be thoroughly understood, because some of these materials are solids, while all others are liquids, until liberated from the containers at the time of the attack. These containers may be special cylinders for cloud gas attacks, special bombs for Livens projectors and mortars, or artillery shell, and even aviation bombs. Some of the liquids which have a very low boiling point volatilize quickly upon exposure to air, and hence require only enough explosive to open the shell and allow the liquid to escape, while practically all solids have to be pulverized by a large amount of high explosive.

Chemical warfare highly technical.

Chemical warfare, besides being the newest, is also the most technical and most highly specialized service of war. There is no class of people in civil life, and no officers or men in the War Department who can take up chemical warfare successfully until they have received thorough training. This applies to the use of materials in both attack and defense. Ten years from now perhaps this will not be true. It is certainly hoped that it will not be. By that time the entire army should be pretty thoroughly trained in the general principles and many of the special features of chemical warfare. If not, chemical warfare can not be used in the field with the fullest efficiency and success. Furthermore, it is believed that within ten years the knowledge of the gases used in chemical warfare will be so common through the development and use of these same materials in civil life, that it will not be so difficult as at present to find civilians who are acquainted with Chemical Warfare Service materials.

Effectiveness of Gas.

Chemical warfare materials were used during the war by Chemical Warfare Service troops, by the artillery and by the infantry. For the future the air service will be added. Chemical warfare, even under the inelastic methods of the Germans, proved one of the most powerful means of offense with which the American troops had to contend. To prove its effectiveness it need only be said that more than 27 out of every 100 men killed and wounded on the field of battle were from gas alone. Unquestionably many of those who died on the battle field from other causes suffered also from gas. No other single element of war, accounted for so many casualties among the American troops. Indeed, it is believed that a greater number of casualties was not inflicted by any other arm of the service, unless possibly the infantry, and even in that case it would be necessary to account for all injured by bullets, the bayonet, machine guns and hand grenades. This is true, in spite of the fact that the German was so nearly out of gas when the Americans began their offensive at St. Mihiel and the Argonne, that practically no gas casualties occurred during the St. Mihiel offensive, and only a very few until after a week of the Argonne fighting. Furthermore, the Germans knew that an extensive use of mustard gas against the American lines on the day the attack was made, and also on the line that marked the end of the first advance a few days later, would have produced tremendous casualties. Judging from the results achieved at other times by an extensive use of mustard gas, it is believed that had the German possessed this gas and used it as he had used it a few other times, American casualties in the Argonne would have been doubled. In fact, the advance might even have been entirely stopped, thus prolonging the war into the year 1919.

Humanity of Gas.

A few words here as to the humanity of gas are not out of place, notwithstanding the army and the general public have now so completely indorsed chemical warfare that it is not believed the argument of inhumanity has any weight whatever. There were three great reasons why chemical warfare was first widely advertised throughout the world as inhumane and horrible. These reasons may be summed up as follows:

The original gas used at Ypres in 1915 was chlorine, one of a group of gases known as suffocants, which cause death generally by suffocating the patient through spasms of the epiglottis and throat. That is the most agonizing effect produced by any gas.

The English had no masks, no gas-proof dugouts, nor any of the other paraphernalia that was later employed to protect against poisonous gas. Consequently, the death rate

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in the first gas attack at Ypres was very high, probably 35 per cent. As a matter of fact, every man who was close to the front line got a fatal dose and died. The only ones who escaped were those on the edges of the cloud of gas or so far to the rear that the concentration had become decreased below the deadly point.

It was good war propaganda to impress upon everybody the fact that the German was capable of using any means that he could develop in order to win a victory. He had no respect for previous agreements or ideas concerning warfare. This propaganda kept up the morale and fighting spirit of the Allies, and was thoroughly justifiable upon that score even when it led to wild exaggeration.

The chlorine used in the first attack by the German is the least poisonous of the gases now used. Those later introduced such as phosgene, mustard gas and diphenylchlorarsine are from five to ten times as effective.

The measure of humanity for any form of warfare is the percentage of deaths to the total number injured by the particular method of warfare under consideration.

American Gas Casualties

The official list of casualties in battle as compiled by the Surgeon General's office covering all cases reported up to September 1, 1919, is 274,217. Of these, 74,799 or 27.3 per cent were gas casualties; also, of the above casualties 48,059 resulted in death, of these 1,400 only were due to gas. From these figures it is readily deduced that while 23.4 per cent of all casualties from bullets and high explosives resulted in death, only 1.87 per cent of those wounded by gas resulted in death. That is, a man wounded on the battle field with gas had twelve times as many chances of recovery as the man who was wounded with bullets and high explosives.



Telephoning and directing artillery fire through gas mask and megaphone. In the Argonne, Oct. 18. The soldier must perform all his proper functions—gas or no gas

Fundamentals of chemical warfare.

Before taking up in detail the methods of projecting gas upon the enemy, it is very desirable to understand the fundamentals of chemical warfare, insofar as they pertain to poisonous gases.

Following the first use of pure chlorine all the principal nations engaged in the war began investigations of gases in the hope of finding others more poisonous, more easily produced, and more readily projected upon the enemy. These investigations led to the use of a large number of gases which seriously complicated manufacture, supply, and the actual use of the gases in the field. Gradually a more rational conception of chemical warfare led both the Allies and the enemy to restrict the numbers of gases to a comparative few, and still later to divide all gases into three groups. Thus the German divided his into three groups known as (1) Green Cross, the highly poisonous non-persistent gases, (2) Blue Cross, or diphenylchlorarsine, popularly known as sneezing gas, and (3) Yellow Cross, highly persistent gases, such as mustard gas. In the American Chemical Warfare Service we have finally divided all gases into two primary groups. These groups are known as "non-persistent" and "persistent." The "non-persistent" gases are those quickly volatilizing upon exposure to the air, and hence those that are carried away by air currents, or which in a dead calm will be in a few hours completely dissipated into the surrounding air. If sufficient high explosive be used to pulverize solids they may be used in the same way, and to a large extent certain highly persistent liquid gases may have their persistency greatly reduced by using a large amount of high explosive that divides the liquid into a fine spray. The "persistent" group includes those gases that are very slowly volatilized upon exposure to the atmosphere. The principal ones of these now used or proposed are mustard gas (dichlorethylsulphide), and brombenzylcyanide, a tear gas. For purposes of economy, and hence efficiency, certain gases, both persistent and non-persistent, are placed in a third group known as the "irritant group." These gases are effective in extremely low concentrations against the lungs and other air passages, or the eyes. Diphenylchlorarsine, and some other solids when divided into minute particles by high explosive or heat, irritate the nose, throat and lungs to such an extent in a concentration of one part in ten millions of air as to be unbearable in a few minutes. The tear gases are equally powerful in their effects on the eyes. The irritating gases are used to force the wearing of the mask, which reduces the physical vigor and efficiency of the troops. This reduction in efficiency, even with the best masks, is probably 25 per cent for short periods, and much more if prolonged wearing of the mask is forced.

One pound of the irritant gases is equal to 500 to 1,000 pounds of other gases when forcing the wearing of the mask alone is desired. The great economy resulting from their use is thus apparent. Due to the rapid evaporation of the non-persistent gases they are used generally only in dense clouds, whether those clouds be produced from cylinders, called "cloud gas," or from bombs. These gases are used only for producing immediate casualties, as the necessary amount of gas to force the enemy to constantly wear his mask by the use of non-persistent gases alone could not possibly be taken to the front.

Mustard gas, which is highly persistent and also attacks the lungs, eyes and skin of the body may, and will be used to force the wearing of the mask. It has one disadvantage when it is desired to force immediately the wearing of the mask, and that is its delay action and the fact that it acts so slowly, and is usually encountered in such slight concentrations that several hours' exposure are necessary to produce a severe casuality. For these reasons the enemy may often take chances in the heat of battle with mustard gas, and while himself becoming a casualty inflict quite heavy casualties upon opposing troops by continuing to operate his guns or rifles as the case may be. A powerful tear gas on the other hand forces the immediate wearing of the mask.

Chemical warfare materials used by C. W. S. Troops.

Chemical Warfare Service troops in making gas attacks use cylinders for the cloud or wave attack, and the Livens

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projector and four-inch Stokes mortar for attacks with heavy concentrations of gas projected by bombs with ranges up to a mile. This distance will in the future probably be increased to one and one-half or one and three-quarters miles. The original cylinders used in wave attacks were heavy, cumbersome and very laborious to install, and hence notwithstanding the wave attack was known to be the deadliest form of gas attack used in the war, it fell into disrepute after the use of gas in artillery shells and in special bombs became general.

Cloud gas.

The Americans at once concluded that since cloud gas attacks were so effective, efforts should be made to make these attacks of frequent occurrence by decreasing the weight of the cylinders, and by increasing the portability and improving the methods of discharging the cylinders.

Cloud gas attacks will usually be made at night, when due to fatigue and sleepiness men are careless, lose their way, neglect their masks, and are thus caught. Experience in the war proved that a wave attack always produced casualties even, as was several times the case when the enemy or the Allied troops knew some hours beforehand that the attack was coming. The English estimated these casualties to be 10 or 11 per cent of the troops exposed.

Livens projectors.

The next most effective weapon for using gas by gas troops was and will be the Livens projector. This projector is nothing more than the simplest form of mortar consisting of a straight drawn steel tube and a steel base plate. As used during the World War by the Allies it did not even have a firing pin or other mechanism in the base, the electric wires for firing passing out through the muzzle and alongside the drum or projectile which was small enough to permit that method of firing. These were set by the hundreds very close behind or even in front of the front line trenches. They were all fired at the same instant, or as nearly at the same instant as watches could be synchronized, and firing batteries operated. These mortars were emplaced deep enough in the ground to bring their muzzles practically level with the surface. As the ones most generally used were 2 feet 9 inches long, the work entailed was very great. Thus it usually took several days to prepare the attack, and consequently allowed an opportunity for the enemy to detect the work by aeroplane photographs or by raids, and destroy the emplacements by artillery fire. It should be added, however, that notwithstanding this apparent great difficulty, very few attacks were broken up in that way. Nevertheless, in line with the general policy of the American troops to get away from anything that savored of trench warfare, and to make the fighting as nearly continuous as possible with every means available, the American Chemical Warfare Service set at work at once to develop an easy method of making projector attacks.

Emplacing projectors.

It was early found that if the excavation was made just deep enough so that the base plate could be set at the proper angle, the drums or projectiles were fired as accurately as when the projectors or mortars were set so that the muzzles were level with the surface. The time required to emplace a given number of mortars in this way was only about one-fifth of that required for digging them completely in. However, one problem in connection with this method of firing remained unsolved to the end of the war, and hence it was not used.

The firing batteries used by the Chemical Warfare Service were ordinarily used for blasting purposes in the United States, and would fire only twenty to thirty fuzes each. As it was highly desirable, if not absolutely necessary at all times to set a great number of these mortars close together, they had to be fired exactly simultaneously, when set above the ground, or else the shock of discharge from nearby projectors threw those not discharged at the same instant entirely out of line. A machine that will fire 100 to 500 at one time will be developed, and will make this method practicable in the field.

Coupled of course with these proposed improvements in methods, studies were made and are being made to produce lighter mortars, better powder charges, and better gas checks in order to develop the full force of the powder. Many improvements along this line can be made, all of which will result in greater mobility, more frequent attacks, and greater efficiency.

4-inch Stokes mortar.

The Stokes mortar is not different from that used by the Infantry, except that it is 4 inch, while the Infantry Stokes is 3 inch. The 4 inch was chosen by the British for gas, as it was the largest calibre that could be fired rapidly and yet be moderately mobile. Its range of only about 1,100 yards handicapped it considerably. The poor design of the bomb was partly responsible for this. The powder charges also were neither well chosen nor well designed. It is believed that great improvements can be made in the shape of the bomb and in the powder charge, which will result in much longer range and higher efficiency, while in no way increasing the weight of the bomb or decreasing the rate of fire. These last two weapons were used during the World War, and will be extensively used in the future for firing high explosive, phosphorus, thermite and similar materials that non-technical troops may handle.

C. W. S. Troops handle all short-range mortars.

Since, however, gas has proven without the shadow of a doubt, that it will produce more casualties for an equal amount of material transported to the front than any other substance yet devised, all troops using short range guns or mortars should be trained to fire gas whenever weather conditions are right. When weather conditions are not right they should fire the other substances mentioned. The Livens projector with its 60-pound bomb, of which 30 pounds will be gas or high explosive, is a wonderful gun up to the limit of its range. The bomb not being pointed does not sink into the ground, and hence upon exploding exerts the full force of high explosive upon the surroundings, whether bombs, pill boxes, barbed wire or trenches, to say nothing of personnel.

High explosive in projectors.

When these are burst by the hundreds on a small area everything movable is blotted out. Thus concrete machine gun emplacements, lookout stations, bomb-proofs, wire emplacements are destroyed, trenches filled up, and the personnel annihilated. This was amply demonstrated on the few occasions when it was actually used at the front. The American infantry wherever they saw it tried out were wild to have more of it used. The German was apparently equally anxious to have the use stopped. It is, however, one of the things that must be reckoned with in the future. It means practically that No Man's Land in the future will be just as wide as the extreme range of these crude mortars, and here a word of caution. While efforts have been made to increase the range of these mortars, whether of the Livens or Stokes variety, no increase will be attempted that re-

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duces the speed of firing or the efficiency of the projectile. In other words results depend upon large quantities of material delivered at the same instant on the point attacked, and if this can not be obtained the method is useless. For this reason these mortars will never be a competitor of the artillery. The artillery will have all that it can do to cover the field within its range, beyond that reached by the mortars.

Phosphorus in 4-inch Stokes.

Phosphorus will be used largely by gas troops, but only in whatever Stokes mortar may be finally adopted as best. The Livens projector carries too great a quantity, and being essentially a single shot gun, is not adapted to keeping



Close burst of a gas shell. The 6th Marines in the Sommedieue Sector near Verdun, April 30, 1918

up a smoke screen by slow and continued firing, or of being transported so as to keep up with the infantry. Phosphorus has also very great value for attacking personnel. Anyone who has been burned with phosphorus or has witnessed the ease with which it burns when exposed to air, wet or dry, has a most wholesome fear of it. The result of it in the war showed that the enemy machine gunners or other troops would not stand up under a bombardment of phosphorus fired from the 4-inch Stokes mortar, where each bomb contains about seven pounds.

Thermite.

Thermite is used in the same way, and while the idea of molten metal falling upon men and burning through clothing and even helmets is attractive in theory, it proved absolutely worthless on the field of battle. It was found impossible to land large enough quantities of molten metal on a given spot to cause any considerable burn. In other words, the rapid spreading out and cooling of the metal almost entirely ruined its effectiveness, except its effect on the morale. This latter, however, was considerable, as one might judge from seeing the thermite shells burst in air. For this reason thermite may find a limited use in the future.

Height of gas cloud.

A few words concerning the behavior of gas on the field of battle are in order. The height to which gas rises in a gas cloud is not known exactly, but is believed to be not much more than fifty feet, and then only at a considerable distance from the point of discharge. Moving pictures taken of gas clouds show this to be true. It is also indicated by the fact that pigeons, which are very susceptible to poisonous gas, practically always return to their cages safely when liberated in a gas cloud. This was a good deal of a mystery until it was realized that the pigeon escaped through his rising so quickly above the gas as to not get enough to affect him seriously. This of course would be expected when it is known that practically all gases successfully used were three or more times as heavy as air. Such gases rise only by slow diffusion, or when carried upwards by rising currents. The absence of these upward currents at night is one of the reasons why gas attacks are more effective at night than during the day.

Horizontal spread of gas.

Another important thing to know in regard to the behavior of the wave of gas is the horizontal spread of a cloud. If gas be emitted from a cylinder the spread in both directions from that point is from twenty to thirty degrees, or pretty closely an average of twenty-five degrees. This varies of course with the wind. The higher the wind the less the angle, though the variation is not as great as might be expected. This horizontal spread of the gas cloud was measured experimentally, and the results checked by airplane pictures taken of heavy wave attacks over the enemy line. In the latter case the path of the gas was very closely indicated by the dead vegetation, grass and bushes. This vegetation was killed and bleached so that it readily showed up in airplane photographs. The visibility of a gas cloud arises from the fact that when a large amount of liquid is suddenly evaporated, the air is cooled and moisture condensed, thereby creating a fog. With gases such as mustard and others of slight volatility, a visible cloud is not formed. For purposes of identification of points struck by shell, smoke substances are occasionally added, or a few smoke shell fired with the gas shell. As future battle fields will be dotted everywhere with smoke clouds, a point that will be touched upon more fully later, the addition of smoke



The Livens projector. The type shown is an 18 cm. German gun captured during the Second Battle of the Marne

to gas shell or the firing of smoke with gas shell will probably be the rule and not the exception.

Requirements for a successful gas.

If we succeed in finding a poisonous gas that has no odor it will be highly desirable to fire it so that it will not be visible. In that case no smoke will be used. Carbon monoxide is such a gas, but there are several very powerful reasons why it has not been used in war. First, its temperature of liquefaction at atmospheric pressure is 139° below

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0 Centigrade. This means too high a pressure in the bomb or shell at ordinary temperatures. In the second place the weight of carbon monoxide is slightly less than that of air, which keeps it from rolling into depressions, dugouts and trenches, as in the case of ordinary gases, and also permits of its rather quick rise and dissipation into the surrounding atmosphere. A third reason is its comparatively low toxic value, it being in that respect only about one-fifth as poisonous as phosgene. However, as it can be breathed without any discomfort, or indeed without any knowledge that it is being breathed, and as it has some delay action, its lack of poisonous qualities would not seriously militate against its use were it not for the other two reasons given.

These considerations in regard to carbon monoxide indicate the general requirements for a successful poison gas. If non-persistent it must be quickly volatilized, or must be capable of being driven off by heat or by other means which can be readily and safely produced in the field. It must be highly poisonous, producing deaths in high concentrations, and more or less serious injuries when taken into the system in quantities as small as one-tenth of that necessary to produce death. If it has a slight delay action with no intervening discomfort, it is still better than one that produces immediate discomfort and more or less immediate action. It must be readily compressed into a liquid and remain so at ordinary temperatures, with the pressure not much above twenty-five or thirty pounds per square inch.

As a persistent gas it must be effective in extremely low concentrations, in addition to having the other qualities mentioned above.

These general characteristics concerning gases apply whether used by the Chemical Warfare Service troops, the Artillery, the Air Service, or the Infantry. In speaking of these substances being used by the Infantry it is understood that ample Chemical Warfare Service officers will be present to insure that the gases may not be turned loose when weather conditions are such that the gas might drift back and become a menace to our own troops. This is absolutely essential since no troops who have as varied duties to perform as the infantry can be sufficiently trained in the technical side of chemical warfare to know when to put it off with safety.

Use of gas by artillery.

The artillery of the future will probably fire more gas than any other branch of the Army. There are two reasons for this, first, the large number of guns now accompanying every army, and second, the long range of many of these guns. As before indicated, the gases are adaptable to various uses, and hence to guns differing both in caliber and range. The gas will be fired by practically all guns—from the 75 millimeter to the very largest in use. It is even possible that if the guns smaller than the 75 millimeter become generally useful certain gases will be fired by them.

Efficiency of artillery gas shell.

It is well to remember in the beginning that all artillery shell so far designed and used, contain only about ten per cent by weight of gas. It is hoped that gas shell may be so designed later that a somewhat greater proportion of the total weight of the shell will be gas. This is very desirable for reasons of efficiency. The bombs used by C. W. S. troops contain nearly fifty per cent by weight of gas, and hence are nearly five times as efficient as artillery shell within the limit of range of these bombs. This fact alone is enough to warrant the use of gas troops to their full maximum capacity in order that the artillery may not be required to fire gas at the ranges covered by these troops.

Guns firing persistent and non-persistent gases.

Considering the firing of non-persistent and persistent gases, it may be said generally that persistent gases will be fired only by the medium calibers which are available in large numbers. In fact, the firing of non-persistent gases will be confined mainly to the 6-inch or 155-millimeter gun.

As our Army was organized in France, and as it is organized at present, the number of 155-millimeter guns will be greater than all others put together, except the 75-millimeters. In order that a non-persistent gas may be effective a high concentration must be built up very quickly. This necessitates the use of the largest caliber shell that are available in large numbers. Of course, a certain percentage of the gas shell of other calibers may consist of non-persistent gases in order to help out the 155-millimeter gun. This is in accordance with the present program for loading gas shell.

Few ideally persistent or non-persistent gases.

Naturally there will be very few gases that are ideally non-persistent or ideally persistent. The groups will merge into one another. Those on the border line will be arbitrarily assigned to one group or the other. It might be said definitely, however, that a gas which will linger more than six or eight hours under any conditions, except great cold, will not be considered non-persistent. For reasons of efficiency and economy persistent gases will not be chosen unless they will persist under ordinary conditions for two or three days or more. Accordingly, a gas which would persist for a day would have to be extraordinarily useful to lead to its adoption.

Firing non-persistent gases.

Of the non-persistent gases phosgene, a chemical compound of carbon monoxide and chlorine, is the one most used at present. Furthermore, so far as can now be foreseen, it will continue to be the non-persistent gas most used. It volatizes very quickly upon the bursting of the shell. Accordingly, in order that the shell fired at the beginning of a gas "shoot," as they are generally referred to in the field, shall still be effective when the last shell are fired, it is necessary that the whole number be fired within two to five minutes. The temperature and velocity of the wind both affect this. If it be in a dead calm, the time may be considerably extended; if in a considerable wind, it must be shortened. Another important consideration requiring the rapid firing of non-persistent gases is the fact that nearly all masks thoroughly protect against phosgene and similar gases. It is accordingly necessary to take the enemy unawares and gas him before he can adjust his mask; otherwise, practically no harm will result. From the considerations previously mentioned, these "gas shoots" are usually made at night when, as before stated, carelessness, sleepiness and the resulting confusion of battle conditions always insure more casualties than in the daytime.

Firing persistent gases.

The persistent gases will be fired by all caliber guns, but to a less extent by the 155-millimeter than the other calibers. Persistent gases must be sufficiently effective in low concentrations to act more or less alone. If it be desirable to fill an atmosphere over a given area with mustard gas, the firing may extend for two or three, or even five or six, hours and all shell still act together. The same is true of brombenzylcyanide, the tear gas. This, then, permits the minimum number of guns to be used in firing these persistent gases. Inasmuch as they persist and force the wear-

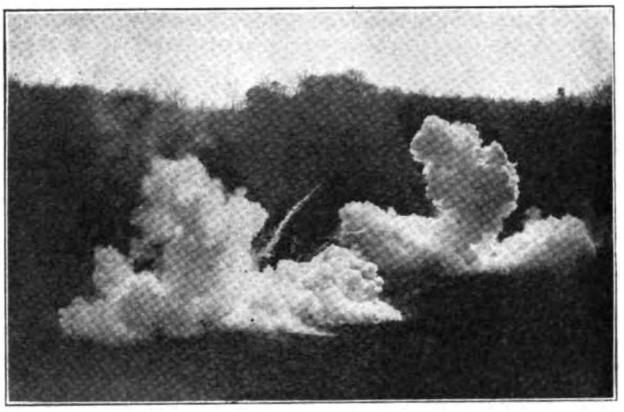
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ing of the mask, they are available for use in long-range, large caliber guns for interdiction firing on cross-roads, in villages, and on woods that afford hiding places, as well as other similar concentration points.

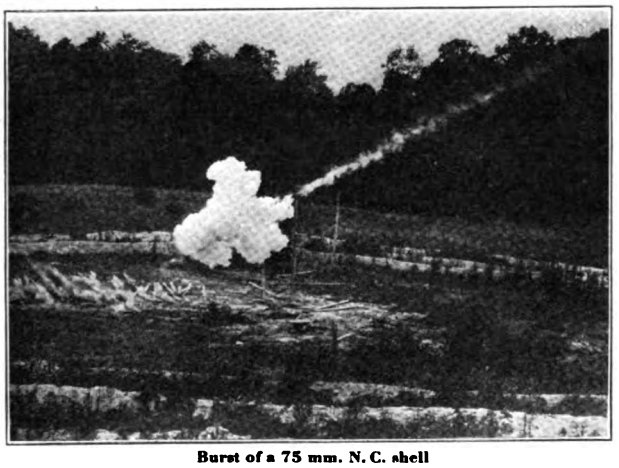
Firing irritant gases

The irritant gases will be fired by the various caliber guns in the same manner as the persistent and non-persistent gases. We will have non-persistent and persistent irritant gases. They are, however, considered as a group because they are used for harassing purposes, due to their efficiency in forcing the wearing of the mask.

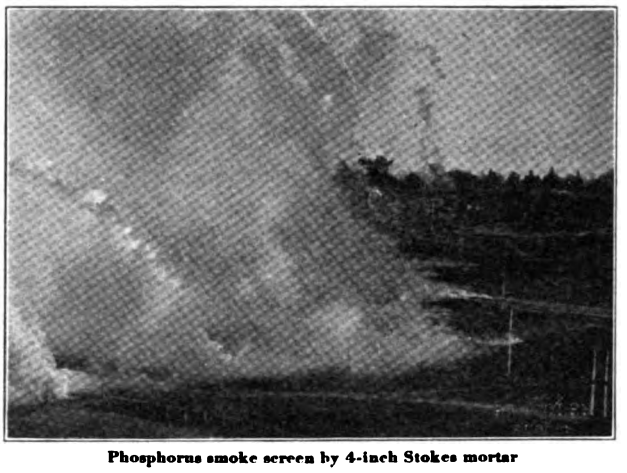
Before the signing of the armistice, the General Staff, A. E. F., had authorized, beginning January 1, 1919, the filling of 25 per cent of all shell with Chemical Warfare Service materials. The interpretation there given to shell was that it included both shrapnel and high explosive.



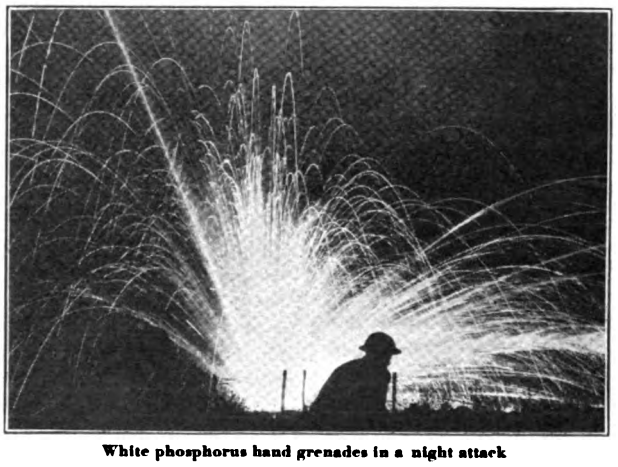
Burst of 4-inch Stokes mortar bomb filled with N. C. (20% gas and 80% smoke)



Burst of a 75 mm. N. C. shell



Phosphorus smoke screen by 4-inch Stokes mortar



White phosphorus hand grenades in a night attack

Of the field guns in use, the 75-millimeter will be best, up to the limit of its range, for persistent gas such as mustard gas, and the tear gas, brombenzyleyanide. A considerable number, however, were filled with non-persistent gases and will probably continue to be so, since, due to the very large number of 75 millimeter guns available, they can be used to add greatly at times to the amount of non-persistent gas that can be fired upon a given point.

Use of gas by the Air Service.

No gas was used by aeroplanes in the World War. Many rumors were spread during the latter part of the war to the effect that the Germans had dropped gas here or there from aeroplanes. Every such report reaching the Chemical Warfare Service Headquarters was run down and in every case was found to be incorrect. However, there was absolutely no reason for not so using gas, except that the German was afraid. In the early days of the use of gas he did not have enough gas, nor had he developed the use of aeroplanes to the point where it would have seemed advisable. When, however, he had the aeroplanes the war had not only begun to go against him, but he had become particularly fearful of gas and of aeroplane bombing.

It does not seem to be generally known, but it is a fact, that after three or four months' propaganda the enemy made a direct appeal to the Allies to stop the use of gas sometime during the month of March, 1918. This propaganda took the form of an appeal by a Professor of Chemistry who had access to Switzerland, to prevent the annihilation of the Allied forces by a German gas that was to make its appearance in 1918. This German professor claimed that, while wishing the Germans to win the war, he had too much human sympathy to desire to see the slaughter that would be caused by the use of the new gas. The Allies believed that this was simply an expression of fear and that the German had no such gas. The Germans were accordingly informed that the Allies would not then give up the use of gas. Later events proved these conclusions to be absolutely correct. The German evidently felt

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that the manufacturing possibilities of the Allies' gas would put them in a more predominant position with gas than with anything else. In that he was entirely correct.

The use of gas by aeroplanes will not differ from its use in artillery or by Chemical Warfare Service troops. Non-persistent gases may be dropped on the field of battle, upon concentration points, in rest areas, or other troop encampments to produce immediate casualties. Persistent gases will be dropped particularly around cross-roads, railroad yards, concentration points and encampments that can not be reached by the artillery.

The aviation gas bomb will be highly efficient inasmuch as it has to be only strong enough to withstand the low pressure of the gas and ordinary handling, whereas artillery shell must be strong enough to withstand the shock of discharge in the gun.

The use of C. W. S. materials by the Infantry.

The use of Chemical Warfare Service materials by the infantry will be limited to fool-proof and readily portable containers of gas.

It will be at once argued that the infantry is already overloaded. That is true, but in the future, as in the past, the infantryman will increase or decrease his load of a given material just as its efficiency warrants. If he finds that gas will get casualties and help him win victories more readily than an equal weight of any other material, he will carry gas. A study of the articles of equipment abandoned by 10,000 stragglers in the British Army picked up during the great German drive towards Amiens in March, 1918, illustrates this very clearly. As I recall, more than 6,000 stragglers had discarded their rifles. The helmets were thrown away to a somewhat less extent, but the gas mask had been thrown away by only 800 out of the 10,000. Now the gas mask is not a particularly easy thing to carry, nor was the English type comfortable to wear, but the English soldier had learned that in a gas attack he had no chance whatever of escape if his gas mask failed him. Accordingly, he hung on to the gas mask after he had discarded nearly everything else in his possession. The same thing will be true of any other gas equipment if it proves its worth.

Smoke and incendiary materials.

The use of smoke or incendiary materials is not dependent upon weather conditions to anything near the extent that gas is. Second, the smokes not being poisonous, are not a danger to our own troops, although they may hamper movements and add to the difficulty of taking a position if used improperly. Of the two classes of materials, smoke and incendiary, smoke materials may be said to be at least a thousand times as important as the incendiary materials. A material that will burst into flame when a shell is opened or that will scatter balls of burning fire appeals to the popular imagination, and yet actual results achieved by such materials on the field of battle have been almost nil. About the only results worth while achieved by incendiary materials have been in occasionally firing ammunition dumps and more frequently, setting fire to warehouses and other storage places. This will undoubtedly continue in the future.

Flame thrower.

Of the incendiary materials the least valuable is the flame thrower. It is mentioned to forestall the question. Even the German, who invented it and who, during the two years of trench warfare had full opportunity for developing its use, finally came to using it largely as a means of executing people that he did not want to shoot himself. Men falling in that class were equipped with flame throwers and sent over the top. The German knew, as did the Allies, that each man with a flame thrower became a target for every rifle and machine gun nearby. The flame thrower is very quickly exhausted when the one equipped with it has no means of offensive action, and in addition, is saddled with a heavy load hampering all movements, whether to escape or to advance.

Inflammable materials.

There will probably be some use for materials such as metallic sodium that will burst into flame and burn when exposed to the air, though white phosphorus is probably equal, and in most cases vastly superior, to anything else so far suggested. Phosphorus, while it burns with an unquenchable flame when exposed to the air, whether wet or dry, has comparatively little value as an incendiary material. It is, however, of great value for screening purposes, and for use against the enemy's troops. The German did not use phosphorus simply because he did not have it, just as he did not use helium in his observation balloons.

The value of phosphorus was just beginning to be realized when the Americans entered the war, while its full value was not appreciated even by the American troops when the war closed.

The work of the First Gas Regiment with phosphorus against machine gun nests proved how valuable it is. It proved also its tremendous value as a screen.

The Chemical Warfare Service was prepared to fill a great number of artillery shell with phosphorus, but due to the failure of our shell program, phosphorus was not used by American artillery to any appreciable extent.

Smoke used by everyone.

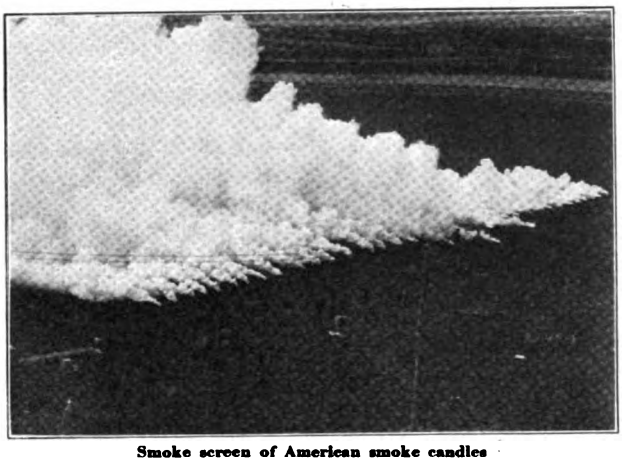
Smoke will be used by every fighting arm of the service in practically every battle, both by day and by night. Anyone who has tried to shoot at a target that was just beginning to be obscured by a fog, will recognize the difficulty of hitting anything by firing through an impenetrable smoke screen. It is simply shooting in the dark. Future battles will witness smoke formed by smoke candles that are kept at the trenches or carried by the troops, by smoke from bursting artillery shell and rifle grenades, from aeroplane bombs and possibly even from what is known as the smoke knapsack. This last is a very efficient apparatus, with two cylinders containing different substances which are brought together near the nozzle. It produces a very dense white smoke and very economically, but will probably not be much used. This is because, notwithstanding its efficiency, the knapsack can not be projected to a distance, that is, the smoke screen is generated on the person carrying the knapsack. On the other hand the great value of phosphorus is that it can be fired to considerable distances in rifle grenades or artillery shell, and dropped from aviation bombs. The smoke screen is thus established in front of the object it is desired to cut off, whether it be a battery of artillery, an advancing wave of infantry, or a lookout station. Thus smoke, for screening purposes alone, will be used to a tremendous extent. It will also be used in conjunction with gas.

Due to the smoky appearance of an ordinary gas cloud, no one on the field of battle in the future will ever be certain that any given smoke cloud is not also a poisonous cloud until he has actually tested it. And there lies an opportunity for the most intense study and for the greatest use of the proverbial American ingenuity that war has ever furnished.

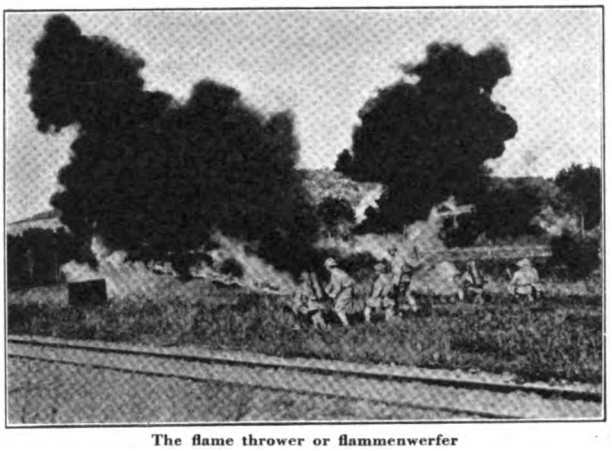
With the variations that can be played with smoke con-

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taining gas, or not containing gas, with smoke hurled long distances by the artillery or dropped from aeroplanes, the possibilities indeed are unlimited. Every officer will need to study the possibilities of smoke, both in its use against him and in his use of it against the enemy. He can probably save more casualties among his own troops by skilful use of the smoke than by any other one thing at his command. On the other hand, the unskilful use of the smoke on the part of one side in a battle may lead to very great casualties in proportion to those of the enemy.



Smoke screen of American smoke candles



The flame thrower or flammenwerfer

Protection by smoke

Smoke in the future will be the greatest protective device available to the soldier. It shuts out not only the view in daylight, but the searching of ground at night by searchlights, by star bombs or other means for illuminating the battlefield. It has already been used extensively by the Navy and undoubtedly will be used far more extensively in the future.

Too much secrecy

It is realized that some of these facts have not been given much publicity. In saying this we are not unmindful that all probable enemies of the next score of years know these things very likely as well as we do. We believe that too great attempts at secrecy only hamper our own movements and do not deceive the enemy, and hence the Chemical Warfare Service is adopting the policy of letting the Army know what it can do, what it proposes to do in the future, and the lines of development along which it is working. We are giving great attention to the subject of smoke and will continue, believing that smoke materials will in the future be of equal importance with either of the two great tactical groups of gases.

Simplicity.

Simplicity should be the keynote in all military paraphernalia and operations. Gas is effective almost in direct proportion to the quantities used. By keeping the bombs, the gas, the shells, or other containers of gas, of as simple construction as possible and with as simple rules for use as are efficient, we will get the quantities that mean success. And this brings up the subject of marking of shells.

Shell markings

Modern artillery shell have distinctive colors for high explosive, for shrapnel, for incendiary materials, and for gases. A grayish color has been adopted as the general color of the paint on all gas shells, bombs and cylinders. In addition, a system of colored bands has been adopted. These bands are white to indicate poisonous non-persistent substances, and red, persistent. Yellow is used to indicate smoke. With any given combination of red and white and yellow bands, the artilleryman at the front can tell, at a glance, whether the gas is non-persistent or whether it is persistent, and also whether or not it contains smoke. There will be secondary markings on each shell which, to the trained Chemical Warfare Service officer, will indicate the particular gas or gases in the shell. These markings, however, will be inconspicuous and no attempt will be made to give the information to the soldier or even to the average officer firing gas.

These secondary markings are for the purpose of enabling the Chemical Warfare Service officers in charge to use certain gases for particular uses in those comparatively rare cases when sufficient gas is on hand and sufficient time available to enable such a choice to be made.

Conclusion.

Simplicity of machinery and materials used at the front is worth the study of every man having to do with military operations, whether in research, design, manufacturing or the actual handling of troops. No soldier under the stress and noise of modern battle can be expected to keep in mind more than two or three basic principles, and any attempt to get him to do otherwise will simply lead to confusion and inefficiency.

Platinum Reserve.—In response to a request from the Assistant Secretary of War for an expression of the attitude of the Ordnance Department in the matter of maintaining a platinum reserve, he has been advised that after a thorough study of the conditions in this country covering the reserve from which platinum can be obtained in times of emergency and the needs of the War Department, a reservation of 25,000 ounces of platinum has been authorized. This reserve is to be stored in the New York Assay Office, subject to call by the proper officers of the War Department. Approximately 20,000 ounces of this reserve at the time of the signing of the armistice was in the form of "contact mass," but in order to properly safeguard this material the mass has been or is being treated for the recovery of the metallic platinum for transfer, as stated above, to the New York Assay Office. This has been effected at a very moderate cost.

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Methods of Placing Concrete Under Water

In early subaqueous concrete work, the concrete was deposited directly under the water by means of a box with a movable bottom, or placed in bags. Of late years three other methods have been used: The tensile or spout system, the ram system and the gravity flow system—the last two were employed on work on the Lachine Canal, New Montreal, Canada. The tremie system has been used on the Detroit tunnel and other work in America.

Ram System.—The ram system is the name given to first method used in the relining work on the canal, but it was used only on thin walls, or where the narrow space between the back wall and the face mold or form might cause the concrete to jam and thus prevent its flow. In wider spaces the gravity flow system was adopted.

The slope walls of the canal had to be rebuilt or faced, without interfering with navigation. A system of large wooden molds, 100 feet by 22 feet, and secured at from 1½ to 2 feet from the slope walls was adopted. The mixing plant, which was operated on scows, was provided with a movable oblique arm, at the end of which was built an iron box, with movable top and bottom. This arm, called the ram, carried the concrete down, and at the required depth the box was opened by a steel cable and the concrete deposited. At times the ram was not operated, but kept near the top and used as a chute, the concrete being deposited in such a manner that it took a natural slope and pushed itself forward.

Gravity Flow System.—Figure 1 is an illustration of the gravity flow method. The concrete is confined both back and front by molds, or by a mold and a previously built wall or embankment, and at the starting end by a bulkhead.

Work is started in one corner, the position of the mixer being indicated by the letter A in the diagram. The various deposits of concrete take a decided shape as indicated by the numerals 1, 2, 3, 4. After the point 4 is reached the concrete is dumped on the top and pushed forward with little effort, by men with light wooden scrapers or a tool in the form of a rake. It then flows down to take the position indicated by 5A, which represents the last material placed by the mixer at A, before it is moved forward to its second position at B—and so on.

This method has been used to build a wall, 9 feet wide at the bottom, 4 feet at the top and 18 feet deep, the structure being in water 17 feet deep, flowing at 6 or 7 miles per hour. There is nothing difficult about it, everything depending upon the quality of the concrete, and careful supervision.

The chief advantage of this method lies in the fact that the concrete flows forward in one direction with its narrowest face for the wash surface; this face is the oblique cross-section shown by the plane of the angle of repose.

Methods Employed on Lachine Dam.—Figure 2 is a sketch of the method of carrying out the underwater reconstruction of the Lachine Dam, in which the "gravity flow method" was employed. The original dam was built of cribwork and filled with heavy stone, but the repeated action of the ice flows and natural water made it quite unstable. With a head of about 1 foot there was a flow of water through the dam, portions of which were undermined. The main difficulty was to secure the big 100-foot molds in place, and to stop this flow; it was also necessary to control the current formed by the inward flow of the water toward the mouth of the canal.

Figure 2 shows a big mold in place, held by inner and outer steel cables, with posts as struts; this method was also used during the construction of some of the 5 miles of walls previously built.

Before the molds were placed a dredge cleaned out the site, and the foundation was further dredged out, partially by machine and finally by the divers. Upstream and downstream bulkheads were used as illustrated in Figure 1. In several places there was difficulty in stopping the flow of water through the timbers of the dam. Sheets of 11 ounce canvas, 24 feet wide, sewed up in lengths of about 60 feet, were placed against the face of the old dam and secured at the top and bottom; in this manner the water was made quite still, and when the concrete was being placed no cement was washed through. No difficulty was experienced in holding the molds, and no slides occurred. As a rule these dangers lie in bringing the concrete too high on the first day's work. It is well to fill only part way and permit this to set, at least over night, before continuing.

When once a sufficient length is finished, such a section, A in Figure 1, and set hard, the concreting can proceed continuously and will flow forward without any trouble.

Precautions in Subaqueous Concrete Work.—In laying concrete under water the points to be noted are:

The stiffness and rigidity of the forms and the bracing of same; cracks in the molds will cause wash lines.

If working in a current begin at the downstream end and block the upper end of a bulkhead to prevent any wash of the water.

Do not commence operations too soon in the year when the water is ice cold, or continue too late in the fall, for the same reason.

Don't remove the molds too early; although in favorable conditions and with good concrete, five days is often not too soon. Take longer time if vessels are apt to bump against the work shortly after completion.

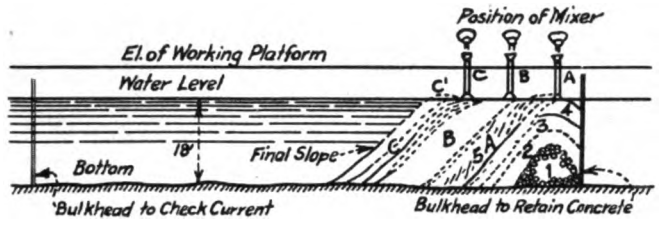
All materials should be the best of their kind. A good quick setting cement should be selected, but only after it has stood satisfactory setting tests in the coldest temperature at which it is going to be used.

A mechanical batch mixer is necessary on all work of this kind, as a constant flow of concrete should be kept up. The concrete should first be emptied into a receiver placed below the mixer from which it can be allowed to flow, as required—the flow being regulated by an automatic gate. A drum mixer is preferable, and each batch of concrete should be turned for at least two minutes at the regular speed of the drum before it is deposited into the receiver. From 180 to 200 cubic yards in 10 hours may be considered a maximum day's work.

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Unless the molds are secured very solidly and their stability is beyond doubt, the depth of any one layer of concrete should not be over 10 or 15 feet, although it is always best to come up to water level.

Continuous mixers with automatic measuring devices have no place on an underwater concrete job. Every batch must be up to the standard and be able to stand the inspection of



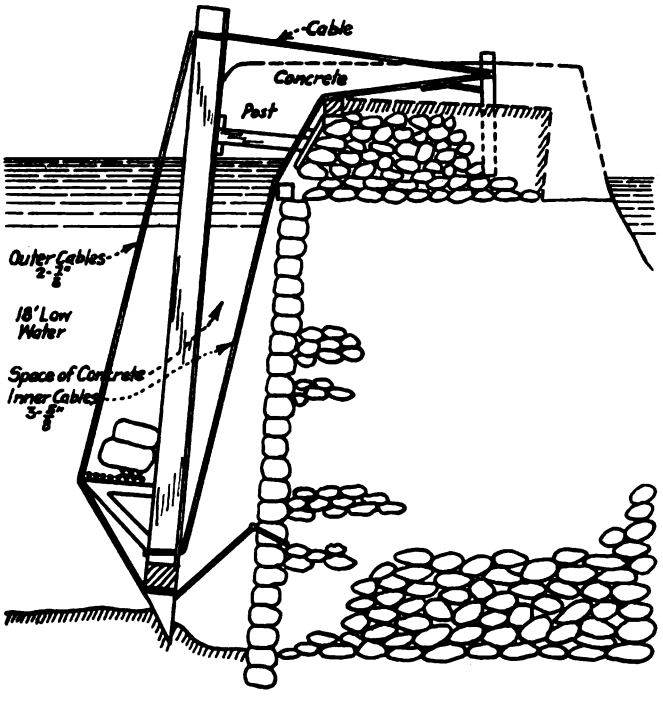


Fig. 1 (upper); Fig. 2 (lower).

an experienced man who can readily detect an off-mix by its color and consistency.

The proportions of cement, sand, and ballast should be within the limits of a 1 to 2 or 2½ of cement and sand, to 5 parts of stone.

The mix should be what is called putty, and care must be taken to insure sufficient water.

On most underwater work it is necessary to have a good diver with capable assistants and an efficient diving outfit.

Subaqueous or underwater concrete is as easy and as sure as any work done in the dry, but it requires, as in all engineering work, care, more care, and still more care. Without that, it will fail.—*Eng. and Cont.*

Another Champion of the Field Lithograph Equipment

It was with some concern that I read the array of heavyweight opinion against the continuance of the lithograph set in the Engineer Regimental equipment expressed in the article and its discussions published in the January-February issue under the title, "Engineer Duties in the Field." Colonel Boggs' defense of this equipment in the March-April number encourages me to step forward as one of its champions.

Throughout the service of the 318th Engineers, 6th Division, in France and in Germany, the topographical section was at all times a busy and useful unit. It contained expert draftsmen and lithographers. At no time did the G2 section at Division Headquarters have either. The work there produced always made that fact evident.

Particularly during the winter of 1918-19 did this equipment justify itself by permitting a task, otherwise difficult, to be performed with ease and with credit. The condition of the roads made it necessary to work the engineer regiment and some 2,000 other troops of the division on their repair. It became evident at the start that work was only one-half the game and that traffic regulation was its complement. To appeal to G1 to properly instruct his M. P.'s and to request G2 to prepare maps would hardly have made the Division Engineer popular.

A map prepared by the topographical section, showing the condition of all roads in the area, clearly indicating by heavy lines those fit for motor-truck traffic and by arrows the proper routing of that traffic, and bearing a legend containing traffic rules, was submitted to the Division Commander with recommendations that it be issued to all motor-truck drivers and chauffeurs and to all M. P.'s. A presentable map, produced in quantity, giving graphically orders that even an M. P. could understand, was gratifyingly acceptable to G1. Its issue was ordered. The results in improving road conditions were immediate. It actually oriented the M. P.'s and transferred truck drivers, never properly provided with maps from the "lost" to the "found" column. Its general usefulness as an area map caused frequent requests to come from various regimental headquarters for additional copies. Thus the Division Engineer actually controlled traffic (though no one knew it, and he kept it a secret, lest that satisfying equilibrium of staff perfection be disturbed).

Similar maps covering two different areas in Germany were issued later with the same real results.

G1 was gratified.

G-3 early became discouraged with the hectograph prints produced by the G-2 section. The Engineer topographic section produced contour maneuver maps of creditable appearance in sufficient quantity to cause a rare and encouraging diffusion of intelligence.

G-3 beamed and became our friend.

Reports were often demanded for which proper forms were not available. The lithograph outfit provided our own needs and occasionally the needs of others, bringing that credit in their submission that other processes failed to secure.

For the divisional horseshow and football games, artistic posters in three and four colors were produced. These were placed in all the towns and on all motor trucks, advertising the event and indirectly the Engineer regiment.

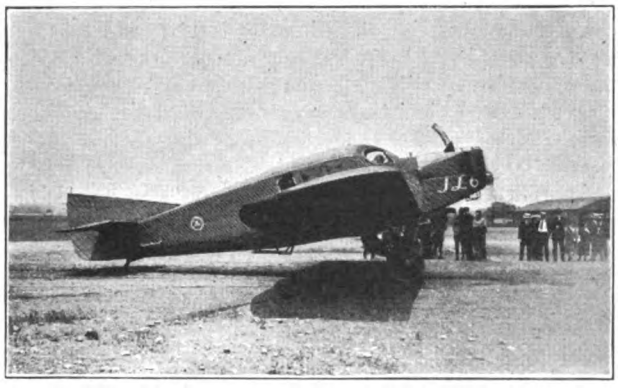
Later the Corps Commander made a personal request that a similar poster be designed and printed by the 318th Engineers for the corps horseshow. In a corps of four divisions the lithographic equipment normally furnished the engineer regiment was the best means of printing that a corps commander had at his call.

Before the war this equipment in the field was considered essential. Since that time our means of transport have greatly improved. During the last war the G-2 section of a division did not have equal equipment or the personnel to properly use it. And yet when a motor truck instead of an escort wagon provides a generous corner for an equipment really not very large, and after having suffered two long years from an overdose of illegible mimeographs and blurred hectographs, its abandonment is considered.

Trabajemos! Let us not willingly reduce our field of usefulness.—C. P. Gross, Captain, Corps of Engineers.

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All-metal aeroplane.—The J. Larsen all-metal monoplane is a new departure in aircraft construction. It is both fire and weather proof and carries four passengers in addition to crew of two. The wings and fuselage are of "duralumi-



num," an alloy. The wings are cantilevered from the fuselage, having no external struts or braces. Each wing contains a gas tank of 35 gallons capacity. This is a step forward in standardization. The machine will be developed in various sizes, both as an aeroplane and hydroplane.

On June 12 Army officers took part in a test of two of these machines, with the inventor, J. Larsen. The flight was from Bolling Field, Washington, to Prospect Park, Long Island, about 250 miles. During the flights the passengers changed seats at will, ate lunch and wrote letters.

Handbook for the automatic rifle.—The handbook for the automatic rifle was prepared at the Infantry School, Camp Benning, Georgia. This handbook covers only description, mechanism, nomenclature, operation and care of the Browning Automatic Rifle. The manuscript was referred to The Adjutant General of the Army for printing.

The Infantry School, Camp Benning, Georgia, is also at present at work on another manual entitled "Automatic Rifle Marksmanship." This will cover the technique and training methods of shooting with the automatic rifle and will be for the automatic rifle what the "Small Arms Firing Manual" was for the rifle. It is expected that this manuscript will be received by the General Staff for consideration in about three weeks.

It is contemplated that the tactical handling of the automatic rifle will be considered in conjunction with the next revision of the Infantry Drill Regulations, which revision, however, is not contemplated until the lessons of the World War have been thoroughly studied and digested.

From an article in the *Proceedings of the U. S. Naval Institute,* by Rear Admiral Fiske, we cull the following gems of thought.

Not until the great war was the advisability of utilizing the inventor in war recognized. It had been feared, and with reason, that we might trust too much to invention, and too little to adequate preparation.

Inventions are not limited to mechanical appliances. Every great idea is an invention, every plan with which a resourceful man meets an emergency is an invention.

The most important inventions were the weapons with which primitive man conquered nature, for thus alone was man able to progress along the pathway of civilization.

Each of the victories of Alexander, Cæsar, Napoleon, was a display of inventive genius of the highest order.

Civilization was created and has progressed by invention. The most important single agency in maintaining civilization has been war. By war the wild beasts were conquered, by war the barbarians who sought to destroy civilization were held in check; and by war these forces of barbarism must continually be held in check now and henceforth.

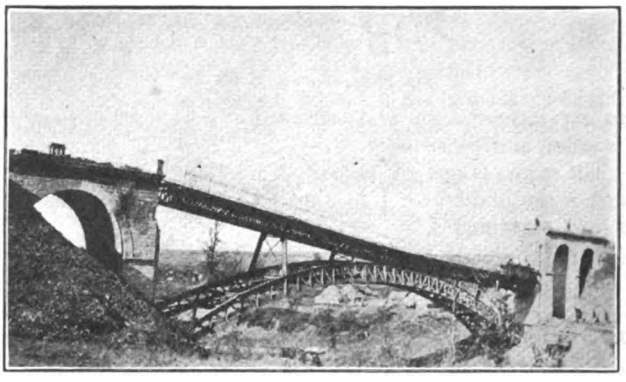
The other agencies of civilization, religion, morality, industry, etc., have likewise progressed by invention.

Accordingly, invention and war are the most important constructive forces of civilization.

The average mind cannot have a thorough grasp of details and general principles at the same time. A different mentality is required for each. The man who showed the greatest capacity for both was Napoleon.

New small-arms projectiles.—In an endeavor to design a small-arms ammunition for machine-gun use which would give an effective range of 3,500 meters, a large number of different types have been tested at Miami and Daytona by the Small Arms Ballistic Station. One type, on which the greatest amount of firing has been done is a caliber .30 boat-tail bullet. Tests have been made with this type of bullet at velocities of 2,400, 2,500 and 2,600 feet per second. The bullet with 2,600 foot-muzzle velocity gives an extremely long range, possible in excess of 4,500 meters. It has been tested to 4,300. This bullet has a slightly flatter trajectory than the regular service bullet up to 1,000 yards, and the trajectory is much flatter than the service bullet at ranges beyond that. This can all be considered to be in the experimental state, as no decision has been reached to adopt any of the various types of ammunition being tested.

The steel arch bridge carrying the narrow-gauge railway over the ravine near Flirey, France, in the St. Mihiel Sector. It was designed by the French in 1914 by cutting



the arch rings and truss near the north abutment. The span of this bridge was 64 meters.

Canadian Power Co. to build hydro-electric plant.—The Bridge River Power Co., Ltd., of Vancouver, B. C., is to develop hydro-electric power at the Bridge River power site. A total of 400,000 continuous hp. will be available when the site is fully developed and power in blocks of from 5,000 kw. up will be available within two years' time. Power will be sold as low as $16 per hp. year, depending on whether the plant consuming the power is located at the power house or at a distance, also on the power and load factors.

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Summer Camp of Instruction for the Engineer Reserve Officers' Training Corps

at Camp Humphreys, Virginia

By

W. D. Styer

Captain, Corps of Engineers

[*Note.*—We present with great pleasure Capt. Styer's entertaining article on the summer instruction camp of the R. O. T. C., because we believe that it is of great interest, not alone to engineering students in every college or university in our land, but also to the faculties of those institutions, and to the engineering profession at large. This first camp of 1920 promises to be an epoch making event. It promises to fill one of the great needs of the profession, to-wit: more *practical outdoor* instruction in engineering for the undergraduates of technical colleges. Its vast possibilities of usefulness as a means of promoting the national defense are well set forth by the author and will be appreciated by every patriotic engineer.

But from a purely civil point of view these camps will justify themselves, and should have the support and co-operation of the colleges and of the engineering profession. In the first place, viewed merely as a refreshing and generally beneficial summer outing, the camp was a great success. It was thoroughly enjoyed by all the participants, and it is believed that all of them will wish to come again, and that every young man who hears of it will wish to attend future camps. Men of wealth spend millions of dollars to send their sons to summer camps. Here is a camp, providing facilities far better than private capital can furnish, which all boys of the right kind may attend without cost. The camp will be popular, and that is the first condition precedent to its success. It combines in the most effective manner the delights of a summer outing in the country with the benefits of practical instruction in engineering.

The disciplinary training, wisely and tactfully applied, will be of incalculable benefit to these young men in all all their future careers, whether purely the careers of peace, or whether including service to their country in case of war.

The possibilities of usefulness of the R. O. T. C. camp are almost unlimited. It is hoped that the scheme may grow and expand until every engineering undergraduate in America may attend one or more of these summer outings, which will promote his physical health and vigor, bring him in contact with a lot of fine, clean young men from all parts of the country, give him useful practical instruction in his chosen profession, make him a better and more useful citizen in time of peace and a better defender of his country in case of war.—Ed.]

IN these days, when nations at war put forth their entire strength in the conflict, there is only one effective scheme of national preparedness, which is involved in the conception of "a nation in arms." This scheme contemplates a regular army of moderate size and a trained reserve of officers and men in civil life, available in case of emergency. To provide a trained reserve of men universal military training is necessary. This we have not, and so, in the next war as in all previous wars, we will take the field with green troops, who will suffer for the nation's neglect.

Universal training alone, however, would not supply the officers necessary to command our troops, for which additional measures are required. As the number of officers is small compared to the number of men (about 1 to 20), the problem of training officers, while more difficult, is of smaller proportions.

Our existing laws provide two means of obtaining at least a few of the officers that would be needed. One of these is the Officers' Reserve Corps, with which all readers of this journal are familiar. The other is the Reserve Officers' Training Corps. The latter is nothing more than an effort to systematize, control and turn to the national advantage the military training now given to students at many educational institutions. In such colleges as desire it the government establishes a military course, with army officers and noncommissioned officers detailed as instructors. Units are organized amongst the students corresponding to the various arms of the service. At a number of engineering colleges engineer units have been establishd.

The chief disadvantage of this training, or the greatest difficulty under which it labors, is that, because of the limited time and facilities available, the instruction, with the exception of infantry drill, is too largely theoretical and too little practical. This is especially true of engineering instruction. The average engineering college has very inadequate facilities for practical instruction in engineering. This is a great disadvantage inasmuch as engineering, both civil and military, is a practical profession. The average engineering graduate, lacking proper practical instruction, can hardly be said to be an engineer. He does not become such until he has gained experience, and his early experiences are often so narrow and one-sided that it may be many years before he becomes a competent, practical, all-around engineer, in whatever field he enters.

The Reserve Officers' Training Corps, with the co-operation and support of the college authorities, can go far in remedying this deficiency. It has been frequently pointed out, and will be fully realized by everyone who took part in the late war, that the practical problems of civil and military engineering are not essentially different in their nature. Training or experience in either fits the engineer for both. The problems of the military engineer are the same as those of the civil engineer, except that they are encountered under more trying conditions, and therefore demand more initiative and resourcefulness.

The "applicatory system" of instruction, which means the actual solution of carefully prepared practical problems, has long been utilized in military training, but it is quite as applicable to any other practical calling.

In order to supplement the theoretical instruction at colleges with practical work, training camps for the R.O.T.C. are to be held each summer. Here the students from various institutions are assembled on a government reservation where the conditions, including available instructors, terrain, plant and equipment are far better than they can possibly be at any college. The practical instruction at the camp vitalizes the theoretical instruction at the college by giving the student a training which will be quite as valuable in his

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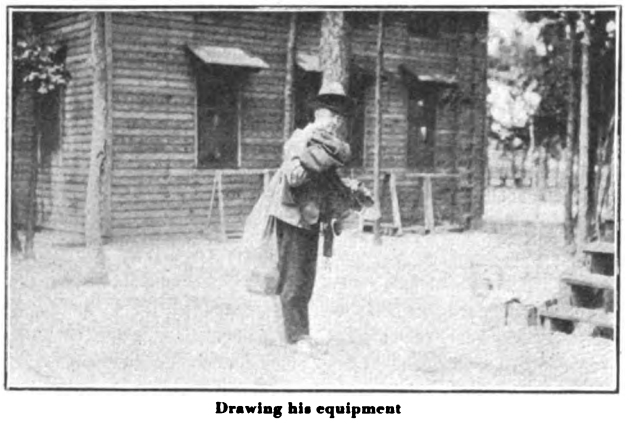
future civil industrial career as it would be should he be called upon to lead the armed forces of the nation in the event of war.

The value of such practical instruction during summer vacation periods has been long recognized by engineering colleges, but their facilities and resources do not enable them to provide a course at all comparable to that which the resources of the Federal Government can provide. Such instruction has been too often limited to surveying and visits to industrial plants or engineering works, etc.

The engineer units of the Reserve Officers' Training Corps were assembled this year at Camp A. A. Humphreys, Virginia, for six weeks of summer camp instruction. This camp site is located at the Engineer School, U. S. Army, on Belvoir Peninsula, about 15 miles south of Washington, D. C., and presents a particularly suitable location for a camp of this kind, due to the excellent facilities it offers for training in practically every phase of civil and military engineering.

The students undergoing instruction numbered about 230 and represented the following educational institutions throughout the country:

Alabama Polytechnic Institute, University of Alabama, Colorado School of Mines, University of Illinois, Iowa State College, Massachusetts Institute of Technology, Missouri School of Mines, State University of Iowa, Oregon Agricultural College, University of Tennessee, California Institute of Technology, Virginia Military Institute, Virginia Polytechnic Institute, University of West Virginia and Yale University.



Drawing his equipment

Upon reporting, students were assigned to companies according to the number of years of military training with which each was credited. "A" Company, the senior company, is composed of men who have had three years of military training; "B" Company, of those who have had two years, and "C" Company, those who have had but one year.

Attendance at this camp is entirely voluntary, and it was fully realized that if it was to accomplish its purpose it must be made interesting and pleasant to the students. It should be such that every boy who attends camp will wish to come again, and all of his friends to whom he tells his experiences will also wish to come. The government possesses ample machinery with which to accomplish this purpose, and no millionaire's summer camp for boys can offer anything approaching the facilities which are provided free of charge at Camp Humphreys. The camp is situated on the water, where every form of water sport may be enjoyed. There is a large theater where lectures, moving pictures and other entertainments are provided. Excellent reading rooms are available, with a "canteen" where refreshments are obtainable. There is an excellent dance hall, and Washington is able and willing to furnish all the young ladies required to make social functions a great success. There are stables with plenty of animals for those desiring to ride. Hospital facilities are provided with medical officers in attendance.

Every effort has been made to make the living conditions of the students at camp healthful, attractive and comfortable. Messing arrangements are handled by hired cooks and waiters, and each company has an excellent mess. A minimum amount of fatigue duty is required of the students in order that a maximum amount of time may be devoted to instruction and healthful recreation. Facilities are provided and time is set aside for athletics, recreation and amusements. Drills end promptly at 4 p. m. daily, except two days a week when parade is held. No night study is required. Week-end passes are granted from immediately after inspection on Saturday morning until 9 p. m. Sunday. Baseball teams have been organized and games have been played with visiting teams; boxing, wrestling, tennis, swimming, boating, fishing, horseback riding, massed games, etc., are encouraged and provided for. Recreation rooms, reading rooms, writing material, a lunch counter and canteen, etc., are at the disposal of the students. Dances are held every Friday evening, and moving picture entertainments are given nightly. The students organized a jazz orchestra and a vaudeville troop which have given entertainments. Students are encouraged during their week-ends to avail themselves of the opportunity to visit the points of interest in the Nation's Capital and vicinity, and means are provided to transport the men to and from camp.

The students began reporting on June 17, and the period from June 17 to 20 was devoted entirely to assigning, organizing, providing uniforms and equipment, examining and inoculating the men, so as to have nothing interfere with the instruction proper, which began on Monday, June 21.

The first week of instruction was a practical review of the R. O. T. C. course and a test, which included the subjects of infantry drill physical training, bayonet fighting, manual of courts-martial, administration, preliminary target practice, rigging, knots and lashings, spar and trestle bridges, preliminary ponton bridge work, demolition, first aid, defense against gas, fortification, etc., and was practically the same for both the advanced and the basic groups. These subjects were arranged in the first week so that the students would progress by degrees to the work demanding more strenuous physical exertion which was to follow in the succeeding weeks. During this period the material for student officers and noncommissioned officers was selected, and the companies were organized into platoons. In this organization into platoons an attempt was made to average up each platoon, the purpose being that in each platoon and in each squad there would be several trained men to set an example for those who were more backward.

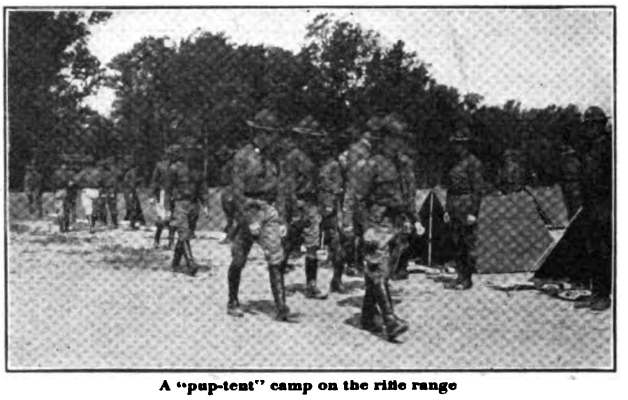
During the second and third weeks quite a radical change was made in the method of instruction, particularly as applied to the advanced group, "A" Company. These men had already had three years of military training and were mostly juniors and seniors in college. Their course of instruction was therefore enlarged and advanced, and consisted in the solution of practical problems which had been drawn up with the idea of instructing these men in the role of the military engineer and at the same time giving them practical instruction which will be of value to them in their preparation for careers in civil life.

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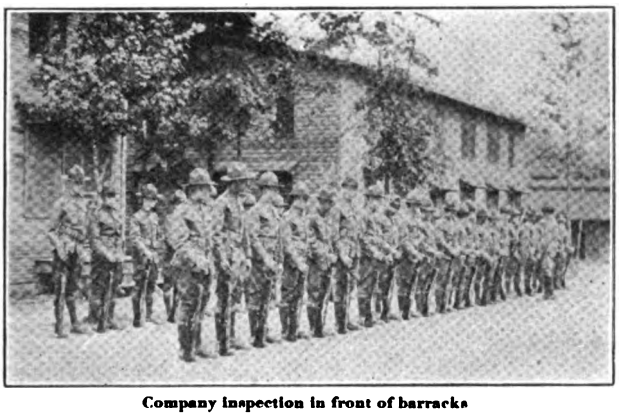
In accordance with the above plan the students of "A" Company were divided into groups as nearly as possible according to the course in engineering which each was pursuing in college. A list of the practical problems (covering the fields of civil, mechanical and electrical engineering, etc.) to be given was also presented to the students, and they were allowed to express their preferences as to which problems they desired to take. One group was detailed by roster to act as noncommissioned officers with the two basic companies; the other groups were sent in rotation to solve the various problems.



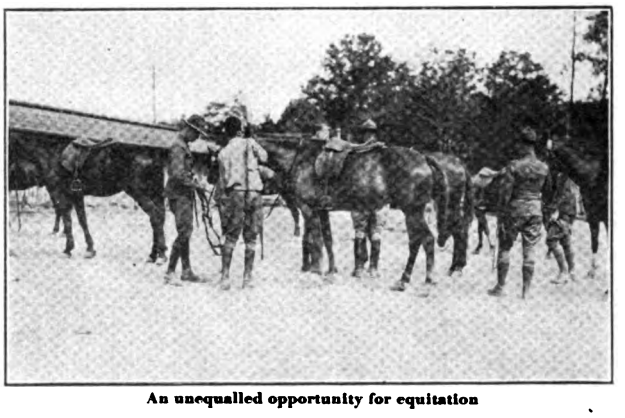
Most of the time the men lived in comfortable barracks



A "pup-tent" camp on the rifle range



Company inspection in front of barracks



An unequalled opportunity for equitation

Each problem is designed with a view to placing responsibility directly upon the student; to developing in him the ability to reason logically and come to a quick decision; to developing his initiative and resourcefulness, and acquainting him with some of the problems which confront both the military engineer and the engineer in civil life. The problems were all based upon assumed military situations and covered the following subjects: Location, design and construction of military bridges; location and construction of military railways (both light and standard gauge); sewerage and sewage disposal; camp water supply; hydrographic surveying; electrical and mechanical installations; military mining; military roads; military demolitions; field fortification; tactical problems, etc. Several problems were prepared under each heading. Some of these problems were based on those given at the Engineer School; others upon actual engineering problems which confronted engineers in the location and construction of the present camp. Each problem was handled by a selected instructor who had previous practical experience in the subject treated in the problem. The groups solving the problems ranged from about 8 to 25 men, thus permitting close supervision and individual instruction. The problems were solved on the ground after personal reconnaissance and inspection by the students, and as much practical work as time permitted was



Even the "kitchen police" enjoyed their work

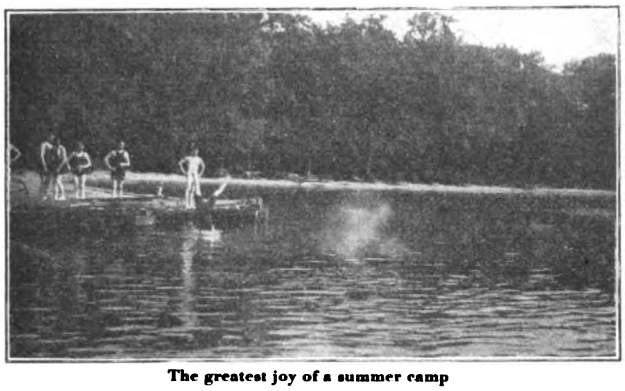


Every form of sport may be indulged in

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actually done in the field. The students have shown keen interest in this kind of work, and the results have been very satisfactory. Qualified students of "B" Company were given an opportunity to engage in this work during the last week of camp.

The fourth week was spent in shelter tent camp at the rifle range in small arms firing. The march from Camp



The greatest joy of a summer camp

Humphreys to the rifle range on July 12 was used for a maneuver problem. On arrival at the camp site on Pohick Bay the student battalion pitched camp immediately so that instruction practice with the rifle could begin at 1 p. m. the same day.

The site selected for the camp was a cleared field on a



"On with the dance"
A gay social event in the beautiful ballroom of the "Hostess House"

small peninsula projecting into Pohick Bay. Ponton boats were ferried from Belvoir to the camp by one of the companies. The boats were used for instruction in ponton bridging and for the construction of bathing piers. During the week at this camp the students lived under field-service conditions, performing all of the duties incident thereto except cooking meals.

Instruction during this period was devoted primarily to the rifle and pistol; but, taking advantage of the excellent opportunities afforded, instruction was also given in camp administration, sanitation and supply, care and handling of troops in the field, minor tactics including night maneuvers, ponton bridging and ferrying, swimming, etc. Rifle practice began on the afternoon of the first day and consisted of instruction firing at 200 and 500 yards, standing, sitting and prone.

The record firing followed, and included:

200 yards, prone, slow fire "A" target.
200 yards, sitting, rapid fire "B" target.
500 yards, prone, slow fire "B" target.

During the course every effort was made to provide a maximum of individual instruction at the firing point. A coach and a scorer were provided for each man firing. The coaching at first was done by commissioned officers and master engineers, but as fast as good student shots were discovered or developed they were given additional instruction and utilized as coaches. The results obtained in the



The ponton bridge is the most interesting of the military engineer's works

rifle firing were very satisfactory considering the brief time allowed and the fact that a large number of the men had never fired a rifle before.

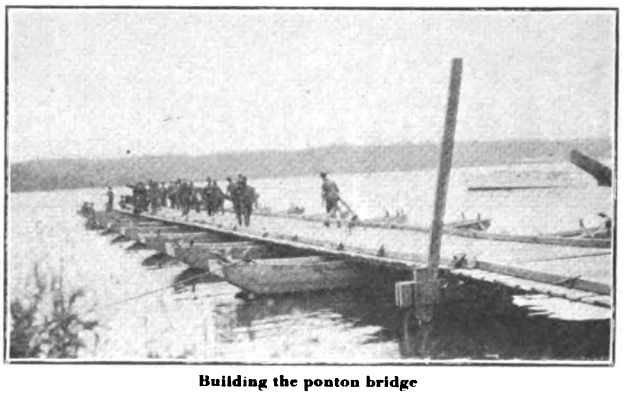
The final record was as follows:

Total number firing, 217.

Total qualified riflemen, 57 per cent, including 6 expert riflemen.

Sharpshooters, 51.

Marksmen, 67.



Building the ponton bridge

The fifth and final week of instruction was spent at Camp Humphreys and included two days of field exercises in which all companies took part. These exercises form part of the course in minor tactics and aim to give instruction in troop leading of units to include the company, through the various phases of combat. The last three days of this week were devoted to engineer troop problems designed to give practical instruction in the handling of engineer troops on various work in the field. This includes reconnaissance, planning of work, location, procurement and distribution of material, issue of tools and equipment, organization of labor and the actual construction of the work under service conditions.

The course outlined was followed with no change, and the results accomplished have been quite gratifying. Provision was made for indoor drills in case of inclement weather, but fortunately there were few rainy days.

The drills had sufficient variety to keep the interest of the students at a high pitch throughout the course. The work of the instructors was very interesting, and the stu-

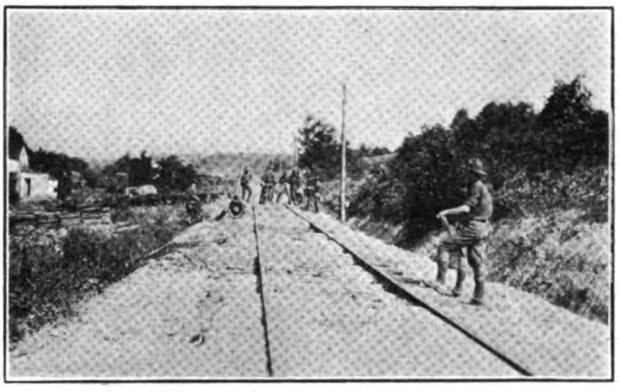
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dents responded to the instruction in a very gratifying manner.

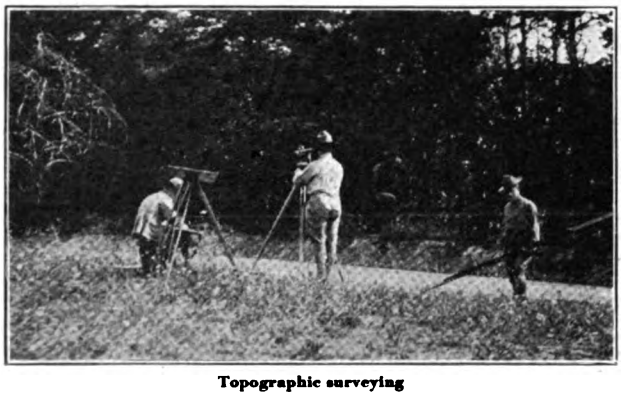
The course of instruction for the camp was planned and arranged with the following objects in view: To make the course interesting as well as instructive; to cover a maximum amount of practical work, leaving the bulk of the theoretical instruction to be covered at the institutions; to give instruction in phases of engineer work which, due to lack of proper facilities cannot be handled at the institutions; to instill in each student a high sense of discipline; to develop qualities of leadership, initiative and resourcefulness by placing the maximum amount of responsibility upon the individual; to teach the students to be instructors, and to give practical instruction in the problems of the military engineer, the solution of which will be of value to the student in his preparation for his future career in his chosen field of engineering.



A hasty trestle bridge, 150 feet long, built by one company in 4 hours



A railroad survey party



Topographic surveying



A task for both civil and mechanical engineers



Railroad survey, the transit party



The army sketching board

It is impracticable within the limits of this article to give more than a general summary of the course of instruction. It consisted in general of (1) lectures; (2) drills; (3) practical problems in civil and military engineering, solved in the field. The drills included the following:

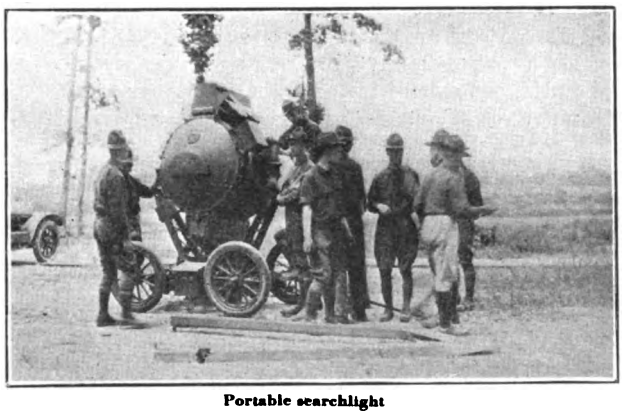
Infantry drill, physical exercises and games, bayonet training, first aid and gas defense, swimming, equitation, engineer reconnaissance, knots, lashing and rigging, ponton and trestle bridges, field fortification, demolitions, target practice, minor tactics and problems of engineer troops.

Practical problems covered the following subjects, in some of which students were permitted to take their choice:

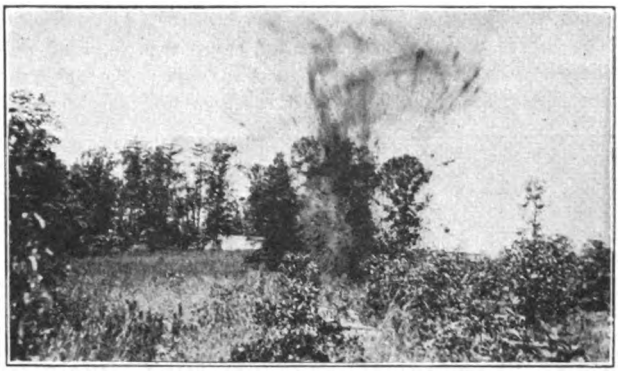
Military sketching, terrain exercises in tactics, survey of campsite, field fortification, engineer reconnaissance, military mining, demolition, bridges, road location, road construction, railroad location (standard and narrow gauge), hydrographic survey, camp water supply, sewage disposal, electrical and mechanical installations.

As indicating the manner in which the "applicatory sys-

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Portable searchlight

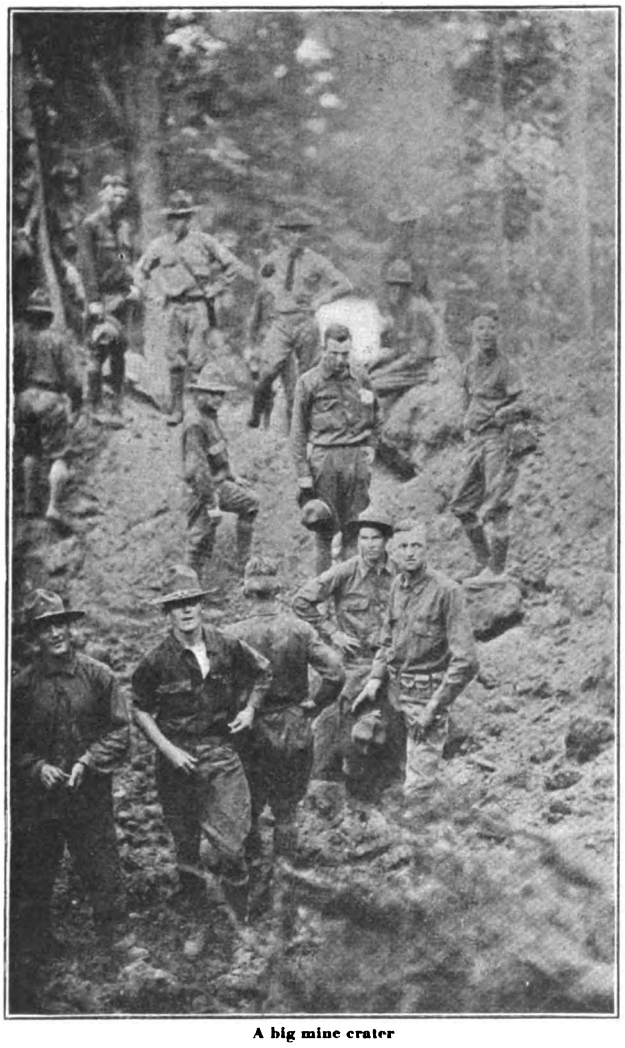


A land mine explosion

tem" of the military may be applied to the problems of the civil engineer, let us describe one of the problems in water supply. This problem was based upon a "situation" as follows:

"The United States has declared war on a foreign power. Mobilization has begun and the immediate construction of cantonments is necessary. It is intended to construct a 30,000-man cantonment on the Camp Humphreys reservation with the possibility of later expansion to accommodate 100,000 men."

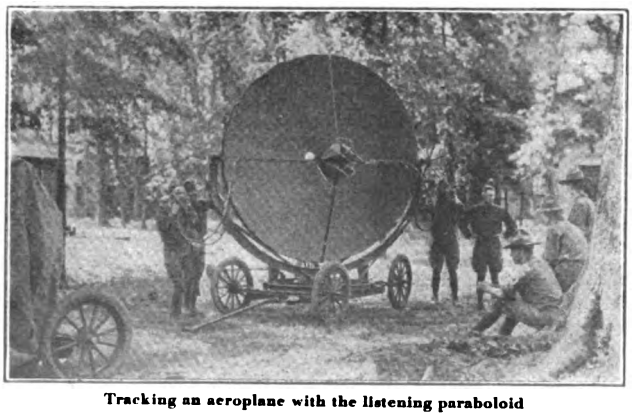
With this general situation in view there had previously been collected and digested all necessary data concerning the available water sources in the vicinity of the reservation, such as extent of drainage areas, average annual rainfall, rainfall for dry years, collectible run-off, record minimum flow of streams, etc. There were also prepared figures showing the probable water consumption of a camp of the size required above, such as average per capita daily consumption, maximum requirements for fire protection, etc. This data was presented to the students solving the problem, who were then confronted with the special situation in which they were required to assume the role of an engineer officer and investigate and report as to whether sufficient water was available to supply the above requirements, to select the source to be developed, to outline the water supply system for the camp and to estimate the equipment and materials necessary for its installation.



A big mine crater

The students were then required to make a personal inspection and reconnaissance of the elements of the present water supply system, in the light of their own solutions of the problem. They were conducted to the Springfield dam and storage reservoir on Accotink Creek, to the diversion dam, filter beds, pumping plant, etc., and each phase of the system was explained and discussed.

Each student was furnished with a topographical map and permitted to use the manuals and text-books in making his solution. In



Tracking an aeroplane with the listening paraboloid



Watching an explosion from a safe place

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the solution of this problem the responsibility was placed directly upon the shoulders of each individual student. He was required to make his own reconnaissance, estimate the situation, weigh the advantages and disadvantages of the various courses open to him and then come to a decision. And having reached his decision he was required to outline his plans and make his estimates for carrying it into effect. The instructors rendered all possible assistance in the way of furnishing information on various points, but in no way did they relieve the student of the responsibility of making his own decision and drawing up his own plans for carrying that decision into effect. The solutions of the students were then examined by the instructors and their mistakes pointed out to them.

Other problems in practical engineering were conducted in a similar manner. The students took an active interest in the work and welcomed every opportunity to visit and inspect works of engineering construction. It is certain that problems of this nature in which the student makes his own solution, and then examines in detail in actual physical existence, the solution made by some one else to meet the same requirements, will be of great benefit to him as a preparation for his industrial or professional career. Basing the problems on assumed military situations is of great value in the training of the student as a military engineer, as it indicates military requirements and furnishes the military atmosphere. It gives him an excellent idea of the kinds of problems which will probably confront him as a reserve engineer officer in case he is called into active service in an emergency. And it impresses upon him the fact that in war the military engineer, separated from the vast and varied resources of material, equipment, labor, etc., usually at the disposal of the civilian engineer, must accomplish his results with the always limited and sometimes very unsuitable material, equipment, labor, etc., which he may find at hand, and that, moreover, he must do his work in such time as allowed him by the military situation of the moment.

The camp was a great success, much appreciated and enjoyed by the students. It will be repeated each year, and a constantly increasing attendance is looked for. It was a splendid demonstration of the power of the Federal Government to administer training, and of the practicability of combining instruction in civil and military engineering without detriment to either.

Army Educational and Vocational Training at Camp Humphreys, Va.

The scholastic instruction and vocational training that is being given to enlisted men of the engineers at Camp Humphreys is typical of the new role of the Army as a great educational institution. Although working under many handicaps excellent results have been attained, the significance of which is far reaching as indicating the benefits which would occur to the nation from universal education under Federal control.

The vocational schools of Camp A. A. Humphreys, Va., were organized during October, 1919. The scope of the schools was to conform as far as possible to the list of authorized courses prescribed by the War Department, particular stress being placed on the organization of courses necessary to engineer troops. However, the purpose was not only to give the troops the necessary training, but also to enable the men to take up studies and trades which will be beneficial to them in later years in civil life.

In some ways the situation was favorable for quickly organizing certain courses, since the camp had previously been used as a training center for engineer troops. The machine shop was particularly well equipped for immediate work, as complete shop equipment was already in place and in operation. The carpentry shop was also running, although small, and was specially fitted for machine work. Another shop in good working condition was the blacksmith shop, and at the start it was capable of accommodating as many men as was thought possible to enroll. Due to the printing train of the 29th Engineers being housed temporarily in camp it was possible to start installation of equipment and organizing a complete printing school which would include all branches of the trade.

The preparation of the various courses consumed the early months of 1920, and it was not until about the middle of March that an outline of the various courses which were to be taught could be issued. This pamphlet was then issued to all troops in camp and sent out to the numerous recruiting parties. The increase of the enrollment was almost immediate, the total jumping from 51, which had been the enrollment since January, to 254 on May 1, when eleven courses started operations. The courses before May 1 had been extremely limited, there being only the elementary school, blacksmith, machine and automotive schools in operation. This condition which existed during January to April, inclusive, was due largely to the very small number of troops in camp and to the fact that many of them expected to leave the service during the succeeding months. Besides this handicap, the school staff was insufficient to carry on the work.

It was found that a number of men were illiterates, hence measures were taken during March to send them to school. This was the beginning of the educational classes, which finally included not only the illiterates but also students up to about the eighth grade in grammar school. This educational work developed into the most popular of all the courses, and it was necessary to hire five instructors to take care of the different grades. Mathematics was made the major subject, the rest of the time being devoted to reading, spelling, penmanship, grammar and composition. No time was placed on the students specifying how long they should remain in one particular grade, but instead they were constantly under consideration for advancement by their instructor, and as soon as the necessary degree of proficiency was shown the students were advanced. This condition was found to be necessary since many of the men needed review more than additional instruction.

In connection with this educational work a class in languages was formed, and French, Spanish and Italian were taught. An advanced English section finally grew out of the language section, and through this medium the foreigners were taught English.

A class which was almost as popular as the educational classes was the automotive school. During the constructive period in the organization of our courses we were handicapped by the lack of equipment for this course. Much

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time had to be spent on the theoretical work, since machines and tools were not available. Finally a shipment of cars and trucks from Camp Holabird (during April and May) relieved the strained conditions that had been experienced during the winter. Upon the arrival of this shipment many more men volunteered for automobile work, and the enrollment equalled that of any other course. With the new cars it was possible to enter into the field of practical automobile work, and the last part of the course has been devoted almost entirely to repairing, assembling and driving.

The demand for more efficient typists led to the organization of a typist school in which the touch system, a course in spelling, business correspondence and composition were to be taught. This course began on April 26 and was filled to its capacity of 30 men within a week. Later the class was enlarged by the addition of ten more machines, and this more than accommodated the rest of the applicants.

It was not until the middle of May that the electricians' course could be started, due to no students enrolling, and also to the lack of equipment. The men who enrolled for this course were given very good practical work under the supervision of the electrician employed by the school. These students, many of whom had had previous experience, did some very good work in installing a small power plant, which will be used to supply the school area. Besides this, many other tasks, such as wiring and storage battery work, were given the students.

Although a sheet metal course was planned, it was impossible to start, as the equipment failed to arrive, although ordered last February. What equipment there was on hand would have been sufficient only for the roofer's trade. There were no applicants for instruction in this work.

As the camp lies in a fairly good agricultural district of Virginia it was decided to organize and operate, under the supervision of the vocational schools, a model farm on which all branches of the subject could be taught. At the same time agriculture and its associate courses were being taught, it was thought possible to help supply the camp with fresh vegetables from this source. A tract of land was selected north of Accotink which suited the needs of such a farm fairly well. At first a few students were taken out to the farm daily to help the civilians who were hired to put the place in shape. Later it was found impracticable to have the students attend only three hours daily, hence a detail was sent out to the farm under the charge of a noncommissioned officer. This detail remained during the entire day, having their quarters and mess on the place. This arrangement was found to be most satisfactory.

The carpentry course failed to attract a sufficient number of students to justify the employment of an instructor until about May 10. However, the equipment and shop had been ready to accommodate students for about a month previous to this date. A number of carpenters' tool chests had been procured, and, together with the equipment already installed in the shop, provided everything which was necessary.

The machinists' course was most satisfactory from the first. The necessary equipment was already on hand, as this shop had been used only a few months previous by the engineer school for a class of officers. The tasks which had been prescribed for the officers were followed by means of mimeographed sheets, and when a student showed a sufficient degree of proficiency he was put on special work. Many capable machinists are being developed by this school.

The printing course was planned with the idea of teaching rather thoroughly all of the different phases of the trade. Starting May 1, as scheduled, the students were placed on job press work at once. These students have done some very creditable work, and as this class is continuing throughout the summer even better results are expected. The equipment in the printing shop includes everything necessary for a thorough course in this trade.

Soon after the welding class began the acetylene generator blew up, and although an order was placed immediately for another generator it failed to arrive in time to start again by May 1. It was therefore decided to incorporate the acetylene welding course in the blacksmith course, making the welding the final subject.

The blacksmith course, which was one of the first to be established, was well equipped in all respects and was also favored with a complete set of job sheets which had been used by the student officers of the Engineer School. Very little preparation for this course was necessary. Although the number of students was not large, those who attended were diligent and anxious to learn. Some of the same men continued the work through the summer as training for the regiment.

As a summary of the accomplishments of the vocational schools it can be said that during their short life they have undoubtedly served their purpose in helping the men to see what the Army has to offer, and to encourage them to take up the work again this fall when the schools reopen on a firmly established basis. Finally, the schools should be credited with increasing the qualifications of many men in educational and vocational lines. Many men who could not write before have, in this short time, written letters home, and a number of others have learned to operate machines in shops, drive automobiles, use a typewriter and so on. It is believed that the men have acquired a desire for knowledge, and if this is so our efforts have been more than repaid.

Educational and vocational schools received a great boom in February when a permanent board of education was appointed. It was found advisable to form various committees in this general board which could handle in detail subjects of equipment, class instruction and teachers. These various committees consisted of two to three officers who made thorough inspections of the school work, equipment, etc., and reported to the general board when regular meetings were called, every week or so.

The Board of Education early decided that educational and vocational training should cease May 31 for the summer period. Many of the vocational classes continued as engineer trade schools during the months of June, July and August. The classes were necessarily smaller, and the instruction not solely voluntary. The vocational schools will reopen on or about the 1st of September.

By far the most aggravating circumstance under which the vocational schools have had to function has been the lack of equipment in certain of the important classes. Quantities of equipment of all kinds were ordered during the latter months of 1919 and early in 1920. In addition the War Plans Division, General Staff, has allotted thousands of dollars worth of vocational training equipment to this camp for future use. It is expected that sufficient equipment will be on hand so that instruction may proceed on a grand scale in the fall. Automobile equipment consisting of 10 trucks, 10 automobiles, 10 motorcycles, trailers, etc., has arrived and has been put in order, so that when class is reopened there will be a sufficient number of machines available for driving and all other instructional work in automechanic course.

According to the plans of the War Plans Division the school for educational and vocational officers and instructors was held during the summer months at Camp Grant.

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Professional Notes

of Military and Engineering Interest

Major Graves Objects to the Limber and Caisson Type of Tool Wagon

I learn that the type of tool wagon for engineer troops is under considration, and I submit the following thereon:

These appear to be the types of wagon to be considered, viz., the escort wagon, the Brown tool wagon, and the limber and caisson wagon.

The features to be considered appear to be the following:

(*a*) Number of men necessary to operate or drive.
(*b*) Animals and harness.
(*c*) Facility for going over roads of all kinds.
(*d*) Susceptibility to being divided into two parts.
(*e*) Ease in getting to contents.
(*f*) Susceptibility to use for hauling by removing tools.
(*g*) Interchangeability of parts with other army transportation.

(*a*) The limber and caisson wagons I have require two men to drive and another to operate the brakes. An escort wagon requires one man to do everything.

(*b*) Limber and caisson wagons use four horses. Escort wagons use four mules. Limber and caisson harness makes horses' necks sore. Horses eat more than mules, and require more care. Horses fail on account of neglect in campaign quicker than mules. Only horses could be used with limber and caisson wagons because mules are not subject to that kind of driving.

(*c*) Probably limber and caisson wagons will travel on a rougher road than an escort wagon, but an escort wagon will go anywhere that is necessary.

(*d*) The limber and caisson wagons ran be divided into two carts and the escort wagon cannot. Has anyone ever seen a necessity for dividing the tool wagon into two carts? I have not, and do not believe the feature is worth considering.

(*e*) It is easier to get at the contents in a limber and caisson wagon than in an escort wagon. The Brown tool wagon, which is nothing but a tool box on an escort frame, is as satisfactory in this respect as a limber and caisson wagon.

(*f*) The escort wagon is better than anything for emptying of tools and for any kind of hauling.

(*g*) The escort wagon has parts same as the bulk of all army transportation, and broken wheels, tongues, bolts, etc., can be quickly replaced almost anywhere. The Brown wagon has the same advantages. The limber and caisson wagon is certain to be extremely difficult to get repaired. This, to my mind, is the most important of all of the features discussed.

5. It is recommended that a wagon be adopted that can be driven by one man; that can be pulled by mules using the most common variety of harness; that is good enough for practically all roads; that does not need to be divided into carts; that affords sufficient facilities to get at contents; that can be easily used for other hauling; and above all, that can use the most available replacements in wagon parts, harness and animals. This wagon is either the Brown wagon or the escort wagon. The escort wagon is the better in my opinion, possessing as it does the supreme advantage of simplicity, so strongly urged by military sages and so greatly appreciated by practical military men.—*Ernest Graves, Major, Corps of Engineers, Comdg. 2d Engineers.*

Changes in Personnel in the Corps of Engineers

Contributed by Mr. J. A. EGAN, Office of the Chief of Engineers.

Since our last issue the following changes of personnel have occurred in the Corps of Engineers, U. S. Army:

Lt. Col. JOHN R. SLATTERY and Majs. Henry C. Jewett, R. R. Ralston, J. J. Bain and Robert S. Thomas have been sent to the School of the Line, Fort Leavenworth, Kans., as student officers.

Maj. WILDURR WILLING has been assigned as Department Engineer, Northeastern Department, relieving Capt. John S. Bragdon.

The following-named officers of the Corps have been relieved from Camp A. A. Humphreys, Va., and assigned as Assistant Professors of Military Science and Tactics at the institutions specified, to report not later than August 20, 1920.

Capt. D. A. DAVISON, Yale University, Sheffield Scientific School, New Haven, Conn.

Capt. LAYSON E. ATKINS, University of Illinois, Urbana, Ill.

Capt. PATRICK H. TANSEY, Oregon Agricultural College, Corvallis, Oreg.

Capt. MICHAEL C. GRENATA, University of Kansas, Lawrence, Kans.

Capt. LUCIUS DUB. CLAY, Alabama Polytechnic Institute, Auburn, Ala.

1st Lt. HOWARD L. PECKHAM, University of Tennessee, Knoxville, Tenn.

1st Lt. ALBERT RIANI, University of Iowa, Iowa City, Iowa.

1st Lt. EDWIN P. LOCK, jr., Missouri School of Mines, Rolla, Mo.

1st Lt. HARRY A. MONTGOMERY, Rose Polytechnic Institute, Terra Haute, Ind.

Capts. PAUL T. BOOK and Elroy S. J. Irvine, and 1st Lt. Frank O. Bowman have been relieved from Camp A. A. Humphreys, Va., and assigned to the office, Chief of Engineers.

1st Lt. FREDERICK FRENCH has been assigned to the 1st Engineers, Camp Taylor, Ky.

The following-named officers have been relieved from Camp A. A. Humphreys and assigned to duty under the immediate orders of the Chief of Engineers:

Capt. ALBERT G. MATTHEWS, Capt. Lewis T. Ross, Capt. Alexander M. Neilson, Capt. Charles E. McKee, Capt. Robert H. Elliott, 1st Lt. David A. D. Ogden, 1st Lt. Richard Lee, 1st Lt. Joseph J. Twitty.

1st Lt. MARK M. BOATNER has been assigned to the 9th Engineers, Camp Travis, Tex.

Maj. WALTER L. WEBB, 1st Lt. Cecil A. Clarke and 2d Lts. Bernard Marvin and Frank E. Briber have been honorably discharged the service.

1st Lt. GEO. F. BROCKMAN has been relieved from Camp A. A. Humphreys and assigned to Co. D., 7th Engineers, Camp Benning, Ga.

Capt. JOHN E. HARRIS has been assigned to duty in the Office of the Chief of Engineers.

Capt. G. B. TROLAND has been assigned to duty at New London, Conn., as assistant to the District Engineer.

Maj. THOMAS H. EMERSON, C. of E., has been relieved from the General Staff College and assigned to the office of the Chief of Staff.

The following-named officers have been assigned to temporary duty as assistants to the District Engineers at the places specified:

Capt. JOHN P. DEAN, Newport, R. I.; Capt. Charles F. Baish, Pittsburgh, Pa.; Capt. James M. Young, New York City; Capt. Preston W. Smith, Boston, Mass.; Capt. Patrick H. Timothy, jr., Boston, Mass.; Capt. Leland H. Hewitt, New York City.

Capt. THOMAS F. KERN and 1st Lts. James L. Rhodes and Robert G. Lovett have been ordered to Manila, P. I.

Capt. WILLIAM C. SHERMAN, upon his own request, has been transferred to the Air Service, with rank from July 1, 1920. Capt. W. H. Henderson and 1st Lts. Marcus P. Taylor and Ernest W. Dichman have been detailed for duty with the Air Service in accordance with the provisions of the Reorganization Act of June 4, 1920.

Capt. CHARLES P. GROSS has been detailed as Inspector-Instructor, Engineers, New York National Guard, with station at Governors Island, N. Y.

Capt. CLARENCE S. JARVIS has been assigned as assistant to the Constructing Quartermaster, Presidio, San Francisco.

Lt. Cols. JOHN M. WARD and Harry F. Cameron, under the provisions of an Act of Congress approved June 5, 1920, have been discharged from their commissions as lieutenant colonels and recommissioned majors, Quartermaster Corps.

Lt. Cols. WILLIAM H. LANAGAN and Bowyer B. Browne have been discharged under the provisions of an Act of Congress approved June 5, 1920, from their commissions as lieutenant colonels and recommissioned majors, Engineers, for the emergency.

Capt. NOTLEY Y. DUHAMEL has been assigned to the 5th Engineers, Camp Humphreys, Va.

Maj. HARRISON V. PITTMAN, Engineers, has been assigned to duty as assistant in the 1st Cincinnati District, Ohio.

Lt. Col. G. R. LUKESH has been assigned to duty as District Engineer, Louisville, Ky., relieving Col. Geo. M. Hoffman of that duty.

Maj. EARL NORTH has been assigned to duty as District Engineer, Mobile, Ala., relieving Maj. Robert S. Thomas of that duty.

Maj. GILBERT VAN B. WILKES has been assigned to duty as District Engineer, Kansas City, Mo., relieving Maj. R. T. Ward.

Col. C. S. SMITH has been assigned to duty commanding the 7th Engineers, Camp Gordon, Ga.

Maj. RICHARD PARK has been relieved from the 5th Engineers and assigned as District Engineer, 2d District, Portland, Oreg., relieving Lt. Col. J. R. Slattery.

Lt. Col. JAMES A. WOODRUFF and Maj. Robert P. Howell have been relieved from duty at Seattle, Wash., and at Vicksburg, Miss., and ordered to Camp A. A. Humphreys, Va.

Maj. JAMES A. O'CONNOR has been relieved from duty at Camp A. A. Humphreys, Va., where he was in command of the R.O.T.C., and ordered to Vicksburg, Miss., for duty as District engineer, relieving Maj. R. P. Howell. In addition, Major O'Connor will take charge of the 3d Mississippi River District.

Col. AMOS A. FRIES has been promoted to Brigadier General and Chief of the Chemical Warfare Service. General Fries was Chief of the C. W. S. of the A. E. F. during the war.

Capt. WILLIAM E. R. COVELL has been re-

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lieved from Camp Humphreys and ordered to Buffalo, N. Y., as District Engineer, relieving Col. C. S. Smith.

Col. EDWARD H. SCHULZ has been relieved from Milwaukee, Wis., and ordered to Seattle, Wash., as District Engineer, relieving Lt. Col. J. A. Woodruff.

Col. WILLIAM W. HARTS has been assigned as Department Engineer, Eastern Department, with station at Governors Island, N. Y.

Maj. ROGER G. POWELL has been relieved as assistant to the Engineer Commissioner, District of Columbia, and ordered to duty in the Office of the Chief of Engineers.

Maj. PAUL REISINGER has been relieved from the Carnegie Institute of Technology and assigned to the 2d Engineers, Camp Travis, Tex.

1st Lt. FRANK O. BOWMAN has been relieved from duty in Washington, D. C., and assigned to the 2d Engineers, Camp Travis, Tex.

Maj. HERBERT J. WILD, Engineers, has been assigned to the 6th Engineers, Camp Pike, Ark.

Maj. CHARLES R. PETTIS has been ordered to the General Staff College, Washington Barracks, D. C., as student officer.

Maj. ULYSSES S. GRANT, 3d., has been relieved from duty in Washington and ordered to San Francisco, Calif., as District Engineer, 3d District, relieving Lt. Col. William Kelly.

1st Lt. EUGENE L. VIDAL has been ordered to Antwerp, Belgium, for duty in connection with the Olympic Games.

Col. GEO. P. HOWELL has, in addition to his other duties, been assigned as District Engineer, Charleston, S. C., relieving Lt. Col. G. R. Lukesh.

Majs. W. T. HANNUM, Mark Brooke and R. C. Moore have been ordered from Camp A A. Humphreys, Va., to Fort Leavenworth, Kans., as student officers at the General Staff School.

Capt. XENOPHON H. PRICE has been ordered to Boston, Mass., as student at the Massachusetts Institute of Technology.

Lt. Col. WILLIAM KELLY has been relieved from duty at San Francisco, Cal., and ordered to Washington for assignment to duty with the Federal Power Commission.

Maj. WILLIAM G. CAPLES has been relieved from duty at Fort Sam Houston, Tex., and detailed for General Recruiting Service, Fort Logan, Colo.

Lt. Col. GLENN S. SMITH has been ordered to Havana, Cuba, on temporary duty in connection with the proposed topographical survey of the Republic of Cuba.

1st Lt. EDWIN G. SHRADER has been relieved from Camp A. A. Humphreys, Va., and assigned to the 4th Engineers, Camp Lewis, Wash.

Col. JOSEPH H. PRATT, Reserve Corps, has been ordered to active duty in the office of the Chief of Staff.

Capt. WILLIAM F. HEAVEY has been relieved from Campt A. A. Humphreys, Va., and ordered to West Point, N. Y.

Capt. ALFRED L. GANAHL, upon the expiration of his leave of absence, will proceed to the Canal Zone, Panama, for duty.

Capt. ALBERT O. TRUE has been relieved from Norfolk, Va., and ordered to Fort Monroe, Va.

Maj. EARL J. ATKISSON, at his own request and under the provisions of an Act of Congress approved June 4, 1920, has been transferred to the Chemical Warfare Service, with rank from July 1, 1920.

The following officers have been promoted to the ranks indicated above their names:

To be Brigadier Generals: Col. Harry Taylor (Assistant Chief of Engineers), Lt. Col. William D. Connor.

To be Colonels: Meriwether L. Walker, Robert R. Raymond, William B. Ladue, William J. Barden, Edward H. Schulz, Harry Burgess, George M. Hoffman, Sherwood A. Cheney, Frederick W. Alstaetter, Harley B. Ferguson, Frank C. Boggs, Clarke S. Smith, William P. Wooten, Lytle Brown, Earl I. Brown, Curtis W. Otwell.

To be Lieutenant Colonel: Maj. Paul S. Bond.

The following-named graduates of the U. S. Military Academy, West Point, N. Y., have been assigned to the Corps of Engineers and ordered to Camp A. A. Humphreys, Va., for duty as student officers, Engineer School, for the basic course, 1920-21:

2d Lts. FRANCIS H. OXX, Thomas H. Stanley, Donald Greeley White, Henry George Lambert, William Weston Bessell, jr., Charles George Holle, Charles Sheafe Joslyn, Arthur Martin Andrews, Edward Crosby Harwood, John Wylie Moreland, Wayne Stewart Moore, Henry Franklin Hannis, Arthur Lee McCullough, Arthur Vinton Linwood James.

The resignations of the following-named officers have been accepted:

1st Lt. MARCUS P. TAYLOR and Wilson G. Saville.

The following officers of the Coast Artillery Corps have transferred to the Corps of Engineers under the provisions of the Act of Congress of June 4, 1920:

Capt. ROBERT A. LAIRD, 1st Lt. Cecil R. Moore, 1st Lt. Glenn H. Stough, 1st Lt. Milton Heilfron.

The following-named emergency officers of Engineers have been honorably discharged the service of the United States:

Lt. Col. ARCHIBALD O. POWELL; Majs. Reuben H. Oglesby, Louis D. Waldron; Capts. Fred A. Dailey, John H. Devine, Waterman C. Guerin, Arthur I. Hunting, George J. Lyon, Thomas B. Motz, Frank N. Smith, Harold A. Tyson; 2d Lts. Merle F. Bennett, Omar E. Swank.

Records of the World War.—The War Department is now preparing for publication the Records of the World War. There have already been prepared and sent to the printer the following volumes:

Field Orders and Annexes, 1st Army—Records of the World War. Class A, Section II, Vol. 1.

Summaries of Intelligence, 1st Army—Records of the World War. Class A, Section II, Vol. 3.

Field Orders, 2d Army Corps—Records of the World War. Class A, Section VI, Vol. 1.

Others will follow as prepared. These records are being published on the following plan:

Class A—Records of Military Operations Overseas.

Class B—Records of the Service of Supplies Overseas.

Class C—Records of Military Activities in the United States.

Each class will be subdivided into sections, and each section into volumes corresponding to the scheme of organization and record files of the War Department and American Expeditionary Forces.

The War Department will print only a limited number of sets strictly for official use, and the Government Printing Office has been asked to provide the sales edition to take care of the outside demand. In view of the limited edition to be printed the War Department will arrange a sales edition, and any one interested in obtaining copies should place his name on file, so that he may receive notice as each volume appears.

Enlistments in the Corps of Engineers.—The enlisted strength of the Corps of Engineers on July 31st was 4,631, or about 38 per cent of its authorized strength of 12,000. The largest unit is the 1st Engineers, which has 1,225 of which 867 are with the American Forces in Germany with Companies A, B and D, and 358 at Camp Dix, N. J., with Companies C, E and F.

Increase in strength of the National Guard and Regular Army.—During the month of August there was an increase of 3,431 in the enlisted strength of the National Guard. The actual strength of the entire guard at the end of the month was 60,545 as compared with the authorized strength of 180,607 (enlisted). At this rate 3 years will be required to bring the guard to its authorized strength, but an increase in the rate of enlistments is confidently expected.

During August enlistments in the Army exceeded 16,000.

War Department report recommends construction of Federal system of highways.—The construction of a Federal system of national highways is recommended in a report of the War Department to the Highways Committee of Congress, made public April 30. The report summarizes conclusions reached as a result of the army convoy of 73 trucks which blazed a trail from Washington to the Pacific Coast last summer.

The recommendations of the Department are:

That the necessity for a comprehensive system of national highways, including transcontinental, or through routes east and west, north and south, is real and urgent, as a commercial asset to further colonize and develop the sparsely settled sections of the country and, finally, as a defensive military necessity.

That existing roads and bridges, especially in the sparsely settled sections of the middle and far western states, are absolutely incapable of meeting present-day requirements, and until modern types of roads and bridges are constructed, which will permit the rapid movement of heavy motor cargo vehicles during any season of the year and in all conditions of weather, economical transcontinental highway traffic will continue to be but a vain hope.

The road problems of the middle and far western states are national rather than local problems, as the states, while possessing vast areas and tremendous mileage of highways, have only a sparse population which cannot possibly undertake the needed highway improvement work, which, moreover, is usually of greater importance to the country as a whole than to the individual states.—*Eng. and Cont.*

War Department expenditures in World War—

Appropriated	$25,544,000,000
Expended	$16,080,000,000
Obligated	352,000,000
Total	$16,432,000,000
Expected recoveries	2,538,000,000
Net ultimate expenditures	$13,894,000,000
Ultimate saving of appropriations	$11,650,000,000

—*Statistics Branch, General Staff*

Emergency officers desiring permanent commissions. The War Department on June 23 had received 12,668 letters from former offi-

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cers applying for commissions under the reorganization act of June 4, 1920. Of these 30 are former colonels and 247 former lieutenant-colonels.

—*Statistics Branch, General Staff.*

Governmental expenditures in ante bellum days.—In 1913 expenditures for purposes of government were as follows:

Municipalities, 42 per cent	$1,247,000,000
Counties, 13 per cent	285,000,000
States, 13 per cent	382,000,000
U. S. Army and Navy, 10 per cent	294,000,000
Other Federal expenditures, 22 per cent	659,000,000
	$2,967,000,000

These expenditures are itemized as follows:

Recreation, health, misc., 5 per cent	$156,000,000
Interest on public debt, 6 per cent	189,000,000
Highways, 7 per cent	202,000,000
Permanent improvements, 20 per cent	586,000,000
General governmental purposes, 9 per cent	273,000,000
Army and Navy, 10 per cent	294,000,000
Other protection, 5 per cent	152,000,000
Public-service enterprises, 11 per cent	382,000,000
Education (schools and libraries), 15 per cent	442,000,000
	$2,967,000,000

—*Statistics Branch, General Staff.*

Foreign officers at Army Service Schools.—About 57 foreign officers, from Central and South American countries, will take courses at various U. S. Army Service Schools, beginning in September, 1920.

Good roads our paramount need.—Roads of all kinds and highway engineering are of paramount interest to both the civil and the military engineer. In time of war more than half the effort of the engineers with the combatant forces is devoted to the construction, repair and maintenance of roads. There is no more important duty of the engineer in war.

In common with *nearly all* the problems of the military engineer roads are of equal importance to the civil engineer in time of peace.

Even though the railroads get back to their normal basis within the next few months or years, the volume of freight which will be transported by truck will probably not decrease perceptibly. Rather it may be tremendously increased. The motor truck is here to stay, only if highways can be built to withstand its loads.

All of which led to the conclusion that engineers must study this phase of construction and must devise a type of road which will give the motor truck the highways it requires, while at the same time meeting the taxpayers' demand for low initial and maintenance costs.

Truck men have resented attacks made some time ago by officials of a motorists' organization against the havoc to improved roads, wrought, it was charged, by heavy duty motor vehicles last winter. Truck operators and dealers have been unanimous in declaring that trucks have done only a small share of this damage and that most of it is due to improper construction, lack of drainage and similar causes.

They point to two cases where pavements have gone to pieces, though no trucks were permitted on them. Obviously the cause is not in the kind of traffic, they say.

The wear and tear on roads incident to military operations far exceeds that of peace times. Roads designed and constructed to withstand heavy motor traffic are an essential item of any scheme of national defense.

Another basis for "cost-plus" contracts.—A correspondent submits the following:

A cost-plus percentage contract which was fair to the contractor as well as the government, was made necessary by conditions some years ago in the Philippines, and the details following offer suggestions for such an agreement which may be made applicable in the future.

The contract was originally let as a unit-price contract on designs prepared by the city engineer's office (Manila). Owing to heavy typhoon damages done between the time of letting the contract and the time designated for beginning the actual work, it was found equitable to enter into a new agreement with the same contractor, as he had placed a rather extensive plant on the site of the work and was ready to proceed under the original plans which, due to the typhoon damages, would have been inadequate. Plans were quickly changed, and the contract agreement mentioned below was made as a "supplemental agreement."

Overhead expenses covering general office, general superintendent, contractors' general shop, etc., were taken from the contractor's cost data sheets for the three preceding years. These were about 12 per cent (which was not excessive in the Philippines).

The time limit for completion set by the engineer was 150 days, to which the contractor agreed. This estimate was based primarily on progress of sheet pile driving which up to that time had always been done by manual labor.

This time limit being accepted, a clause was inserted in the contract making it a basis of compensation. To the actual costs of labor and materials 12 per cent was added for overhead expense and 15 per cent allowed for contractor's profit, also a daily plant rental was allowed.

The overhead allowance, profit and plant rental was to continue in force for 150 days, after the expiration of which time only actual cost of labor and material was to be allowed. If contract was completed in less than 150 days the contractor was to receive the plant rental for the whole period of 150 days.

The foresight of taking a contractor into partnership, so to speak, in this work was justified by the fact that he did satisfactory and good work; that he devised at his own expense and finally put to work on this job an electric sheet pile driver specially adapted for this work. This machine cost the contractor the equivalent of about 10 days plant rental for the entire plant on this job, but it paid him and incidentally also paid the government. Due to some saving in sheet pil driving the work was completed in 88 days, and the contractor saved for himself 62 days plant rental, and a considerable amount to the government in inspection and reduced labor costs and time.

Aerial mail routes.—An aerial mail service has been conducted daily, except Sundays, between New York and Washington, for two years; and between New York and Chicago for one year. Within a year it is hoped to establish a direct line between New York and San Francisco. An average of 3.2 miles is flown per gallon of gasoline.

Strikes and lockouts in 1919.—During the year 1919 there were 3,372 strikes and lockouts in the United States, involving 4,156,000 persons. It is estimated that the number of days of labor lost by strikes averaged about 36 for each person involved. On this basis the number of "man-days" lost was approximately 150,000,000. the average daily compensation of these workers be assumed at $5, the loss of wages alone, from strikes in 1919, was $750,000,000. Manifestly the strike is an expensive method of settling (or not settling) labor disputes.

Economical limit on "fineness of grinding" for cement.—At a recent conference between representatives of the United States, of the American Society for Testing Materials, and of the cement industry, the desirability of reconciling the government specification for fineness with that of the American Society for Testing Materials, was discussed.

It was stated that the value of finer grinding—that is to say, its effect upon the strength of cement—was quite well understood within the limits under consideration, namely, 78 to 80 per cent passing a No. 200 screen. It has been found that 1 per cent increase of fineness corresponds roughly to 1 per cent greater strength, or, in other words, near these limits the increase of 1 per cent in fineness might be held to justify the use of 1 per cent less cement. This, however, is not practicable for ordinary work, in which other conditions are not so readily controllable as is the quantity of cement used, so that the consensus of opinion was that the additional strength due to a small increase in fineness ought properly to be regarded merely as additional insurance.

A representative of the manufacturers stated that mills are now equipped to grind cement of such fineness as to pass 78 to 80 per cent through a No. 200 screen, and that it has been found that increasing the fineness of grinding of a particular mill, whose equipment has been balanced with a view to output of another, lower degree of fineness, caused a reduction in output. An effort was made to find what this reduction was per 1 per cent of fineness ranging between 78 and 83 per cent, and an average of reports received shows that this reduction in output was about 5.07 per cent for each per cent of increased fineness. He stated also that the cost of production did not increase directly in the same proportion, but that only 60 or 70 per cent of the total cost of production was correspondingly increased, making the final increase in the cost of a barrel of cement from 11 to 15 cents at the present market price of about $1.75 per barrel for a 2 per cent increase of fineness—this being the difference between the two specifications above referred to.

It was further stated that owing to the lack of uniformity of the screens, it was the practice of the cement trade to grind from 3 to 5 per cent finer than the low limit of the specifications—this simply as a measure of protection.

Alkali damages part of Winnipeg concrete aqueduct.—Four miles of the 97-mile aqueduct completed last year for the water supply of Winnipeg are being underdrained to protect the concrete conduit from destruction by alkaline ground water. tudies of the deterioration of concrete indicated that while other methods of protecting concrete from alkali might be effective, the best protection was the removal of the alkali, getting at the root of the evil. The drainage project involves completely uncovering the 8-foot conduit, throughout the affected sections, and the placing of continuous 8-inch open joint tile underdrains on each side of the trench, 2 feet 8 inches below the lowest point of the conduit and 6 feet 10 inches from the center line, and then back filling the trench. Cross drains at 1-mile intervals connect the two side drains with each other and with a drainage well off the line of the conduit. Six-inch vitrified pipe risers connect each drain

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with the surface of the ground, for inspection purposes.—*Eng. News-Rec.*

Reservoir and plant for new Southern water power.—The Bridgewater reservoir of the Western Carolina Co., at Bridgewater, N. C., on the Catawba River, is designed to provide storage capacity, not only for the Bridgewater power-house, but for a number of allied down-river plants as well, by conserving the flood waters of the upper Catawba and discharging them through power-house into the lower river during periods of drought. The drainage area tributary to the Bridgewater reservoir is 370 square miles, over which the average annual rainfall is between 55 and 60 inches. During the flood of July 16, 1916, which was 100 per cent greater than any other flood ever recorded, the discharge into the reservoir site corresponded to 150 cubic feet per second per square mile of drainage area, equivalent to 5.58 inches over the entire watershed. The spillway capacity provides for twice the discharge of the flood of July 16, 1916, before the reservoir level would reach the top of any of the impounding earth dams.

The reservoir consists of three arms, formed by the valleys of the Catawba and its two tributaries, Paddy Creek and Linville River, both on the north side, and involved the construction of three separate dams. The available storage capacity in the first is 5,315,599,000 cubic feet, and in the two latter is 7,266,244,000 cubic feet, giving a total available capacity of 12,581,843,000 cubic feet. Though providing only 42 per cent of the storage capacity, the Catawba discharges 75 per cent of the flow into the reservoir, and a 2,500-foot canal was constructed to connect the lower end of the Catawba reservoir with those of Paddy Creek and the Linville, which are themselves connected by natural arms. The cross-section of the canal is ample to pass flood waters at low velocities when water in the Catawba arm is at El. 1,167. When they are full, the water in all reservoirs will stand at El. 1,200, and the aggregate area of the reservoirs will be 6.509 acres.

As long as the water surface is above El. 1,167 all water is discharged through the turbines at Bridgewater. Below that elevation no water can pass through the turbines nor the diverting canal, but the Catawba reservoir may be emptied to El. 1,160 by sluice gates in the spillway. When the water surface in the Paddy Creek and Linville reservoir drops to 1,150, it is intended to suspend operation of the Linville power house. The stored water between Els. 1,150 and 1,105 may be discharged through the penstock, to make up the deficiencies of the flow in the Catawba below Bridgewater station. It is estimated that the total available storage can be exhausted 1.39 and 3.52 times in extreme dry and wet years, respectively. Not considering the Bridgewater station, the water released would be available for six down-river stations with an aggregate head at the stations of 353 feet. Using this head, a station efficiency of 80 per cent, and the available storage capacity of 12,581,843,000 cubic feet, the potential energy contained in the full reservoirs is 83,667,000 kilowatt-hours. The energy referred to the Bridgewater station of the storage available for that station is 18,490,000 kilowatt-hours.

The requirements of the new installation are for 17,000,000 kilowatt-hours for all stations in addition to their existing minimum output. Using the average head of 115 feet at Bridgewater and the 353-foot combined head of the lower stations, the Bridgewater station must produce monthly 4,177,000 kilowatt-hours in addition to its minimum primary output without storage regulation of 1,477,000 kilowatt-hours, giving a total of 5,624,000 kilowatt-hours as the maximum monthly output. The actual installation is 20,000 kilowatt-hours, giving a load factor of 39 per cent under extreme conditions.

The three dams in the Catawba, Paddy Creek and the Linville were decided upon rather than a single dam making one reservoir on account of property considerations. Earth dams were decided upon because of geological and topographical features, and the abundance of suitable material for earth fills, to meet the total requirements of 4,520,000 cubic yards. The spillway structures and the extensions tying in the earth work are of cyclopean masonry. No unusual features are involved in the design of the impounding structures or power installations.—*Eng. News-Rec.*

Alaska road commission.—The Alaska road commission, as recently reorganized, is now composed of Major Jas. G. Steese, Corps of Engineers, U. S. A., President,; Capt. John C. Gotwals, C. E., Engineer, and Capt. C. S. Ward, C. E., Secretary and Disbursing Officer. The headquarters of the commission are located at Juneau, Alaska, the capital of the Territory, and sub-offices are maintained at Valdez, Seward, Fairbanks, and Nome.

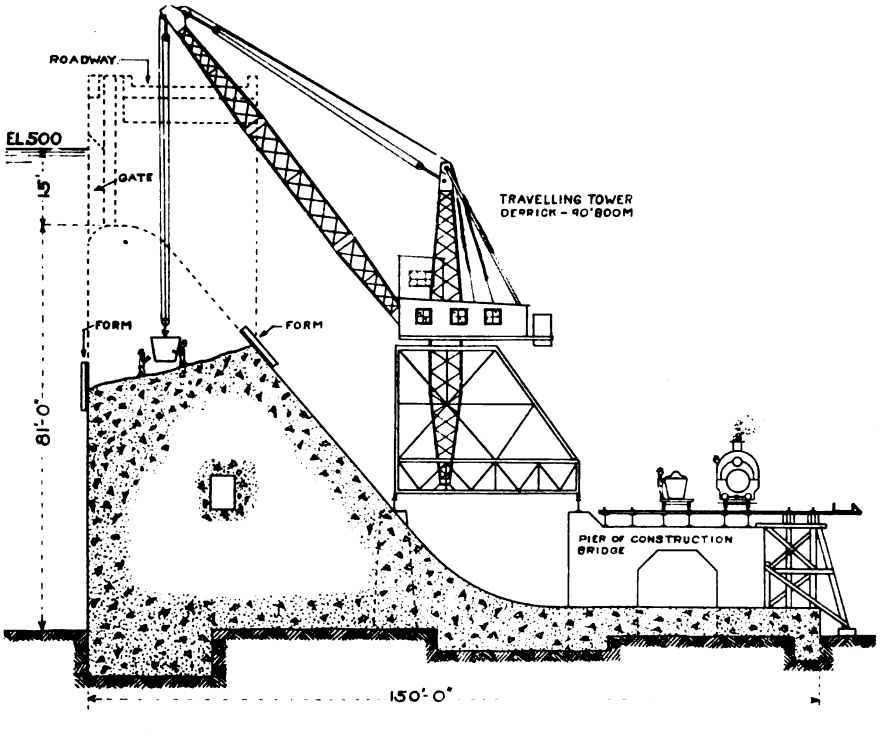
During the sixteen years of its existence, the commission has constructed and maintained a system of wagon roads, sled roads, and trails, which now aggregate nearly 5,000 miles, including a connected system of 4,600 miles reaching to all parts of the Territory. About 1,050 miles are classed as wagon roads. During the past summer, a regular service by automobile was maintained between Fairbanks and Chitina on the Copper River Railroad, a distance of 320 miles, the usual time being three days, with a record trip of 22 hours, actual running time. This road encounters about every possible construction difficulty from sub-tropical swamps to snow-covered mountains.

The Commission has at its disposal appropriations from the Federal Treasury for "Military and post roads, bridges, and trails" from the "Alaska Fund" supported from local federal taxes, and from the Territorial Legislature. In the forest areas it works in co-operation with the Department of Agriculture.

The Alaska Advisory Committee (Federal) reported on June 11, 1920 that "the construction of wagon roads and trails is one of the most important and urgent needs of Alaska. Without the construction of a large mileage of wagon roads and trails the resources of the Territory cannot be made available. Nothing will contribute more to development of tonnage for the Government Railroad than a system of tributary wagon roads. The Committee recommends that *Congress be asked to make an annual appropriation of not less than a million dollars for the construction and maintenance of wagon roads and trails in Alaska.*"

Progress on the Wilson dam.—The erection of seven traveling derricks for use on the spillway section of the Wilson dam, is now well advanced. Two of these derricks are in successful operation. They are briefly described as follows:

The derricks are of the traveling tower type, capable of revolving in all directions. The operator is about 40 feet above the tracks and from his platform controls all movements. The top of the mast is about 75 feet above the track and supports a boom 85 feet long. The capacity is 10 tons on a low boom, hoisted at 75 feet per minute, requiring a counterweight of about 17 tons. The swinging rate is 1 1-3 revolutions per minute and the travel rate 150 feet per minute. All operations are done by electricity and can be carried out simultaneously, the current being transmitted by three wires and a trolley. The motors are 3-phase, 60-cycle, 220-volt, alternating-current type, that for the hoisting being 75 horsepower; for the traveling, 52 horsepower, and for the swinging, 11 horsepower. Each of the four tower legs rests on a truck of two wheels. The maximum load on each front leg is 100,000 pounds, and on the back leg, 67,000 pounds. The bases of the legs are 38 ft. apart up and down stream and 36 feet across stream. They were constructed by the E. F. Terry Mfg. Co. See illustration.)



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The Reserve Corps in the New Army

The following provisions of the Army Reorganization Act of June 4, 1920, will be of special interest to the Reserve Corps:

"For purposes of administration the continental area of the United States shall be divided into corps areas. Each corps area shall contain at least one division of the National Guard or Organized Reserves. Territorial distribution shall be made by a committee composed of members of the General Staff and an equal number of reserve officers, including reserve officers who hold or have held commissions in the National Guard.

"All policies affecting the organization, distribution and training of the National Guard and the Organized Reserve shall be prepared by committees of the General Staff to which shall be added an equal number of Reserve Officers, including Reserve Officers who hold or who have held commissions in the National Guard. While so serving such officers shall receive the pay and allowances of their grades.

"Persons hereafter commissioned as officers of the National Guard shall not be recognized unless they shall have been selected from the following classes: Reserve Officers, etc.

"So far as practicable, Reserve Officers shall be assigned to units in the locality of their places of residence. Any Reserve Officer may hold a commission in the National Guard without thereby vacating his Reserve Commission.

"After January 1, 1921, the Chief of the Militia Bureau shall be appointed by selection from lists of present and former National Guard officers who hold commissions in the Officers Reserve Corps. He shall have the rank, pay and allowances of a Major General of the Regular Army. The President may assign not exceeding 500 officers of the National Guard, who hold reserve commissions, to duty with the Regular Army, in addition to those attending service schools, and while so assigned they shall receive the same pay and allowances as Regular Army officers of like grade.

"Captains and Lieutenants belonging to organizations of the National Guard shall receive compensation at the rate of one-thirtieth of the monthly base bay of their grades as prescribed for the Regular Army, for each regular drill or other period of instruction authorized by the Secretary of War not exceeding five in any one calendar month at which they shall have been officially present during the entire required period. Captains commanding organizations shall receive $240 a year in addition to the drill pay herein prescribed. Officers above the grade of captain shall receive not more than $500 a year, and officers below the grade of major, not belonging to organizations, shall receive not more than four-thirtieths of the monthly base pay of their grades for satisfactory performance of their appropriate duties. Pay shall not accrue to any officer during a period when he shall be lawfully entitled to the same pay as an officer of corresponding grade in the Regular Army.

Commissions in the Regular Army still open to former emergency officers.—A *competitive* examination of eligible candidates who were for any good reason unable to take or complete the July examinations for appointment in the Regular Army, under Section Twenty-four, Act of June 4, 1920, will be held October 25, 1920, to fill two hundred vacancies in grades from Major to Second Lieutenant, inclusive.

Examinations will be similar to July examinations, and will contemplate appointment in the Infantry, Cavalry, Field Artillery, Coast Artillery Corps, Air Service, Corps of Engineers, Signal Corps, Ordnance Department, Chemical Warfare Service, Medical Corps and Dental Corps.

Applications for this examination will be accepted *only* from the following classes:

(*a*) Eligible persons who for any reason were not authorized to take the July examinations.

(*b*) Persons authorized to take the July examinations who for any good reason failed to appear before an examining board.

(*c*) Persons authorized to take the July examinations who appeared before an examining board but who for some good reason of their own volition or through illness or accident failed to complete the examination.

(*d*) Persons examined during the July examinations who were found disqualified on account of physical defects which have been removed by operation or do not exist at the time of the next examination. The physical qualifications of such persons to be finally determined at the time of the next examination without any further delay for recuperation or other examination at a later date.

All applications should be forwarded to The Adjutant General of the Army, Washington, D. C., on Form 739, A. G. O., and must reach the War Department *on or before October 9, 1920.*

When plans are developed for the examination of applicants for appointment in the Regular Army under the provisions of Section 24e, Act of Congress, approved June 4, 1920, announcement will be made through the public press, and those who are eligible may submit applications at that time.

Capt. J. H. DEVINE, formerly of the First Engineers, Camp Knox, Ky., has accepted a position with Edward R. Bacon Company as their District Representative at Sacramento, California.

Proposals

PROPOSALS FOR LEVEE WORK.—U. S. Engineer Office, 519 Canal Street, New Orleans, La.—Sealed proposals will be received here until 11 a. m., September 8, 1920, and then opened for constructing about 2,777,000 cubic yards of earthwork in the Atchafalaya, Lafourche, Barataria, Pontchartrain and Lake Borgne Levee Districts. Further information on application.

PROPOSALS FOR JETTY CONSTRUCTION.—U. S. Engineer Office, Customhouse, New Orleans, La.—Sealed proposals will be received here until 11 a. m., September 16, 1920, and then opened, for extending the jetties at the mouth of the Southwest Pass of the Mississippi River.

PROPOSALS FOR STEEL HULL FOR U. S. S. "CHISCA."—Office, Mississippi River Commission, 1st and 2d Districts, Customhouse, Memphis, Tenn.—Sealed proposals will be received here until 11 a. m., August 26, 1920, and then opened, for furnishing one steel hull for U. S. S. *Chisca.* Further information on application.

PROPOSALS FOR LEVEE WORK.—Office Third Mississippi River District, P. O. Box 404, Vicksburg, Miss.—Sealed proposals will be received here until 11 a. m., September 3, 1920, and then publicly opened for constructing about 260,000 cubic yards of levee work. Information on application.

U. S. ENGINEER OFFICE, NASHVILLE, TENN.—Sealed proposals for four steel barges will be received here until 11 a. m., September 13, 1920, and then opened. Further information on application.

U. S. ENGINEER OFFICE, JACKSONVILLE, Fla.—Sealed proposals will be received here until 12 m., September 15, 1920, and then opened, for jetty construction at entrance to St. Johns River, Fla. Information on application.

SALE OF GOVERNMENT PROPERTY.—Office, Mississippi River Commission, 1st and 2d Districts, Customhouse, Memphis, Tenn.—Under authority of the Secretary of War, dated July 21, 1920, contained in E. D. file 102092/3, there will be sold at Public Auction, at the Government Fleet, below the bridge, at Memphis, Tenn., at 10 o'clock a. m., September 2, 1920, one wooden hull, stern wheel steamboat belonging to the United States, 138 feet long by 28 feet 9 inches wide and 4 feet 10 inches deep. Terms: Cash at time of sale. Further information on application.

PROPOSALS FOR FIVE RETURN-FLUE BOILERS FOR U. S. S. "CHISCA."—Office, Mississippi River Commission, 1st and 2d Districts, Customhouse, Memphis, Tenn.—Sealed proposals will be received here until 11 a. m., August 26, 1920, and then opened, for furnishing and delivering five return-flue boilers for U. S. S. *Chisca.* Further information on application.

PROPOSALS FOR LEVEE WORK.—Office, Mississippi River Commission, 1st and 2d Districts, Customhouse, Memphis, Tenn.—Sealed proposals will be received here until 11 a. m., August 16, 1920, for constructing about 700,000 cubic yards of earthwork in the Upper and Lower St. Francis and White River Levee Districts. Further information on application.

PROPOSALS FOR STERN WHEEL STEEL TOWBOAT HULL.—Office Mississippi River Commission, 3d District, Vicksburg, Miss.—Sealed proposals will be received here until 11 a. m., August 23, 1920, and then publicly opened, for constructing one stern-wheel steel towboat hull. Information on application.

U. S. ENGINEER OFFICE, JACKSONVILLE, FLA.—Sealed proposals will be received here until 12 m., September 15, 1920, and then opened for constructing and delivering ponton catamarans for the dredge *Maj. J. C. Mallory.* Information on application.

PROPOSALS FOR HIRE OF TOWBOAT.—Office, Mississippi River Commission, 1st and 2d Districts, Customhouse, Memphis, Tenn.—Sealed proposals will be received here until 11 a. m., August 16, 1920, and then publicly opened, for the hire of a towboat of about the following dimensions: Length, 130 feet; beam, 28 feet; engine, 12 inches by 5 feet. Further information on application.

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U. S. ENGINEER OFFICE, ST. LOUIS, MO. Sealed proposals for constructing and erecting a steel traveling yard-bridge for handling iron ore, coal, etc., from barges at St. Loius, Mo., will be received at this office until 11 a. m., August 21, 1920, and then opened. Information on application.

U. S. ENGINEER OFFICE, CUSTOM-HOUSE, ST. LOUIS, MO.—Construction of an all-steel traveling yard-bridge, length about 500 feet, clearance height above rail 70 feet, with electric trolley and clamshell bucket, capacity 500 tons per hour, is contemplated for unloading iron ore from river barges at St. Louis, Mo. The dock wall and foundations and track for the bridge will be furnished. Contractors with experience in the construction and erection of such machines are requested to communicate with this office.

U. S. ENGINEER OFFICE, LOUISVILLE, KY.—Sealed proposals for furnishing and delivering Structural Steel, Castings, etc., for Lock No. 44, Ohio River, will be received at this office until 12 o'clock noon (central time), September 9, 1920, and then opened. Information on application.

PROPOSALS FOR ROCK.—U. S. Engineer Office, 519 Canal Street, New Orleans, La.—Sealed proposals will be received here until 11 a. m., September 7, 1920, and then opened, for delivery of 20,000 tons of one-man rock. Further information on application.

PROPOSALS FOR DREDGING.—U. S. Engineer Office, Providence, R. I.—Sealed proposals will be received here until 2 p. m. (Eastern standard time), August 26, 1920, and then opened, for dredging in Providence River and Harbor, R. I. Further information on application.

PROPOSALS FOR REMOVING WRECK.—U. S. Engineer Office, Wilmington, Del.—Sealed proposals will be received here until 11 a. m. (standard time), September 7, 1920, and then opened, for removing sunken steamer *Sylvan Dell* from Salem River, N. J., the wreck to become the property of the contractor. Further information on application.

PROPOSALS FOR LEVEE WORK.—Office of the Secretary, Mississippi River Commission, 1311 International Life Building, St. Louis, Mo.—Sealed proposals will be received here until 11 a. m., September 30, 1920, for constructing about 55,000 cubic yards of earthwork in the Riverland Levee District, Mo. Further information on application.

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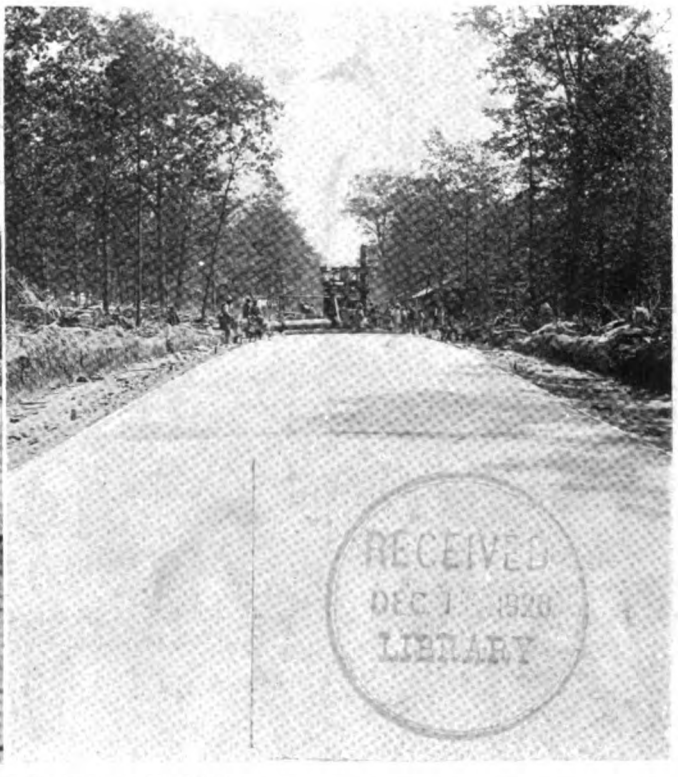


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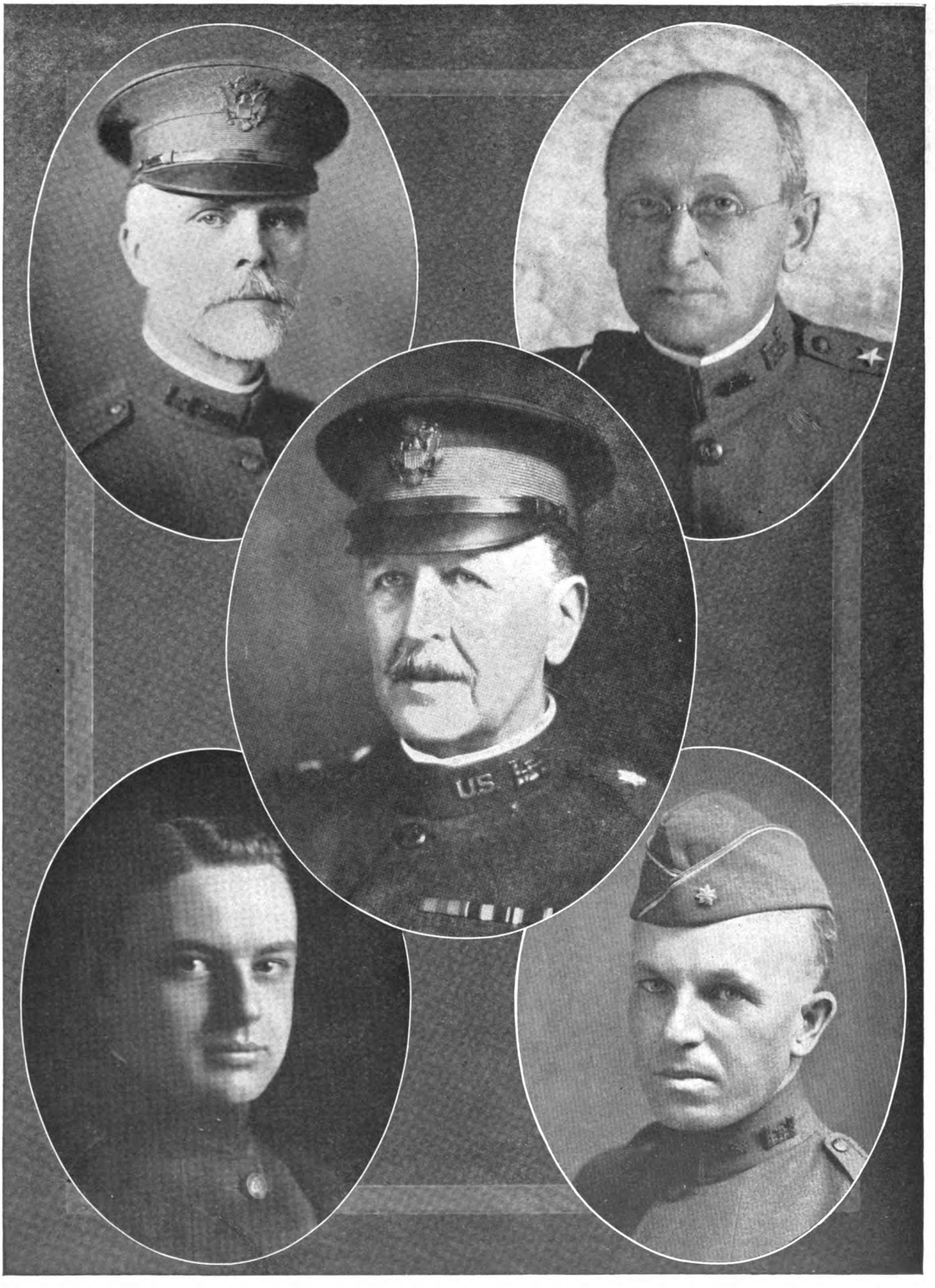
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The Fundamentals of Staff Control

By

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[*Introductory note.*—It is with pleasure that we present to our readers the two articles which follow, with discussions, on the all-important subject of staff functions and organization in military operations. The subject is one of great importance and of interest, not alone to the "highbrows" (so called) of the staff, but to the plain soldier on the battlefront, or "doing his bit" back in the S. O. S., to whom the "staff" were mystical and little known individuals enthroned in those celestial (or infernal) regions called "headquarters," angels with flaming swords, or devils with tridents, to be referred to in awesome whispers, or loud curses, according to the reverence of the individual (or his lack of it), his mood at the time, or his most recent experiences.

The workings of the "staff," whether familiar or mysterious, are of vast interest to all military men, and in these articles are discussed in most illuminating and entertaining fashion.

The two authors, both of whom are engineer officers, saw, between them, the entire field of staff activity. Captain Young, of the Staff at G. H. Q., had a close view of and participated in the operations of the Great General Staff at Headquarters. He observed, so to speak, the workings of the central power plant. He was a keen observer and expert analyst of what he saw. Major Lee, many miles away, observed with equal acumen, the temper of the cutting edge of the tool. As G-3 and Chief of Staff of one of the most active of the combat divisions throughout its operations, he saw at close range, the workings of our staff system on the field of battle.

Each of the authors saw things beyond the other's ken. That these different points of view should have caused considerable divergence of opinion was to have been expected. But this divergence of opinion is both instructive and interesting. It makes good reading.

The various commentators, as keen and perspicacious as the authors themselves, fall in line with one or the other or develop new points of view, adding to the knowledge and gayety of nations. Amongst them are included men who gained national, even international reputations, in the functions of both staff and command.

The discussion of Captain Young's article closes with a lively comment by Major Lee, and Captain Young completes the discussion of Major Lee's views with an equally spirited comment. And the battle ends with a final review by Major Lee, which he submits to the editor with the remark: "Herewith my 'come-back' at your 'highbrow' friends."

In spite of differences of opinion, which are more apparent than real, truth struggles to the top in both articles and in the comments thereon. All of the writers are especially qualified by their abilities, training and experience, to speak with authority on the subject, and no reader who has any interest in military affairs or in our national defense, can afford to miss what they have to say.—ED.]

A LARGE part of the "army reorganization," of which one hears so much, will in the next few years center around the evolution of a satisfactory working relation between the General Staff and the bureaus of supply services. It appears to the writer that there are certain fundamentals in this relationship which we can not afford to lose sight of, and which should be written into our staff doctrine in plain words.

By "general staff" is here meant not only the staff organization at Washington, but also the general staff sections with territorial departments, field armies, corps and divisions, etc. Similarly the bureaus are represented in such organizations, on the technical and administrative staff. Contact between staff and bureaus thus exists throughout the army, and this will continue.

Before the war the problem scarcely existed, for our army, administratively, was built around the bureaus and The Adjutant General. The general staff was considered to be a body, august, remote, brooding on problems of strategy and Weltpolitik. It was presumed that when war broke out the staff would have its plans for a campaign with Germany "on file in the drawer marked 'G,' as the tale goes. Except for this, the staff seemed to the army at large to have little contact with reality. It was in fact principally an emasculated War Plans Division, or G-3, of a staff. It had never been permitted to be anything else; it labored under the burden of a curious national conception that a general staff was in some way bound up with militarism. The fact that the enunciators of this theory knew as little about the general staff as they did about militarism, did not prevent this concept from existing, and hindering a proper staff development.

It is true that Field Service Regulations outline a staff organization for units larger than a brigade, whose composition is almost that of the existing system. It includes (*a*) a Chief of Staff; (*b*) "Such assistants as are necessary" to handle the work of the "three general divisions of general staff work," *i. e.*, combat section, administrative section and intelligence section; and (*c*) a technical and administrative staff—representatives of the staff corps and departments.

But we had never until 1918 fought a great war under this organization; and there had never been worked out in practice the critical point in the above—the relation between the assistant chiefs of staff and the technical and administrative staff.

When a division wants a bridge built, what are the respective functions of G-1 and the division engineer? Such a concrete question is a type of the hundreds that arise, when the staff organization came into play on a large scale. And speaking for the army as a whole, there was not even any generally known doctrine on the matter, let alone the actual experience of the system needed to give a doctrine life.

With the working out of the problem during the war, with the various interpretations put on staff functions and the successes or failures in carrying it out, the writer has neither the space nor the experience to deal. But he believes that a clear statement, in Field Service Regulations and wherever else the subject is dealt with, of the following points, would aid materially in ensuring a smooth-working organization.

1. *What does the General Staff do?*

There are only two things that it can do—advise, or give orders. A general staff officer's functions are advisory with respect to his commander. To the subordinates of that command, within his province, his relation is that he gives orders.

There should be no mistake about this, for the point is often obscured. It is said, for example, that a staff officer does not exercise command. In his own name, of course, he does not. He issues orders in the name of his commanding general. The French express the same idea by saying that a general staff officer is "anonymous." The distinction is of importance when one considers, as I shall below, the *sphere* of general staff authority; but as regards the *nature* of the authority, is rather metaphysical than practical. If I, as a general staff officer, tie things up, I lose my job; but if I do not, if I run things as the gen-

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eral wishes, then within my sphere I issue orders and exercise control. It matters little that to exercise it I must use the formula "by command of General Blank."

It is sometimes said that the general staff is "advisory." As stated above, this is true with regard to the commander. But this is only one side of the shield. It *would* be possible to have a purely advisory staff, a group of elder statesmen who sat to be consulted, and then relapsed while some one else did the work. But our staff does not work that way. G-1 of a division advises his general when consulted—just as the brigadier commanders do. But advice is not the sole nor even the principal function of either.

It is also sometimes said that the general staff "co-ordinates," or "supervises," or "outlines general policies." This again is dodging the issue. "Co-ordination" (surely the most overworked word in the army dictionary) implies, to begin with, a general getting together. But after the get-together is consummated, and everyone has said his say, some one must give orders. "Supervision" implies looking things over. But after they have been looked over, if anything is wrong, it must be righted by some one giving orders. "Outlining of general policies" implies a breadth of view essential to staff work; but you can neither outline a policy, nor put it into effect, without giving orders.

Advice—co-ordination—supervision—anonymity—general policies—all these words and phrases are valuable as expressing aspects and characteristics of staff work. But they should not be used to obscure the point that the general staff officer, besides thinking thoughts, has things to do, and that the way he does them is by giving orders.

2. *What is the nature of General Staff control?*

As stated above, a general staff officer gives orders as definitely as does anyone else in the army, except that his power to do so proceeds from position rather than from rank and is in the commander's name. The really distinguishing point about staff orders is what they are *about*.

Our pre-war army was used to two kinds of control—that of tactical or territorial commanders, and that of bureaus. Both consisted in the exercise of command over *men*, or over *organizations*, or over a certain *territory;* and as regards the men, or organizations, or territory in question, *all* matters arising which could not be settled by subordinates were referred to the single authority in question for decision.

There has now been introduced a third type, general staff control, which differs fundamentally from this. General staff authority is allocated and subdivided not over men, nor over organizations, nor over territory, nor (most particularly) over bureaus. It is allocated and subdivided by the *nature of the question.*

Suppose several questions arise in a brigade, or in a territorial department, or in a bureau organization such as the Corps of Engineers, for decision—let us say, a question of transportation, and a question of espionage, and a question of combat, and so on. There is no doubt in any officer's mind of who must settle those questions. They must be sent, if subordinates can not settle them, to the brigade or department commander or the Chief of Engineers as the case may be. *Whatever the nature* of the questions, they must, so long as they affect the territory or organizations in question, be routed to a certain man.

But suppose several such questions arise in units of a division and must go all the way up for a decision. "All the way" means to the division commander, but that in most cases means his general staff. To which staff section then shall they go? The answer is no longer inherent in the territory or men affected—in the *source* of the question—but in the *nature* of the question.

G-3 handles operation and combat questions; and if the infantry or engineers or signal troops are going to fight, they take their troubles to G-3. G-1 (divisional) handles supply and transport questions; and if the engineers or signal troops are going to establish a depot or run a convoy, and need a decision from higher authority, they go to G-1. The division engineer takes orders from G-1—make no mistake about that—but not *as* division engineer; he takes orders from G-1 *to the extent that* he has supply and transport *questions* that higher authority must solve. Similarly he takes orders from G-3 to the extent that he has combat questions.

This is the real meaning of the saying that a general staff officer "does not exercise command." For he controls not one man nor one foot of ground—wholly. But he controls perhaps millions of men, and a whole country, as regards *certain* of their activities. He is one element of the general's brain—magnified. And in general, chief of staff and G-sections should be considered as one unit giving decisions. Thus the elementary staff diagram is as shown in Fig. 1 (p. 507).

The lines indicate channels of reference of questions (up) and of decision (down). Point A may be taken as the adjutant, or whatever office receives and sorts papers. As indicated, questions are sorted at this point and pass up to the various staff sections according to the nature of the question, also, of course, according to the nature of the questioner who may take his difficulties direct to the staff officer concerned and thereby save time.

This expresses the meaning of "co-ordination." A question should not go up to the staff at all, as will be shown below, unless its answer affects some one other than the asker. So, when the division engineer goes to the general staff for a decision, it is because the answer will affect, say, the division quartermaster also. Say it is a question of which is to get the use of certain transportation. It must be decided—co-ordinated—by some one who thinks, not in terms of engineer or quartermaster questions, but in terms of transportation questions—namely, G-1. G-1 will not know one-tenth as much about engineer matters as the division engineer, and if he is wise, he will not pretend to. What he does know more about is what the general wants moved, and what there is to move it with. He co-ordinates. And co-ordination can be done only by this *functional* control.

This conception of functional control is simple enough—a regimental adjutant and regimental supply officer are common small-scale illustrations—but it is curious how often the point is missed in staff work. For example, I have heard it proposed that the bureaus or services of supply should be divided among the staff sections—the division quartermaster under G-1, for example, the division engineer under G-3. Or diagrammatically as in Figure 2.

In other words, G-3 would control, not only the operations activities of the division engineer, but also his supply activities. But that is not the business of G-3; he is the lobe of the general's brain that thinks operation thoughts, and nothing else. If the general wanted to subdivide his brain differently, and to think not combat and supply thoughts but engineer and quartermaster thoughts, he would not need any general staff; for the best thinker of engineer thoughts that he has is his division engineer. Another variation is the idea of putting all bureaus or supply services under one staff section. Do it, and you cease to have a staff section. You get instead a super-bureau, which still

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has the typical bureau characteristic—it exercises organizational or territorial control, not functional control, and needs some one above it to be a real staff section and coordinate things.

The *character* of general staff control then is *functional.*

3. *What is the extent of general staff control?*

In other words, how far may the general staff control or interfere with the workings of the bureaus?

The elementary staff diagram (Fig. 1) shows that questions referred up to the staff are re-sorted en route. When they start up they are classified by source, when they arrive they are classified by character. With this difference, however, staff control is similar to the other kinds of control that we have been used to. The problem of determining its extent is simply that of deciding what questions must be referred up to the staff at all. The answer is the same as for any other kind of control.

X, a subordinate, should refer questions to Y, his superior, when, and only when, the answer affects some one else besides X and co-ordinates with or superiors to him.

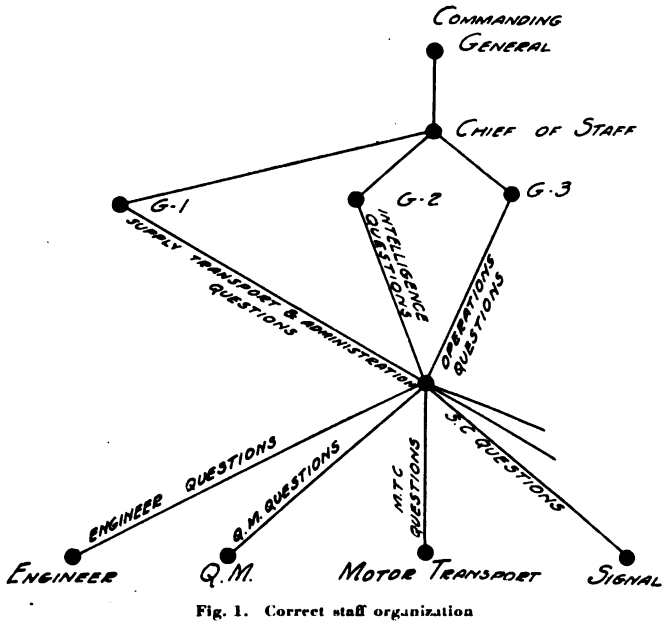


Fig. 1. Correct staff organization

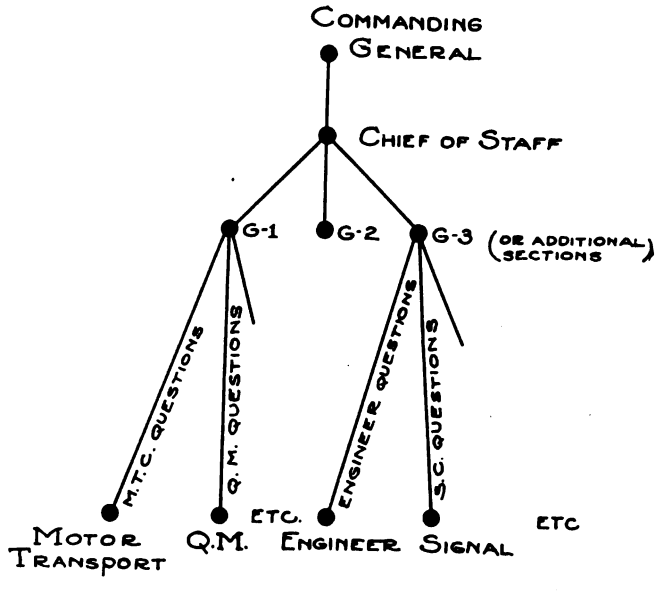


Fig. 2. Incorrect staff organization

Exceptions will be found to this, but as one goes higher and deals with larger and more decentralized units, the exceptions become progressively fewer. It is a good working rule.

Suppose a division engineer must build a bridge, preliminary to an attack. When and where shall it be built? What engineer troops, and what other troops shall be used? What engineer and what other transportation? Ponton or trestle—design—material—width of roadway—strength? What tools shall he provide, and how shall he organize his labor? These are samples of the questions put up to him. Which ones must be referred to the general staff for decision?

The time of construction, and in general the location, affect many people besides himself. If he needs troops or transport other than those under his control, that affects other people. And he must know what his bridge is to carry. These points must go to the general staff for decision, since they affect others than the division engineer. The other points mentioned do not, and he must be permitted to decide them himself.

Suppose the Chief of Engineers wants to buy, for engineer depots, some field searchlights and some canvas. A large war is on, and the production facilities of the country are strained to the limit. How far should the general staff concern itself with the purchase?

With the searchlights, not at all, except insofar as necessary to avoid complication of allocations of raw materials. Nobody issues field searchlights but the Engineers. With the canvas, yes, for many other bureaus issue it, and many arms of the service use it. Just what the staff would do here—whether it should make the purchase itself, limit the quantity which the Engineers purchase, etc.—I am not prepared to discuss. But it should do something; for if it permits the Engineers either to grab all the canvas or to be frozen out of the canvas market, if it permits uncontrolled price and priority competition in the market between bureaus, it is not on the job. Here, as in the first case, the general staff interferes when, and only when, some one besides the Engineers is concerned.

In discussions of the extent of staff control and interference, one finds—as elsewhere—much camouflage. It is said that the general staff should handle only "broad general" questions. This is well enough as far as it goes, but as a working rule it is a bit indefinite. It is said that the general staff should not interfere with "technical details." But this may not be correct. If our bridge-building division engineer wants to borrow the divisional supply train and build a rock fill half across a river, it is quite permissible for G-1 to ask if he can not arrange some other design needing less transportation to construct; and a highly technical discussion may develop. But if the engineer, *with his own forces,* can make that fill, and wants to, it is not a G-1 matter. The criterion is not the technicality of the question, but whether the answer affects anyone besides the division engineer.

G-1 may, of course, think that such a bridge will be washed out at the first flood and raise the question on that basis. But he takes his life in his hands if he does, for he is discussing with an expert a question which concerns only that expert. If the division engineer is on the job, he will demonstrate that his judgment is correct, and spend the next month telling his friends how he took a fall out of the general staff.

And, on the other hand, the method of cooking beans is a non-technical question; but no G-1 should interfere with the bean-cooking of the detachment working on the bridge, unless they showed signs of starvation, or at least chronic dyspepsia.

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None of these formulæ cover the case. The writer believes that his own does. The general staff co-ordinates; and co-ordination is needed only when there is duplication, or competition, or combined action on the part of two or more bureaus. In other words, decisions are made by the staff when they affect more people than the man asking the decision.

Conclusions

The general staff system, which came in with the late war, did not arrive without much inevitable friction and complaint. Reduced to their fundamentals and stripped of complications of many kinds, these complaints are easily classified under one of two heads:

A—Complaints by general staff officers that bureau representatives object to receiving orders from them, or to being subjected to general staff control.

B—Complaints from bureau representatives that staff officers interfere unduly with them, trespass beyond their province and try to "run" the service.

[It is not, of course, meant that such complaints were universal or even customary; but when there *were* complaints, they were along these lines.]

As regards "A," the answer is inherent in the doctrine given under "1" above. The bureaus must cease to object. Of course the general staff gives them orders. What else is it for? It is the mouthpiece of the general.

For various reasons it often occurred in the late war, and may occur again, that general staff officers, especially in smaller units, were junior in rank and length of service. But there is no valid reason here for making trouble. A regimental adjutant is junior to a battalion commander, yet the latter receives orders over the former's signature.

As regards "B," the answer is believed to be the training of our general staff as stated in "2" and "3." The staff must remember that it *co-ordinates*, and that co-ordination implies two things—functional division of duties and non-interference except when questions concern two or more bureaus or services.

The writer believes that there is nothing new in the above; that it is the basis of our staff doctrine. But he also believes that there is a vast amount of uncertainty about it, and that the points are often slurred over or concealed in vague words. If the above doctrines are those approved as basic for our general staff practice, they should be enunciated in our regulations so clearly that no doubt exists about them in the minds of the Army.

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Staff Organization and the "Theoretical Single Mind"

By

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In November, 1918, G. H. Q. of the A. E. F. issued a provisional Staff Manual. It was somewhat more complete, particularly in regard to higher staffs, than The Staff Manual published by the War Department in 1917. Neither publication, however, was at the time recognized to be complete, and both are known to have been loosely written. It is not the purpose of this article to present a staff manual, but it is hoped to offer a few principles of staff organization which the writer believes should be built into the foundation of a staff manual for the Army.

The Leavenworth "staff doctrine," which appears to have been the basis of both staff manuals, seems to be built on the following assumptions:

That the division or higher unit must be governed by "a theoretical single mind," the commander and his staff constituting the theoretical single mind which controls and influences the unit;

That the work of such a staff is logically divided into "general staff" and "technical and administrative" duties;

That a staff officer, as such, can give no orders in his own name;

And yet that a staff officer may properly control operations of the very troops themselves "in the name of the commander";

That a head of a service is expected "to function under" and "be co-ordinated by" one, two, or sometimes even three general staff "Gs";

That no limit is placed on the number of subordinates which a general staff "G" may be expected to "co-ordinate," "function over" or "control";

And that direct responsibility and command play no essential part in staff organization—a fair inference, since the idea is never expressed.

Moreover, the present doctrine coming from the Leavenworth schools in the form of lectures on staff organization, indicates that there has been no appreciable change in American staff policy as a result of our experience in the war.

It is not known why Leavenworth should indoctrinate the American Army with such an impracticable framework when the simple principles of organization can be applied to the staff as well as the line.

The writer has been told that the Leavenworth staff system was originally copied from the German, because it was thought that American armies would surely have political figureheads in command, much as the German armies must necessarily be led by titled figureheads, each case requiring trained technical experts to do the real brain work. If this were the hypothesis, our recent experience has eliminated the argument, for we had no political figureheads as higher commanders. Certain critics of the system say that it was formulated by a group of gifted young men desiring to create a system by which they, although juniors in rank, might gain control of the conduct of campaigns

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which must be handled in name by their seniors in service. Such discussions are interesting but get us nowhere. Nearly every member of the American Army, however, has seen a few if not many of the bad effects of this system. Those of us who saw it intimately should, before we forget, endeavor to point out the reasons for poor results and suggest, if possible, improvements.

It is believed that the word "organization" is and has been the most misused word in the language of the American Army. In the line we have by regulation a spendid framework which should guarantee "organization" throughout all the units of tactical command from the brigade down. That for the great majority, these organizations were not, and are not, real organizations, is due mainly to the fact that the first principles of "organization" were not and are not put into effect.

The first principles of "organization" seem to the writer to be these:

1. There shall be a single head who commands the organization. He is responsible for it to his proper superior. This single head alone commands the organization as such, and all orders or instructions for the organization should come to or be known by him. This is his responsibility and his command. He is responsible for all results of his organization, all that it does or all that it fails to do. It is his. He must produce with it—or be replaced.

2. The organization commander must divide his task into several distinct parts, as few as possible consistent with his mission, and divide his personnel to carry out these tasks. He must place in command of each part a responsible principal assistant whom he charges with the duty of carrying on that part of the work. This is the first subdivision within the organization.

3. To each of his principal assistants the commander must make it clear—

a. That the commander is the assistant's boss.

b. Just what the assistant's own mission is.

c. Just what the assistant can count on as his own means in personnel and in materiel.

d. That the assistant will be considered the boss in his own subdivision, will be backed up so long as he produces results and lives within the law, but must be held responsible for everything that his subdivision does or fails to do.

4. Each principal assistant must similarly "organize" his own subdivision along the same lines and require his assistants to do likewise. In this way is created the chain of command.

5. In military organization no single man can be expected to supervise personally and effectively, the work of more than seven immediate subordinates. The corporal, the lowest ranking field commander, has seven men under his immediate orders. This is the maximum. If a man has more subordinates, he won't know what they are doing in action, or in other times of stress, when it is most important that he do know. As the administrative duties and brain work of the successive commanders increase, the number of immediate subordinates should decrease. Where a commander's organization is stationary, the force can consist of larger echelons than where it is mobile and must meet constantly changing conditions.

6. There must be no one in the organization who does not know who his immediate superior is, and no officer or N. C. O. who does not know what his own job is and what he has of his own to do the job with. It is well for each private to know his general's name and the cause of the war—but it is essential that he know his own corporal as his boss. No man must have more than one "boss." If a superior officer interposes an order, the subordinate must, of course, obey—but the man's loyalty to his own commander must prompt him immediately to inform his commander of the circumstances. Each man must feel that he "belongs" to his boss and is responsible to him for all his time.

7. In any real organization, civil, military, religious, or otherwise, there are two general classes of duties—line and staff. In the military profession the line has the primary mission in war of inflicting loss on the enemy—our allies used to say, "killing boches." The staff has as its mission the duty of assisting the line in every possible way.

There are other principles which should be followed in guaranteeing the continuance of sound organization, but it is believed that the above are the essential ones. True organization may not be the cure-all for military troubles, but it is believed that the faithful application of these principles will go further toward success in campaign than any other known phase of military art.

Take, for example, a statement I heard on the boat coming home, made by a general staff officer who had held a very important position in the A. E. F. He said, "It has been demonstrated that the company of 250 men is too large. No captain can command 250 men. Why, he can't even feed and clothe, let alone control 250 men in action." Of course not. Neither did Marshal Foch personally control the Allied Army in action. Had this officer said that "a squad of 250 men" is too large we would quite agree with him. He apparently forgot that the company commander's organization properly consists of four platoons and a company headquarters, each one of which is properly commanded by a platoon leader or a headquarters chief. The company commander, if his organization is properly developed, need deal ordinarily with only five men. He looks on the company, its needs, requirements, its mission, *as a company,* and he requires his assistants to take care of the details. This does not mean that the lieutenants commanding platoons must handle and discipline the privates. If they do, they are wearing themselves out unnecessarily, as most of the officers did, while utterly neglecting, as most of them did, the proper development of their non-commissioned officers. Few, if any, of our companies had sergeants who really commanded their sections. The sergeant is usually considered as an indeterminate factor, as a corporal who has graduated from hard work and who is available for any old job anybody wants to give him.

When a company is actually an organization, the corporal commands the privates. Each corporal has his squad of seven men, for all of whom he is responsible in billets, on the march and in action. He should, moreover, be responsible for the equipment, clothing, physical condition and discipline of each man in his squad. The corporal thus supervises seven men (and otherwise they will not be properly supervised), and, moreover, the corporal, if worthy, will develop rapidly in initiative and responsibility. The sergeant, next, is given the command of two or more squads for which he is held responsible and with which he must produce results in billets, on the march and in action. His principal duty is to know his corporals, to be sure that they are producing for him and that they have everything that is necessary. In a similar way the lieutenant commanding the platoon deals with his sergeants (section commanders) and with the N. C. O. who commands his platoon headquarters. It is poetic perhaps for the captain to look after the feet of his soldiers; but who expects him to care for 500 feet! He will do well to take good care of *two*. Let him be sure that the lieutenants see the sergeants' feet, and that they see to it each sergeant knows, personally, how his corporals' feet are, having each corporal assure his sergeant that the feet of each private in his squad are inspected and being cared for. Such a company will have marching feet, and what is far more important, will be an "organization."

Besides the great advantage of thus guaranteeing a real framework whereby results can be assured and responsibility at any time be fixed, there develops within the organization a splendid morale due to the fact that every non-commissioned officer has a job, every non-commissioned officer has responsibility, every non-commissioned officer is given an opportunity to make good. He can win commendation or he can be found lacking. Every man knows just where he stands. Where these principles are put into effect the great majority of the non-commissioned officers are able to step efficiently into the next higher grade. If

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officers can give their attention to the larger phases of their tasks, the entire outfit is relieved of that curse of mental and physical strain causing the commander and one or two efficient men to break down from overwork which should have been performed by all.

In general, therefore, it is safe to say that true organization is based upon responsibility and command. These form the foundation and framework without which no military superstructure can be expected to stand through the storm of campaign.

Now let us apply these first principles to the organization of a combat division. The writer spent most of his war service on divisional staff work and is therefore familiar with this phase of the problem, although his observation elsewhere leads him to believe that the principles would work out much the same way in corps and general headquarters.

As to the division, the major general is the single head who commands it. He is responsible to his superior, the corps commander, for all that his division does or fails to do. All orders for the division must come to or be known by him. The corps engineer does not command the division engineer. The corps artillery commander does not command the divisions' guns. The corps commander himself should give no orders to a subordinate commander in the division without informing the division commander (and the subordinate must report it, too.) The corps chief of staff must not personally send orders to the division chief of staff. Orders must be addressed to the division commander. He properly wants assurance that such orders express the corps commander's wish either given in person, or by signed order, or by a recognized staff officer "by command of the corps commander." The division commander is the single head, but it is not a "theoretical single head" made up of some four or five enthusiastic "functionaries."

The division commander divides his task and his personnel into two general classes—line and staff. In the line are three brigades, each commanded by a brigadier, a logical subdivision for infantry relief and artillery support. These are the commander's line subdivisions, and upon them he must depend to carry out his will in battle. He must be sure of results. He must have direct responsibility without interference. In the chain of command he must let no one come between him and his brigadiers. They must feel the power of his personality, the strength of his will, his determination, and never forget their responsibility directly to him. A staff officer, even the Chief of Staff, can give orders to the brigadier only in the name of the major general. In fact the staff officer is merely a trusted bearer of dispatches, expressing the will of the commander, and is unable, of course, to assume any responsibility for the execution of the order, when the order, expressing the commanders' wish, is delivered and understood, the staff officer's responsibility ends.

Now, as to the other distinct part of the division commander's task,—the supplying of his troops with "everything," not only all the material things of arms, equipment, ammunition, clothing, food, transportation and roads, but also accurate information of the enemy, and sound profitable plans and orders explaining the commander's wish. All this is staffwork—assisting the line. It includes all the supply services, of course, the engineers, signal troops, trains, sanitary personnel—in fact, all "divisional" units other than the brigades—every element whose primary mission in battle is to *assist* the line in its duty of inflicting loss on the enemy.

The division commander has by regulation a "chief of staff." Sound organization requires that this man be put in responsible control of all staff functions. This means he must command the staff and all the staff troops. He will thus relieve the division commander of all staff details—be responsible for them, one and all. To the division commander and to the brigadiers, he is in fact the staff. They look to him for results and they should deal with him. The division commander thus holds his tactical assistants (brigadiers) responsible for the tactical details of the work while holding his staff assistant (chief of staff) responsible for all staff details. The distinction is important. The chief of staff has no authority over the brigadiers. But he has full authority over all the staff. He can not "control the troops," but he does give orders to the staff in his own name.

The division commander thus assures his four principal assistants that he is their boss—no one else. They owe all loyalty to him. Then to each he gives the proper mission which is briefly to command the brigade or staff, train it, keep it fit, and produce results with it. He makes it clear what each brigadier's command includes—and similarly for the chief of staff. The commander allots the material means available—billets, transportation, equipment. He assures each assistant that he won't undercut him and, so long as results are produced within the law and regulations, backing up will not be lacking. When any censure is to be handed out for failure, the brigadier or chief will catch it unless that officer can put his finger on the responsible person and correct the trouble. The commander is responsible that his assistants pull together as a team.

Each line brigade has its interior tactical organization. The brigadier general need only see that it is actual and effective. The chief of staff, however, has a harder task. If he follows the French system, which seems sound, he divides his task into three parts—supply of all material things, arms, ammunition, equipment, food, clothing, transportation, tools, wire, shelter, bridges, roads, lines of communication, traffic control, sanitary care, evacuation, replacement and all matters of administration—this is the "first bureau" (G-1), then all "intelligence" or enemy information placed in the hands of the line commander who can use it—all maps, photographs, captured documents, and the examination of prisoners, all that pertains to censorship—this is the "second bureau" (G-2); and finally the tactical office, the supply of sound tactical advice, plans and orders, of tactical information up and down, right and left, of training plans, the putting of the commanding general's wishes into orders certain of comprehension by the line and the staff—this is the 'third bureau" (G-3).

The first bureau has by far the widest range of activities. That is the one in which we as engineers are most interested. According to an old custom we are said to be on a "line status when serving with troops," but this must be considered an obsolete expression when dealing with the organization of a combat division. Although we proudly, and quite rightly, maintain that we are soldiers first and foremost, nevertheless our primary duty as sappers and pioneers is to assist the fighting man by doing engineering for him in battle. Before action and following it, and, indeed, for the large part during any active operation, the engineers of a combat division must perform innumerable services for the welfare and comfort of the line. Of course, this is not all. We not only provide and maintain roads and rail lines from the base or from the distributing point to the troops, but passable routes of advance into enemy territory, working alongside the fighting man. In combat the pioneer may do many things, but his main function is either to help

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the line soldier get forward so as the better to reach and subdue the enemy, or in defense to stop the enemy by obstacles so that the line soldier can dispose of him at more leisure.

This duty of assisting the line in all phases of its activi ties, in a material and practical way, places the engineers in accordance with sound organization under the first bureau of the staff. There they must be trained, kept fit and employed for all divisional purposes. For tactical use in direct contact with the line soldier, engineer battalions, companies or platoons must be assigned temporarily under the orders of the tactical commanders. While so serving the tactical commander controls these engineers entirely and is responsible for them. When the emergency demanding their use has passed they should be returned to the division engineer under the first bureau for refitting, replacement and further service.

The G-1 officer must, of course, organize his bureau along sound lines, dividing his work into distinct parts and putting responsible assistants in charge of cash. With our present complement of staff and staff troops, the writer believes that the best subdivision is:

1. An assistant for administration, under whom will serve adjutant, judge advocate, inspector and the commanding officer of the headquarters troop and detachment, senior chaplain and welfare agents.
2. An assistant for supply, under whom will serve the quartermaster, the ordnance officer, an engineer officer for supply, a signal officer for supply, and such other representatives of supply departments as may be necessary.
3. The division engineer commanding the engineer regiment and engineer train.
4. The commanding officer of divisional trains, under whose orders will serve the division supply train, the military police, the division veterinarian and the division motor transport officer.
5. The division surgeon, under whom will serve the commanding officer of the sanitary train, the sanitary inspector and the division dental surgeon.

Under the second bureau, which includes enemy information, called "intelligence" after it has reached the man who can use it, a comprehensive development requires a good organization. The writer found it best under our present system to have reporting directly to the assistant chief of staff, G-2:

1. The first assistant, G-2, in charge of the reports section, for receiving all intelligence reports from the tactical units and for preparing reports for higher authority. This section maintains the enemy order of battle and issues the intelligence reports and bulletins.
2. The reconnaissance section, which should be preferably commanded by an officer with topographic experience. He will have charge of all maps, all divisional observations and reconnaissance, airplane photographs and will command such units of the air service as the division has for observation.
3. Next is the enemy section under the senior interpreter in charge of all interpreters, translators, examination of prisoners, handling of civil affairs in occupied territory and counter espionage.
4. The fourth section, that of censorship, under the second assistant, G-2, includes mail, press, correspondents and attaches.

The third bureau under the assistant chief of staff, G-3, worked out for the writer very efficiently with only three sections:

1. The first was the operations section under the assistant G-3, where all tactical reports were digested and reports prepared for higher authority. The daily situation map was kept in this section, and all tactical, training, march and battle orders were prepared.
2. The second section was under the divisional signal officer, who was in charge of all divisional communications. Under his orders are such parts of the divisional signal battalion as are not assigned to the brigades, the division message center and all liaison agents reporting from adjacent and higher organizations.
3. The third section, under the division machine-gun officer, in charge of training with particular attention to specialties and automatic weapons. Visitors from our army were placed under his orders for reconnaissance duty. Other than in action (and once during an offensive) the division machine-gun battalion was placed under his orders and was used as the division machine-gun center, forming the basis for the infantry school of arms.

The assignment of personnel can not be fixed nor can the exact framework within the staff be considered permanent. The personal equation in practice becomes almost the ruling factor and must be recognized in order to get the best results. Granting this, however, it must be remembered that the first principles of organization should be faithfully adhered to, that at no time should responsibility be impaired, should command be disregarded, or should any subordinate be required to work for more than one boss at the same time. As seen above, the division engineer is placed directly under the orders of G-1 where the greater part of the engineering work is performed. In the supply section, however, where the services of an engineer are required to handle the routine of engineer supply separate from the regiment, a junior officer is so detailed and this engineer officer's boss is G-1's assistant for supply. Under the G-2 office, the officer in charge of the reconnaissance section will probably be an engineer. His boss will be G-2 and no one else. If for personal reasons, any of these officers are shifted, the matter is simple—let the officer, his old boss and his new boss, know of the change. But at no time must he be required to report to, function under, or be commanded by more than one superior.

It is believed that the proper assignment for the division munitions officer, if there be one, is on the staff of the commanding officer of the ammunition train who serves under the artillery brigadier. Moreover, the proper assignment for the senior chemical warfare service officer is on the staff of the artillery commander. Defense experts in chemical warfare should serve with the infantry brigades and with the sanitary train, at least until the line and medical personnel become thoroughly instructed in this phase of warfare. The sooner, however, that this work is absorbed and handled in action by the line itself, the more efficiently it will fit in with the combat organization.

The question of relative rank immediately arises in the minds of engineers. The division engineer with the rank of colonel is, according to sound organization principles, placed apparently under the orders of a junior. He must not be under the orders of a junior. The assistant chief of staff, G-1, must be in every way capable of commanding the division engineer, and not only the engineer but the surgeon and the commander of trains, his own assistants for administration and for supply. This is a large order. It takes an able man to fill the job. He must not only be capable along executive, administrative and co-ordinating lines, thoroughly grounded in this G-1 work, but he must be capable of appreciating the tactical requirements of each situation that confronts the division commander. The G-1 officer should be picked as the best executive supply and service man who has had sufficient tactical training to fit him for the job.

The writer feels that too much importance can not be placed on the proper conception of the G-1 qualifications of the general staff. As warfare has developed and the entire strength of a nation is placed behind its combat forces, the duty of co-ordinating all this material strength becomes every bit as important as the making of sound military plans, gaining accurate enemy knowledge and conducting successful strategic operations. Moreover, no one of these operations can be performed with efficiency without knowledge of the capabilities and possibilities of the other parts. Unless the G-1 chief has a military mind, his work and the final result must fall short of its full possibilities. Unless the tactical chief appreciates the G-1 situation, impractical plans or incomplete operations are cer-

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tain to result. In other words, the true mission of the general staff, not only for the division but for any military body, is the duty of fitting all military activities of supply (material and otherwise) into a soundly organized system for control by the superior commander. It furnishes the "members" of the military framework which positively connect the commander with all the agencies that supply the line and make its successful operations possible.

It must be distinctly recognized, however, that the staff members should not be considered in any respect as coming between the tactical commander and the tactical subordinates. That responsibility must be direct and uninterrupted. The tactical details of any operation should be worked out by tactical subordinates. For example, on the division staff, the division commander having made his decision, the chief of staff must see to it that the G-3 officer supplies a comprehensive order expressing the commander's wish to his tactical assistants and to the chief of staff. G-3's duty is to see that the order is quickly framed into language that can be understood, that it contains no inconsistencies, that the orders of the corps commander are complied with and that there are no omissions. It is not his duty to work out the details of the brigadiers' plans. That is interference. Such details must be left to each brigade commander and his tactical subordinates.

The matter of relative rank under this system would work itself out. We should not be seriously concerned with such details so long as infinitely more important matters are at stake. If it seems necessary to have the division engineer a lieutenant colonel, well and good. When such an officer's duties are important enough relatively to warrant his holding a higher grade, that will be apparent and can be met. The writer personally feels that the division engineer, the division surgeon, commanding officer of trains and assistant for supply in the G-1 office should, under our present system, be lieutenant colonels. The assistant for administration should be a major. The G-1 officer should have the rank of colonel as should the G-3 officer who, during the absence of the chief of staff in active operations, perform the duties of the senior staff officer of the division. The assistant chief of staff, G-2, however, should be a lieutenant colonel.

As for the chief of staff, his duties and responsibilities demand an officer of caliber at least equal to that of the brigadiers. His responsibility if anything is larger, and his training should have been even more varied than that of a brigade commander, while being in all respects thorough; he is the division commander's first advisor and should be a man in whom the commander and the brigadiers have confidence. It is not felt that he should be senior to the brigade commanders, but he should have the same relative rank. This, however, is a matter of relatively small importance. Colonels can command colonels when the regulations require it. But, of course, the commander must not be of junior grade to his assistants. It should be remembered, when discussing rank on the staff, that this system is economical. A capable G-1 and assistant for supply will release older quartermasters and ordnance officers for better jobs, turning over to a junior officer the Q. M. and ordnance work under efficient G-1 supervision.

What we need in our military organization is not a single theoretical mind to control the troops—but one single head, the real master mind, to command the organization. We must recognize the responsibility and command go hand in hand, and form the real foundation and framework of the military structure; that the chain of line command must be direct, positive and unmolested by the staff; that sound organization being as vital to staff success as it is to line success, then full responsibility and complete command must be given to staff chiefs over their subordinates; that the rudiments of organization, applicable the world over, must not be disregarded in such an essentially practical business as war. All this means getting the desired results in the easiest, best and quickest manner—the essence of efficiency.

We should not be satisfied with the remark that capable staff officers will make any system work out. We must have a system which will develop good staff officers—a system which will produce results with "the run of the mine" material, sorting it automatically, requiring every individual in authority to prove his worth.

When such a system as this is put into operation and is maintained, it will be the greatest possible eliminator of dead wood. Every man in the entire organization will have his job, will have somebody requiring him to produce, will have the necessary means to make good or to prove his inefficiency. This is not merely a theory. It has been done. Its application will be fought by reactionaries and by the inefficient, but the writer feels that, imperfectly as these principles have been stated, their truth will carry conviction to all practical men.

For Discussion, see Page 565

Making Wood Fire-resistant with Paint

The inflammability of wood may be decreased by: (*a*) keeping it wet; (*b*) injecting chemicals into it under pressure; (*c*) painting it with fire retardent paint. The U. S. Forests Products Laboratory finds the last method the most practicable for the economical treatment of small quantities of wood. For interior use, ordinary calcimine or white wash has proved as effective as any paints investigated. It rapidly loses its effectiveness when exposed to weather, and for such conditions the Forest Products Laboratory recommends a paint consisting of linseed oil, zinc borate, and chrome green. Numerous patented fire resisting paints have also been found satisfactory.—*Eng. News-Rec.*

A Defense of "Essayons"

One of the older officers of the Corps of Engineers writes as follows:

I have noticed with regret a lack of due consideration in the way in which a question of a change in the time-honored motto of the Corps of Engineers, "Essayons," has been discussed in the columns of THE MILITARY ENGINEER.

Of all things most needed in this country at present, cool and judicial conservatism in combatting hasty and ill-considered action is the most desirable. It is as necessary to check the ultra-radical as it is to prod the ultra-conservative.

The radical efforts of fanatical minorities in demanding the enactment of endless laws to cure moral defects and to effect changes in every conceivable relation of social, business and industrial life on the mere grounds that because it is, it is wrong, will lead us into an endless maze of half baked legislation and executive action, which will eventually terminate in contempt for both law and executive authority.

The proper significance of "Essayons" is "Let us undertake it," "Let us carry on" no matter what the task presented, the order given, the problems to be solved, the difficulties to be encountered, the fatigues and dangers to be incurred, the personal sacrifices involved. The answer of the Corps of Engineers in the past has aways been, and with proper guidance and handling in the future, will always be "Essayons," "Let us undertake it" for "duty, honor, country."

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The Port of Mobile as a Factor in Foreign Trade

By

R. S. Thomas

Major, Corps of Engineers, U. S. Army; M. Am. Soc. C. E.

[*Note.*—Fundamental economic principles are of more importance and more interest than technical details. They bear the same relation to the latter that the *control* of a survey bears to the details which fill up the map. Without a good control we can not have a good map, however carefully the details may have been executed. Similarly a commercial project, however vigorously and efficiently it is carried out, will certainly fail to achieve the full measure of success if based on an incorrect conception of economic principles.

These remarks are also true of warfare. In war, however, there is often opportunity to retrieve a bad plan and poor preparation by vigorous execution. In fact, this has been America's invariable method of conducting war. And we have achieved success, or apparent success, but regardless of cost. A very moderate amount of planning and preparation would have avoided war or have greatly reduced its cost. We are now bearing the burden of the unnecessary cost of war due to deliberate refusal to make preparation, and we will bear it for many years to come. And the next great war will impose an even heavier burden than the late conflict.

The principles of economics are of general application, and the author of this article furnishes us an excellent example of their concrete application to the most important of man's activities—commerce. His clear statements can not fail to be interesting and profitable to any engineer, whatever his particular line of activity.—ED.]

CONSIDERATION of the commercial prospects of any port requires a detailed examination and discussion dealing with—

(*a*) The geographical location of the port with reference not only to the trade centers in the interior, but also to foreign ports;

(*b*) The question of railroad rates on export traffic from the producing centers to the port;

(*c*) Combined rail-and-water rates on exports;

(*d*) The effect of these factors on the commerce of the port;

(*e*) Commercial statistics;

(*f*) Steps that might be taken to stimulate the movement of traffic through the port, and

(*g*) Port facilities and the physical efficiency of the port.

The port of Mobile, Ala., is selected as a concrete example for discussion. Local features have been omitted where not essential to indicate the method of treatment. In the practical study of a particular port, however, the local features predominate and must of necessity be treated in greater detail than herein, while the more general economic features can be greatly condensed or omitted.

Geographical location

In commerce, as in any other competition, whether on the race track or in warfare, an important factor is position. On the race track, as everyone knows, the "inside track" gives the horse an advantage. In military history there often occur the phrases "a strategic position," "interior lines," etc. It is also well known that the horse having the inside track does not always win the race, nor does the army in the best strategic position always win the war. Position, then, is an important factor but not the only factor.

In considering Mobile as a port let us first examine the advantages and disadvantages that accrue by reason of its position. In the first place, what is the position of Mobile with reference to trade? The chart herewith shows the United States divided by broken lines into zones which may be called tributary zones to a certain seaboard on the basis of railroad mileage. It will be noted that on the chart near the intersection of the longitude line 85 degrees and the latitude line of 30 degrees there begins a broken line extending almost due north to near Lexington, Ky., thence northwest to St. Paul, Minn. Points east of this line are nearer by railroad to the Atlantic seaboard than to the Gulf or to the Pacific. Near the southern extremity of the boundary line between Arizona and New Mexico there begins another broken line extending in a northeast direction. Points west of this line are nearer in railroad distance to the Pacific seaboard than to the Atlantic or to the Gulf. Points east of this line and west of the line before mentioned are nearer the Gulf seaboard than to the Pacific seaboard, or to the Atlantic seaboard. For the purpose of comparing the position of Mobile to that of New Orleans, its competitor, there has been drawn a third line of dashes extending north and northeast from Gulfport, dividing the territory tributary to the Gulf seaboard into two parts, that which is nearer to Mobile and Pensacola and that which is nearer Galveston or New Orleans. In this discussion no attempt has been made to distinguish the tributary area of Mobile from that of Pensacola—the geographical position of these two points is for all practical purposes identical. It should also be pointed out that from such points as Kansas City and Omaha the distance to Mobile is less than the distance to New Orleans, but that on a distance basis only the logical port for these cities is Galveston, which is the nearest port.

Thus we see that in distance alone Mobile and Pensacola have the inside track on exports from a large area in the South and Middle West, including the entire State of Alabama and large portions of Iowa, Missouri, Illinois, Kentucky, Tennessee, the southwest part of Indiana and the eastern half of Mississippi. This area includes the most fertile agricultural section of the United States and the coal and iron fields of the Birmingham district.

An idea of Mobile's geographical position with reference to these interior points may be obtained from a consideration of those cities which may be considered to lie within the "twilight" zone or near the border line of the tributary zone. For example, the following cities are slightly nearer the Atlantic seaboard, namely, Atlanta, Nashville, Cincinnati, Indianapolis, Chicago and Milwaukee. On the other hand, the following cities are slightly nearer the Gulf seaboard: Birmingham, Montgomery, Chattanooga, Louisville and St. Paul. These cities are said to be in the "twilight" zone inasmuch as the difference in distance to the Gulf and to the Atlantic seaboard is so slight that the matter of position alone offers practically no material advantage in

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favor of either seaboard, and trade from these cities would result from such factors as storage and transfer facilities at the port, favorable schedules, direct haul, banking facilities and habits of trade.

As between the Gulf ports, Hattiesburg, Meridian, Memphis, Louisville, St. Louis, Dubuque, Des Moines and St. Paul are nearest to Mobile; Gulfport and Jackson, Miss., Chicago and Milwaukee are nearest to New Orleans, and Little Rock, Kansas City, Omaha and Denver are nearest to Galveston.

Positions with reference to foreign ports

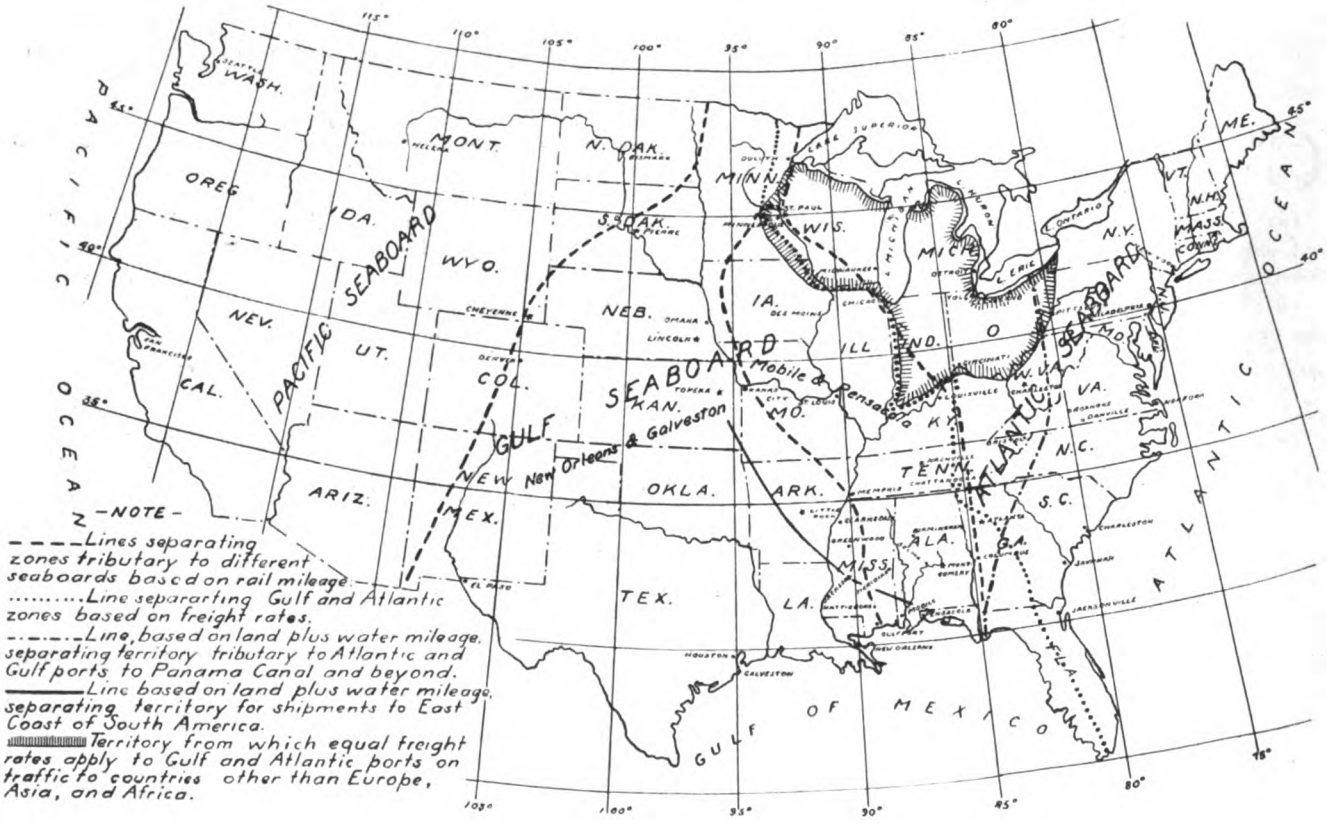
In the competition between cities as exporting points the advantage of position with reference to producing centers is not alone sufficient to insure control of trade. Goods in transit have a point of origin, and a short haul from that point of origin to the seaboard is a material advantage; but these goods also have an ultimate destination, and therefore the distance from the port to that point of ultimate destination is also a matter to be considered. Let us now examine the position of Mobile with reference to the various ports of the world that receive the products of America. This is shown in the table on page 515.

Havana, Cuba; Cartegena, Colombia; the west coasts of Mexico and Central America via Panama Canal, and the west coast of South America via Panama Canal are all nearer to the Gulf ports than to the Atlantic ports, while Nassau, in the Bahamas; Port Au Prince, Haiti; Port of Spain, Trinidad; and the east coast of South America are nearer to the Atlantic seaboard than to the Gulf seaboard. As between the Gulf ports, Mobile and Pensacola enjoy a slight advantage over New Orleans and Galveston in having a somewhat less distance to Belize and points south, including the Panama Canal. This obviously gives Mobile and Pensacola a slight advantage in distance to all points on the west coasts of Central and South America. As for the west coast of Mexico the advantage lies with the Pacific seaboard.

Thus it appears that the "inside track," the logical trade territory for Mobile, consists of Cuba, Central America, Venezuela, Colombia, Ecuador, Peru, Bolivia and Chile.

Habits of trade

For the purpose of illustrating the functions of the ports of the Atlantic and Gulf coasts and for illustrating the various factors that determine the volume of trade through the several ports, let us imagine a small community situated in a fertile valley bounded on the east and south by a range of mountains through which there are several passes and beyond which lie good roads and the several markets for the products of this community. Now, let us consider Mr. Chicago who lives in the center of this valley and wishes to haul his products to the town of Liverpool situated to the east. Naturally he would haul his product by way of the east pass through the mountains. It so happens, however, that the road to the east pass is much more hilly than the road to the south pass, and it would be advantageous to go out by way of the south pass even if the haul is a little longer, but his grandfather and his father had always hauled by way of the east pass so Mr. Chicago continues to haul the same way. Now, suppose Mr. Chicago wants to haul his products to the town of Panama, lying south of him. The logical way, naturally, would be through the south pass, but there is a favorite merchant of his living near the east pass that will buy his wheat, corn, eggs and chickens, and sell his dry goods; so



Producing zones tributary to various seaboards on the basis of railway mileage

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Mr. Chicago prefers to sell his stuff to this merchant rather than to haul it all the way to Panama, and this merchant at the east pass collects the produce from the various farmers in the community in large loads and ships out the produce to various markets in other communities.

Now, let us consider Mr. Meridian, a big cotton planter. He finds a better market for his cotton in the town of Liverpool than at Panama, but Mr. Meridian is nearer to the south pass than to the eastern pass. The southeast, however, has another pass over the mountains near Mr. Savannah's plantation, and the total distance to Liverpool by way of the Savannah pass is less than by the south pass, although he has a longer distance over bad roads to travel. If Mr. Meridian did his own hauling he would probably prefer to take the longer route and the better roads by way of the south pass. It so happens that Mr. Meridian doesn't own the necessary transportation, so he employs a truck company to do the hauling for him. The truck company charges a higher rate to go by the south pass than by way of the Savannah pass, and, of course, Mr. Meridian does not care what route the transportation company uses so long as he gets the cheapest rates.

In this parable one can see the advantage of nearness to the port; that is, the shorter rail haul or the shorter haul over the rougher and more expensive road. It will be seen also that nearness to the port is not necessarily the controlling factor, for the total combined distance from the point of origin to the point of destination must be considered. It will also be seen that where the producer does not do his own hauling that the combined distance from the point of origin to the point of ultimate destination is also not a controlling factor, but that the actual price that he pays for the service of transportation is what decides him. Generally speaking, the distance of haul naturally determines the price that he pays for his transportation, but the cost of this transportation is not always directly proportional to the distance over which the produce is hauled. There can also be seen in this parable the influence of that factor which may be called "Habits of trade." People follow the crowd and hold to well-established paths. This movement of commerce may be also compared with that of a river, once established in a definite channel it is very difficult to divert.

Total distance from point of origin to ultimate destination

How Mobile is situated as an outlet for commerce from various producing centers in the United States to the Panama Canal, can be determined by comparing the total rail-and-water distances from certain typical cities to Colon via the nearest Atlantic port and via Mobile. For example, Pittsburgh, Pa., is nearer to Colon via Philadelphia than via Mobile, the total distances by the two routes being, respectively, 2,702 and 2,594 miles. On the other hand, Cleveland, Ohio, is 82 miles nearer the Panama Canal via Mobile than via Philadelphia, its nearest Atlantic port. Charleston, W. Va., is 36 miles nearer by way of Mobile than by way of Norfolk; Danville, Va., is nearer via Norfolk. Knoxville, Tenn., and Atlanta, Ga., are, respectively, 163 and 186 miles nearer by way of Mobile than by way of Savannah.

These facts are shown graphically on the chart by the line of dashes and dots starting on the Gulf coast of Florida and extending northeastward and northward near Atlanta, Charleston and Cleveland. For the points east of this line, shipments to the Panama Canal would move by a shorter route by way of the Atlantic seaboard than by way of the Gulf. For the points west of this line, distances to the Panama Canal and to points beyond would be less by way of the Gulf than by way of the Atlantic seaboard.

For points north and east of the solid line that passes near Meridian, Jackson, Little Rock, toward Topeka, shipments to Buenos Ayres are nearer by way of the Atlantic seaboard. For example, the distance from Meridian, Miss., to Buenos Ayres via Savannah, Ga., is 22 miles less than by way of Mobile. It must not be forgotten, however, that these figures apply only to combined distance. As the cost of moving by rail is greater than the cost of moving by water, Mobile now draws shipments from territory north

TRADE ROUTE DISTANCES BETWEEN U.S. AND FOREIGN PORTS [NAUTICAL MILES]

BETWEEN	Seattle	San Francisco	Galveston	New Orleans	Mobile	Pensacola	Jacksonville	Savannah	Norfolk	Philadelphia	New York
Honolulu	2409	2091	6221(1)	6118(2)	6099(1)	6072(1)	6244(1)	6291(1)	6507(1)	6674(1)	6702(1)
Hong Kong	6029	6306	11210(8)	10628(2)	11088(8)	11061(8)	11233(8)	11280(8)	11496(8)	11663(8)	11605(9)
Sidney		6744(3)	9330(4)	9220(5)	9208(4)	9181(4)	9353(4)	9400(4)	9616(4)	9783(4)	9691(6)
Colon	4064	3288	1493	1390	1371	1344	1516	1563	1779	1946	1974
Callao		3987	2882	2779(2)	2760(1)	2733(1)	2905(1)	2952(1)	3168	3335	3363
Buenos Ayres				6281	6225	6183	5841	5854	5824	5918	5871
Belize			935	850	846	850	1047	1124	1503	1674	1704
Vera Cruz		4708	623	789	825	831	1325	1415		1953	2017
Havana		4291	769	603	553	515	528	606	985	1156	1186
San Juan		4281	1716	1535	1479	1437	1121	1153		1395	1399
Gibralter			4753	4577	4524	4484	3764	3689	3369	3350	3207
Liverpool		7836(1)	4773	4597	4544	4504	3692	3613	3272	3250	3107
Port au Prince			1400	1219	1163	1121				1343	1372
Saint Thomas			1786	1605	1549	1507		1210		1434	1434
Port of Spain			2230(7)	2051	1995	1953	1685	1714		1938	1939(10)

(1) Via Panama Canal.
(2) Via South Pass and Panama Canal.
(3) Via Honolulu and Pago Pago.
(4) Via Panama and Tahiti.
(5) Via South Pass, Panama, and Tahiti.
(6) Via Panama and direct.
(7) Via Yucatan Channel.
(8) Via Panama, San Francisco, Yokohama and Shanghai.
(9) Via Suez Canal, south of Sokotra Id.
(10) Via Virgin Passage.

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of this heavy line, by reason of the shorter rail haul.

Freight rates

The advantages and disadvantages hereinbefore indicated are based solely on distance and are therefore more theoretical than actual. The actual cost of handling commerce on the present basis is the artificial but well-established railroad rate plus the somewhat fluctuating ocean freight rate. Where shippers own their own transportation they will generally take the shortest distance from their farm to their market, but where they have to pay a transportation company for the delivery of their product the distance is not of so much importance as the actual charges of the transportation company. We will suppose that when the first transportation company was organized they figured how much it would cost them to operate and charged prices that would enable them to make a profit. On such a basis the charges might be said to be based on the "cost of service."

But the transportation company may be supposed to have found later that they could raise the prices without reducing the volume of goods they handled and that the farmers would stand for it. They also found that a certain part of the community was not developing and therefore not producing much freight for handling by reason of its remote distance. The company therefore made cheaper rates for similar service to the remoter sections of the country, at the same time charging other sections as much as possible without discouraging production. The rates were then based on the rule called "All that the traffic will bear."

Let us suppose that other transportation companies were then organized. Then freight rates had to be adjusted to meet competition, and the rates were then placed on a "competitive basis." It was then found that people living in one section were getting a freight rate which made it uneconomical for the people living in another section to attempt to produce the same commodity. Freight rates were then "adjusted" so that one community could continue to produce in competition with the former and thus furnish freight to the transportation companies.

Now, let us suppose there were several farms in this community on the banks of a river, by means of which the produce could be hauled to market more cheaply than by the trucks or railroads of the transportation company. In order to meet this water competitor, the transportation company offered the farmer a price of transportation below that which it would cost him to haul by water, and, in order to make up this loss from the income of the transportation company caused by reduction in rates to the farms on the river, the price of transportation from the farms not situated on the water was increased correspondingly. This was a most usual practice.

This story shows in a general way the evolution of our existing elaborate and complicated system of freight rates. It is now easily apparent how far the basis of existing rates has departed from the original basis, *cost of service.*

Let us now apply these considerations to our local port. What effect would the return to the original basis of cost of service in the fixation of freight rates have upon Mobile?

First. Consider the topography of the eastern portion of our country. There is the Appalachian chain of mountains separating the Middle West from the Atlantic seaboard. Crossing these mountains involved a greater first cost in the construction of the railroad, a greater cost of maintenance of trackage and a greater cost of traction on the east and west railroads to the Atlantic seaboard as compared with the lesser cost of similar items on the north and south railroads following natural grade lines to the Gulf coast. This factor should have a tendency to enlarge the tributary area of the Gulf seaboard.

Second. The volume and density of traffic to the Atlantic seaboard is greater under present habits of trade and under existing freight rates than is the volume and density of traffic to the Gulf coast. The greater the volume and the density of traffic, naturally the less will be the proportionate charge per ton-mile of overhead expense and therefore the less the total cost per ton-mile. This factor would have a tendency to contract the area tributary to the Gulf. It is largely upon the theory of this latter factor, density of traffic, that existing freight rates are established. It is also claimed that the east and west railroads are better equipped and organized and more economically operated. than the north and south roads.

Referring again to the chart there will be seen a line of dots running through central Florida and Georgia, Tennessee, Kentucky; thence along the Ohio River to the western boundary of Indiana; thence to Chicago and St. Paul. This is approximately the line of equal freight rates between the Atlantic and Gulf seaboards on general freight. Points west of this line enjoy a differential in favor of the Gulf seaboard. The shaded area of Indiana and Wisconsin, Ohio and the southern peninsula of Michigan indicates neutral territory in which the freight rates to the Atlantic and to the Gulf are equal. On certain special commodities, however, there are special rates to which the foregoing remarks do not apply. The class rates applying on export traffic to countries other than Europe, Asia and Africa from Chicago, St. Louis, Indianapolis and Cincinnati are identical for Mobile and New Orleans, which cities enjoy a differential of about 12 per cent under the respective rates from the foregoing cities to New York. For shipments to Europe from the central territory, rates are favorable to the eastern and south Atlantic ports and unfavorable to the Gulf ports.

The data upon commodity rates that were available at the time of preparation of this article are not sufficient to permit of an exhaustive study of the influence of freight rates upon the commerce of the port of Mobile, but they are sufficient to warrant some interesting conclusions, among which are the following:

(*a*) Flour can be shipped from Kansas City, Mo., to Cuba or Liverpool via Mobile and New Orleans at less than via New York.

(*b*) Agricultural implements can be shipped from Chicago to Liverpool and to Buenos Ayres via Mobile or New Orleans at less than via New York.

(*c*) Cotton can be shipped to Liverpool from Memphis, Tenn., Montgomery, Ala., and even Meridian, Miss., at a less rate via Savannah, Ga., than via Mobile or New Orleans. The Interstate Commerce Commission has recently ordered a readjustment of these rates, declaring the present rates unfair and discriminatory.

(*d*) In general, the ocean rates on similar commodities from Gulf ports, except Key West, are the same, and these rates to Cuba and South America are also the same as the rates from the Atlantic seaboard, and the ocean rates to Europe are greater from the Gulf ports than from the Atlantic ports.

A glance at the rates reduced to a ton-mile basis is sufficient to show that actual mileage is not the controlling factor in the determination of present freight rates.

Competition between producing localities for trade in certain markets appears to exert the predominant influence in the establishment of the combined rail-and-water rate,

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the railroad or ocean carrier absorbing the greater proportion of the rate, depending upon the principle of charging what the traffic will bear. Generally the longer the haul the less the cost per ton-mile, and the shorter the haul the greater the cost per ton-mile. This last principle is reasonable in that the shorter the haul, the greater the proportion of overhead expense to be borne per ton-mile of traffic, but the application of this principle has established some very unfair rates. This is especially noticeable in the rates for cotton, which are soon to be readjusted.

These rates on cotton have had a marked influence on the commerce of Mobile, although this city is located close to the center of the cotton-growing country and has connection with the interior by an improved water system and by five railroads traversing the cotton regions. The once large cotton trade has dwindled in recent years to an almost negligible figure. The combined rail-and-ocean rate on this commodity from Memphis, Tenn., a cotton center, to Liverpool, is $2.20 per hundredweight via Mobile and New Orleans and $2.05 per hundredweight via Savannah. Although the rail distance from Memphis to Savannah is about double the distance from Memphis to Mobile, the rail freight rate is 55 cents per 100 pounds to Savannah and 45 cents per 100 pounds to Mobile.

The effect of existing rail and ocean rates upon the commerce of Mobile

In general, the rail rates from the Middle West on like commodities are the same for New Orleans and Mobile; from points west of Chicago there is a differential in favor of the Gulf ports, and from points east of Pittsburgh and Buffalo there is a differential in favor of the Atlantic ports.

The minimum ocean rates established by the Shipping Board place the Atlantic and Gulf ports on the same basis for like commodities to Cuba and to South America. On account of the shorter haul the ocean rates to Europe are less from the Atlantic ports than from the Gulf ports. As between New Orleans and Mobile, on general merchandise, there is practically no difference in rail or ocean rates from the producing centers of the Middle West and to foreign markets.

Except for special commodities, and for products from certain producing localities, the *existing* rail-and-ocean rates are not the controlling factor in trade combination. *The volume of commerce through a port appears to be more largely influenced by the harbor facilities, banking and mercantile facilities and established habits of trade than by freight rates.*

With ocean and freight rates via two ports equal, the influence of a shorter mileage by way of one port than by way of the other is materially felt in the time element. For example, the ocean rate from Mobile to Havana is $0.51½ per hundredweight, and the rate from New York to Havana is also $0.51½. Although the rate is the same, an advantage lies in the nearer port, in that the time of passage is about one and one-half to two days less than from the more distant port. This factor increases the profits of the carrier and should encourage tramp steamers to come to the nearer port. This time factor should have a marked influence in favor of Mobile in the competition for future trade with Central America, west coast of South America and points via the Panama Canal.

Discussion of commercial statistics

Local details are here omitted. The discussion involves total tonnage by decades, the period of maximum and minimum total tonnage, trend of imports and exports of principal articles handled through the port, and a study of tendencies for certain articles to increase or decrease in volume, and, where data is available, a study of the causes for such increases or decreases in the volume of the principal commodities.

For Mobile the year 1907 was the banner year with 3,304,998 tons. In 1919 the total commerce was a little short of 2,000,000 tons, which is somewhat in excess of the average for the past decade. Present indications show a greater valuation than ever before and a marked increase in volume over recent years.

The principal imports are petroleum products (coastwise), bananas, iron ore, molasses and sisal grass. During the war and the Mexican disturbance, imports of iron ore, pyrites and sisal grass have fallen off.

The principal articles now being exported are lumber, cooperage, iron products from the Birmingham district, agricultural machinery and naval stores. Additional exports of the following products could be reasonably expected if proper steps be taken to improve existing facilities where lacking and to stimulate traffic: Coal, flour, grain and cotton.

Unbalanced commerce

A most unbalanced commerce through Mobile is noted. It is seldom that any vessel sailing from this port brings a return cargo. Generally speaking, sufficient cargoes have been assembled for export to fill available bottoms; but, as a rule, the ships loading at Mobile will bring a return cargo either for New Orleans, New York or some other port. This is not as serious a handicap as the figures would indicate, as may be explained by reference to the boats of the Munson Steamship Line. This company has regular sailings from Mobile for Cuba and Buenos Ayres. There is ample freight for export to fill their vessels. On the return trip from Cuba the boats generally carry sugar to New Orleans, returning light from New Orleans to Mobile. From Buenos Ayres the ships bring a return cargo of hide and quebracho, a tanning wood utilized by the Eastern shoe manufacturers. This return cargo is generally carried to New York, the ship returning to Mobile with only a partial cargo. These return cargoes, while not imported through Mobile, do at least enable the ships that sail from Mobile regularly to obtain a return cargo from the port of destination to some American port, thereby enabling them to continue profitably the export business from this port. Although, as stated above, the unbalanced commerce of this port is not as serious a matter as the figures would indicate, it is sufficiently serious to warrant a careful study and an effort by local interests to stimulate imports.

Recommendations for stimulating commerce of the port

It can be concluded that the foreign trade with the Pacific Coast and portions of the east coast of Central and South America should naturally be handled through the ports on the Gulf. Also it would be advantageous for a larger portion of the European trade to be routed by the Gulf if congestion of traffic is to be avoided on the east and west lines with the consequent tie-up of freight cars. This congestion is aggravated during the winter when snow and ice block the lines during a considerable period and at a time when the heaviest movement of coal is in progress in the eastern portion of the country. These causes of delay are practically unknown to the Gulf region.

It is believed that the Gulf ports would greatly profit by an adjustment of freight rates on the basis of cost of service. The shorter haul that would follow such an adjustment would allow the full cars to be moved to destina-

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tion and then returned in less time than is now consumed, and this would require less equipment to carry existing traffic and would result in final economy to the public.

The creation of a body to stimulate the trade in certain definite commodities would result further to the port's advantage.

Special study of the import traffic to enable both the water carriers and railroads to handle nearer their capacity in both directions would effect further economy. Among the commodities that efforts should be concentrated on, and which could be economically handled through this port, are coffee, quebracho, bauxite, asphalt, dye woods, fruits, mahogany and nitrate of soda. These products are now handled in limited quantities, and any increase would greatly assist in reducing the present unbalanced condition.

Mobile's favorable location with respect to the Panama Canal is an advantage that should be utilized to the utmost. The logical trade territory of Mobile is Central America, Columbia, Venezuela, west coast of South America and Cuba. A concentrated, well-organized effort should be made by the chamber of commerce, or by some other commercial interests, to study the needs of this portion of Latin America, to provide for these needs, and to establish banking, mercantile and social relations that would attract the buyers from these countries to visit and market in and through Mobile.

Port facilities and physical efficiency of the port.—This phase of the problem is the kernel of the nut from the port engineer's standpoint, and local questions require their own special treatment. Some of the advantageous features of the port of Mobile are:

(*a*) Depth of channel of 28 feet to be increased 30 feet at an early date; (*b*) physical connection of railroads with warehouses, wharves and shipside; (*c*) highway connections to water terminals; (*d*) interconnection of railroads; (*e*) favorable port charges and expenses; (*f*) repair facilities up to 10,000 tons; (*g*) fresh water berths; (*h*) small variation in tides and floods; (*i*) ability to load from cars, wharves and water at same time; (*j*) adequate banana unloaders; (*k*) inland waterway to iron and coal fields.

The following are considered unsatisfactory conditions:

(*a*) Divided control of harbor facilities; (*b*) inadequate warehouse space; (*c*) high cost of stevedore services and labor disturbances among longshoremen; (*d*) absence of adequate mechanical appliances for loading and unloading and for handling in the pier sheds; (*e*) need for export coal terminal which, however, is now projected; (*f*) belt-line connections controlled by railways; (*g*) insufficient advertising and efforts to draw trade; (*h*) water front partially railbound; (*j*) inadequate depth in slips and lack of private dredging plant; (*k*) immediate hinterland undeveloped.

Recommendations and suggestions

(*a*) *Central control.*—There is need for all the facilities to be concentrated under one head or executive body, which should have the power, funds and *disposition* to initiate, plan and construct as well as to administer.

(*b*) *Additional warehouses* should be constructed, and existing warehouses should be improved and equipped with modern handling appliances.

(*c*) *Cost of stevedore service.*—Installation of labor-saving devices.

(*d*) (*e*) *Mechanical appliances* within reason and suited to the principal commodities handled through the port should be provided; these should include a stationary power derrick to handle steel containers of the Mississippi Warrior Service, belt conveyors or storage battery trucks at the wharves and sheds, and a coal terminal for bunker and export coal.

(*f*) *Belt-line connections* operated by a central harbor control are almost essential for efficient and equitable service.

(*g*) ***Mercantile and advertising facilities:***

(1) Establishment of a coffee exchange and facilities for grading and storing coffee.

(2) Improved and more efficient cotton warehouses.

(3) Establishment of large export and import company specializing in the needs of Latin America, affording credit and banking connections.

(4) An advertising campaign in the tributary area of the Middle West.

(5) Visits of commercial committees to Cuba, Central America and South America to study trade conditions and to establish trade relations.

(*h*) *Relocation of certain tracks.*—This is a delicate problem requiring vision, force, boldness, tact and perhaps ultimate drastic action.

(*i*) Organize co-operative dredging company among private interests.

(*j*) *Development of surrounding country.*—This can be accomplished only by time, encouragement of immigration from other ports of the United States and other countries, cheap fertilizers, improved roads and general agricultural development.

A continuous and progressive development of the harbor, of its terminal facilities and of its storage and warehouse facilities and the installation of such labor-saving and cargo-handling devices as may be economical and practicable are essential if Mobile is to take the place among the world ports to which its strategic location and its natural advantages entitle it.

Light Creosote Oils in Wood Preservation

Light creosote oils properly injected into wood apparently will prevent decay until the wood wears out or until it checks so badly that the untreated portions are exposed. Such is the indication of service records collected by the U. S. Forest Products Laboratory on railway ties and telegraph poles preserved with low boiling creosotes.

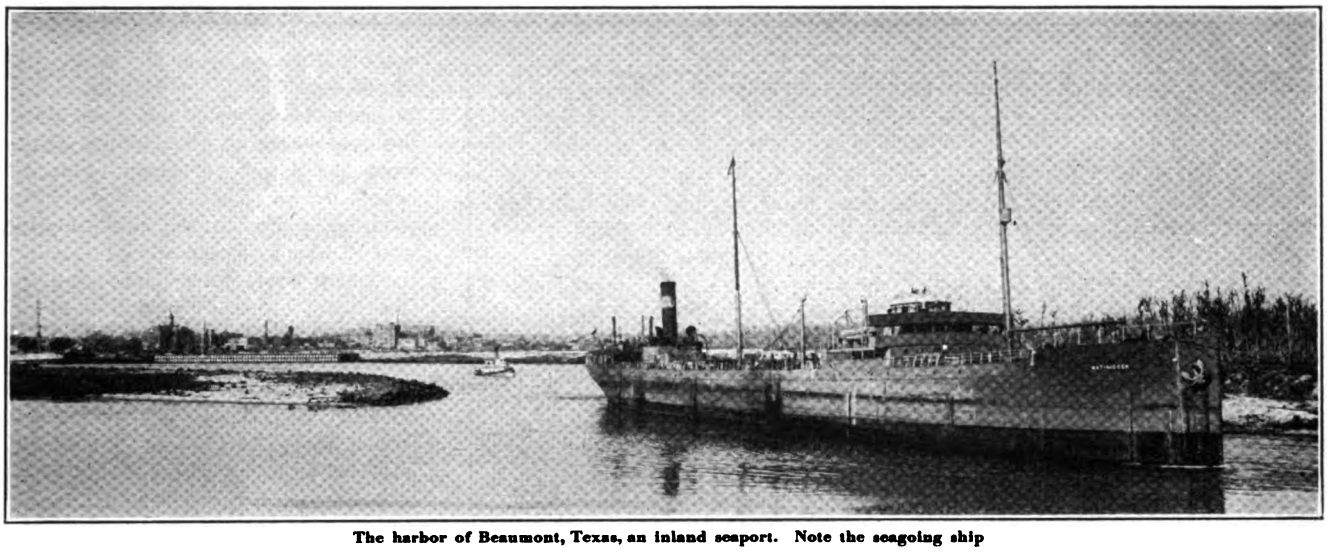
Creosotes used in ties from 25 to 50 years ago were for the most part oils having 50 per cent or more distilling below 235 degrees Centigrade, with a residue not to exceed 25 per cent at 315 degrees Centigrade. The ties so treated lasted from 15 to 20 years, and failure was traceable in most cases to mechanical wear, such as rail cutting and spike killing. In no case was failure found to be the fault of the preservative.

Of 1,558 telegraph poles in the Montgomery-New Orleans line, which were pressure-treated with a light creosote oil, 1,049 poles were still sound after 16 years. In 91 per cent of the cases of decay the fungi had entered the wood through checks and shakes. Representative sections in the Norfolk-Washington line showed that after 17 years' service, of the 1,614 poles inspected, 1,469 were sound, 92 decayed at the top, and 105 decayed at the ground line. The decay at the top was caused chiefly by cutting off the poles. In those decayed at the ground line, the causes of failure, as determined in 88 per cent of the cases, were checks or shakes. Here, again, as in the ties, the preservative outlasted the mechanical life of the wood.

The following conclusions are from the Forest Products Laboratory "Technical Notes":

"Unless some other factor than protection from decay is considered important, therefore, there is apparently no need to specify high boiling oils. The important point is that any coal tar creosote which is not extremely low boiling or extremely high boiling will satisfactorily prevent decay, and in the selection of an oil, factors such as price, penetrability, and convenience in handling should receive greater consideration than moderate differences in volatility."—*Eng. News-Record.*

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The harbor of Beaumont, Texas, an inland seaport. Note the seagoing ship

The Sabine-Neches Canal

An Example of a Successful Inland Waterway

By

A. H. Weber

U. S. Assistant Engineer

[*Note.*—The world is full of examples of unsuccessful inland waterway projects. Countless millions of dollars have been spent in this and other countries on projects which have never justified their cost. So great has been the waste that many economists, investigating these ill-advised projects, have been led to utter sweeping condemnations of improved inland waterways, and to assert that such waterways can never successfully compete with railroads. Inland waterways have accordingly fallen into a disrepute which is perhaps deserved in view of the carelessness and lack of study with which many of them have been planned.

But we must beware of extremes. Transport by water is inherently cheaper than transport by rail, and when applied under favorable conditions and after careful study of these conditions, has been almost invariably successful. Of this there are many notable examples, chief of which is the water transport on the Great Lakes. The Sabine-Neches Waterway, described by Mr. Weber, is another successful example.

One of the most advantageous applications of inland waterways is to provide *deep-water access* from the sea to inland points, which are thus converted into seaports. The Sabine-Neches Waterway is an example of this form of economy, and the astonishing growth of its commerce is the proof of its success and of the skill and forethought with which it was planned.—Ed.]

THIS waterway extends from the Gulf of Mexico through Sabine Pass, Port Arthur Canal, Sabine-Neches Canal, the Neches River to Beaumont and the Sabine River to Orange. The entrance to the pass is protected by jetties. Beaumont is 51 miles and Orange 42 miles from the outer end of the jetties at Sabine Pass. Port Arthur, the principal shipping point, is at the head of the Port Arthur Canal 16 miles above the outer end of the jetties. (See map, page 521.)

The chief purpose of the present waterway is to provide a deep draft outlet to the sea from the oil fields in the vicinity of Beaumont, Tex. The project was favored by the existence of Sabine Lake and the "pass" connecting it with the Gulf of Mexico.

Originally, a bar extended for about 3½ miles beyond the mouth of the pass having an available depth over it of only 6 feet at mean low gulf level.* The original project, adopted in 1875, contemplated a dredged channel through this bar 12 feet deep and 150 feet wide. The jetty project was adopted in 1882, since which time the scope of the improvement has been enlarged by progressive steps until now it provides for jetties about 4 miles in length and a ship channel 25 feet deep, from the Gulf to Port Arthur, Beaumont and Orange. About 21 miles of this channel is artificial, having been cut through low lying prairie lands, at a moderate cost.

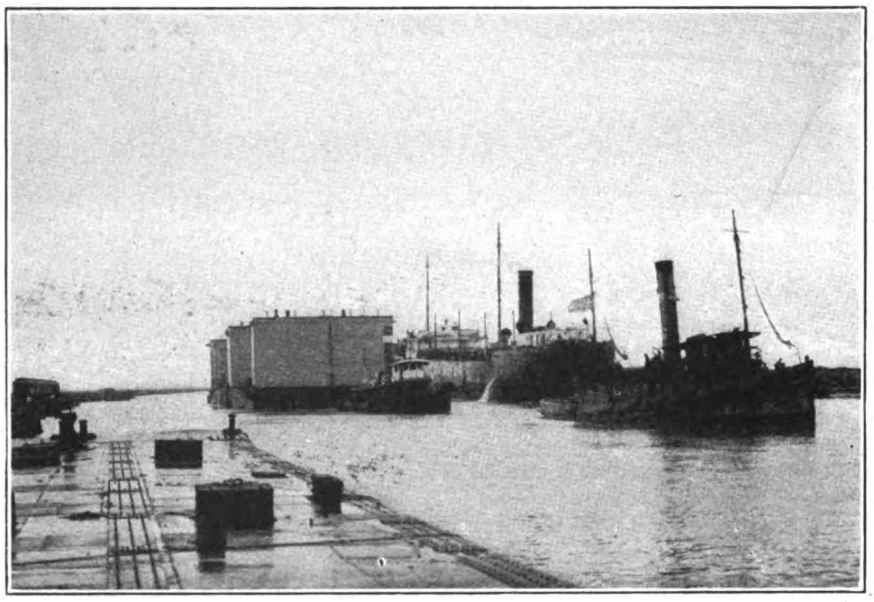
Commerce has taken full advantage of its opportunities here and has grown in proportion to the facilities afforded. It is well known that ever since the inception of the improvement vessel keels have dragged the bottom. The principal item of commerce is crude oil and its products, which now amount to about 7,000,000 tons annually. The total commerce on the waterway is about 8,000,000 tons. Of this, about 6,800,000 tons is loaded or unloaded at Port Arthur and the balance above. Modern oil tankers draw generally 25 to 28 feet, but some of them as much as 30 feet, and it is this class of vessels that is engaged in handling the business of this waterway. The splendid growth of commerce is shown by the following table of statistics:

1900	217,000 tons.
1905	1,779,000 tons
1910	2,304,000 tons.
1915	6,002,000 tons.
1918	7,261,000 tons.
1919	8,005,000 tons.

The total cost of the improvement to date is about $8,500,000. Interest on this sum at 5 per cent is $425,000. If to this be added $200,000 annual maintenance, the total government subsidy is $625,000 per year. On a basis of 8,000,000 tons commerce this amounts to less than 8 cents per ton. However, this does not take into account the distance over which this traffic moves. If it be assumed that 6,800,000 tons is loaded or unloaded at Port Arthur, 16 miles from the outer end of the jetties, and the balance at Beaumont and Orange, an average distance of 48 miles

*To the Board of Engineers for Rivers and Harbors.

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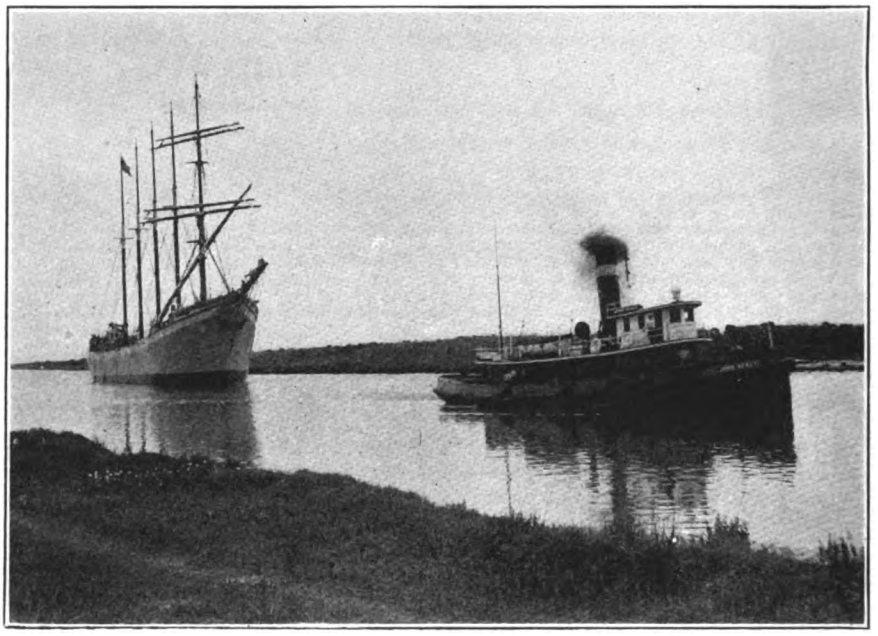
Beginning of the Sabine-Neches Canal, showing dry-dock being towed out toward the Pass and vessel heading up to Beaumont

from the end of the jetties, we have the following annual ton-mileage:

1,200,6,800,000 × 16---	108,800,000
1,200,000 × 48--------	57,600,000
Total (ton-miles)----	166,400,000

The government subsidy per ton-mile is thus $0.0037; that is, 3.7 mils per ton-mile. This figure requires no comment—it speaks for itself.

The steady growth of traffic and the increasing size of ocean-going vessels has led to a request on the part of the business interests of the community for greater channel dimensions, and the Engineer Department has now under consideration a project looking toward a channel depth of 30 feet, with suitable width. It is thought that such a channel will meet present and immediately prospective needs of commerce. One of the interesting features of this improvement is the guard lock located a short distance below the mouth of the Neches Canal, its purpose being to check the inflow of salt water during low stages in the Neches River when the supply of fresh water is being drawn upon by the large pumping plants of the rice growers who at certain periods use practically the entire fresh water flow in irrigating their crops. Beyond a small degree of brackishness, salt water is very injurious to rice culture. The present lock has but one set of gates opening downstream. It was expected that these would be needed only during low stages when the flow was reversed, but experience in navigating large vessels through the lock in times of freshets, when the currents are swift, indicates the desirability of gates opening both ways, and this change is being considered in connection with the enlarged project.



Lumber schooner being towed down section "A" of Sabine-Neches Canal. View taken short distance below point where canal enters Neches River

Tests of aged cements in concrete mixtures

Owing to a shortage of cement in the District of Columbia for use on construction work being carried out by the Engineer Corps of the Army, the Bureau was asked to determine the strength of concrete made up from cement which had been in storage for about a year and a half. The cement as received was first put through a sieving process to remove the lumps. The cement after sieving, as well as the crushed lumps, were then made into separate concretes which were compared with concrete made from cement recently purchased in the local market. It was found that a 1 : 1¼ : 2½ mix of the old cement would give approximately the same strength as a 1 : 2 : 4 mix of the fresh cement, and it was recommended that the lumps be sieved out of the old cement before using. Similar tests were conducted on aged cements submitted by the U. S. Engineer Office at Vicksburg, Miss. The results indicated that a 1 : 2¼ : 4½ mix of the aged cements gave approximately the same strength as a 1 : 3 : 6 mix of fresh cement.—*Bureau of Standards.*

State highway work in Washington

The State Highway Department of Washington has located, prepared plans and estimates, secured right of way and let 113 contracts for the construction and improvement of 526.36 miles of new road at a total cost, not including engineering, of $10,378,000, and for the construction of 25 concrete and steel bridges at a total cost, exclusive of engineering, of $1,001,000.—*Eng. and Cont.*

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Hydraulic Control of the Red River of the North

TO convert Lake Traverse into a detention reservoir by a dam with permanent outlet, to straighten and improve the Bois de Sioux River for nearly 30 miles from this outlet to the Otter Tail River, and to construct main ditches to drain the land below the reservoir, are the preliminary steps of an interstate project for drainage and flood control in the valley of the Red River of the North. Minnesota, South Dakota and North Dakota are the three States concerned.

An annual run-off of 23,430,000,000 cubic feet was determined as a maximum for the drainage area of Lake Traverse. To control this by converting the lake into a detention reservoir, it is proposed to build an earth dam about 2¾ miles long and 15 feet high across the two outlets at the northern end, 4 miles south of White Rock, S. D. A concrete sliceway would provide for normal discharge. A spillway for maximum discharge would have its crest at elevation 983, with capacity for discharging 2,000 cubic feet per second when the lake level reaches elevation 985. The combined capacity of culvert and spillway would be 4,000 cubic feet per second, which is far in excess of any probable requirements. At the south end of the lake, levees would be built for protection of low lands. Reservoir capacity would be 9,840,000,000 and 12,035,000,000 cubic feet at the two elevations mentioned. Below the outlet a defined and direct channel would be built along or near the present winding course of the Bois de Sioux, with levees on each side, to retain flood discharge.

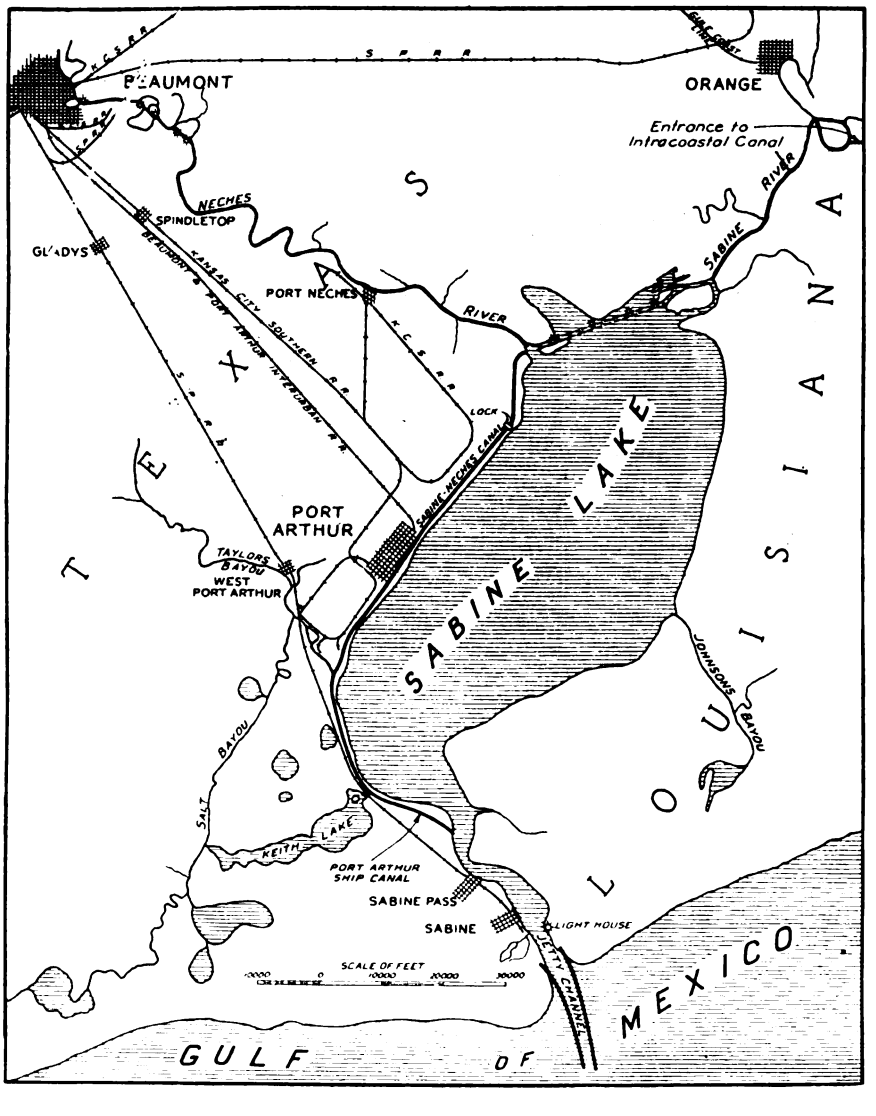
These proposed improvements are designed to control the run-off from the upper drainage area of 1,335 square miles above the dam. This control would be effected in three ways: By storing in the reservoir all the run-off during March and April; by storing after May 1 any flow in excess of the 1,000 cubic feet per second discharged through the control outlet; by storing all the run-off that occurs during any summer period when the run-off from territory below the dam fills the discharge channel.

To drain the reclaimed land on either side of this channel, or the straightened Bois de Sioux River, there would be main ditches practically parallel with the channel and having a fall toward the north. These ditches would serve also to relieve the upper part of the channel from the run-off of the adjacent land, below the dam. Drainage works under the plan proposed would provide outlets for water from 112,370 acres below the dam, this area having at present no adequate outlets. The lake and the Bois de Sioux constitute the drainage outlet for 1,200,000 acres, or 1,875 square miles, the drainage from which affects that of the smaller area served by the ditches. Of the 112,370 acres, there are 31,140 acres in Minnesota, 76,160 acres in North Dakota and 6,070 acres in South Dakota. The total cost of the project is estimated at $1,400,000, or $12.50 per acre directly affected.

In their annual report recently made public, the Harbor Commissioners of the Dominion of Canada state that the development of the northern districts of Manitoba is restricted, owing to the lack of proper dockage facilities on the Red River in the City of Winnipeg.

The report also indicates that the extensive dredging of the Red River is probable, especially in the vicinity of the present docks. It is fully realized that the utilization of the Red River as a traffic route connecting lower Manitoba with Lake Winnipeg is most essential. Locks, involving an expenditure of upward of two million dollars, have already been constructed for the purpose of making the river navigable.

Lake Winnipeg is one of the largest bodies of water on the North American continent. The upper end of the lake extends to the mineral deposits of northern Manitoba, as well as pulpwood area. The Red River has its source in United States.



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Retirement of Brig. Gen. James P. Jervey

COLONEL J. P. JERVEY, Corps of Engineers, was retired September 21, 1920, at his own request under the provisions of the Act of Congress of March 4, 1915, with the rank of brigadier general in recognition of his services as one of the builders of the Panama Canal.

James Postell Jervey was born in Powhatan County, Va., November 14, 1869. He graduated from the United States Military Academy, West Point, N. Y., in 1892, number two in his class. All of his service has been with the Corps of Engineers, in which he rose through all the grades to that of colonel in 1920. Upon graduation from the Military Academy he served with the battalion of Engineers at the United States Engineer School at Willets Point, N. Y., for about three years, from 1892 until 1895. His first field duty in engineering work was as assistant to Major Mahan and Captain Flagler in the Montgomery, Ala., River and Harbor District. He served here from 1895 until 1898 and was engaged a large part part of this time in constructing the then modern fortifications at Fort Pickens, Pensacola Harbor. For six years, from 1899 to 1905, he was instructor in the Department of Civil and Military engineering at the United States Military Academy. In 1905 he went to Manila, P. I., with the 1st Battalion of Engineers and served there about two years, part of the time at Zamboanga, assisting in the government of that province. On his return from the Philippine Islands he was detailed as instructor at the U. S. Engineer School, which had then moved to Washington Barracks, D. C.



Brig. Gen. James Postell Jervey

Shortly after this Colonel Jervey was ordered for duty on the Panama Canal Zone and spent something over five years as resident engineer in charge of the construction of the great Gatun locks. The locks were sufficiently completed under his direction to enable him to make the first trip through them on a small vessel of the Isthmian Canal Commission. Returning from the Isthmus in 1913 he was detailed as District Engineer, Wheeling, W. Va., in charge of certain work on the Ohio and Great Kanawha Rivers, and a year later as District Engineer, Norfolk, Va., in charge of the rivers and harbors of that vicinity.

On the outbreak of the World War Colonel Jervey was assigned to the command of a regiment of Engineers, the 304th at Camp Meade, which he organized, trained and took to France in July, 1918, as part of the 79th Division. He commanded the regiment at the front until compelled by sickness to relinquish his command and go to the hospital. Upon his recovery he was assigned to duty as assistant to the Chief Engineer of the American Expeditionary Forces. He also served a short time as engineer of an army corps. For his services in France he was awarded the Distinguished Service Medal by General Pershing.

After the armistice he again resumed river and harbor work under the Chief of Engineers with station first at Wilmington, Del., and later as both district and division engineer at Baltimore, Md., on which duties he was engaged at the date of his retirement.

General Jervey has been appointed City Manager of Portsmouth, Va. His comrades in the Corps of Engineers regret the loss to the Corps of this efficient and popular officer, but congratulate him upon his appointment to an important position in civil life while still a young man.

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The Passing of Permanently Emplaced Artillery?

[Summary of an article in the *Journal of the U. S. Artillery*, by Lt. Col. H. R. Oldfield, Coast Artillery Corps, with discussion by Col. J. C. Oakes and Majs. C. O. Sherrill and C. L. Hall, Corps of Engineers.]

SINCE early times armament has largely controlled strategy and tactics. Artillery is the most immobile part of an army. In early times, it was divided into three classes—field artillery, siege artillery and fortress artillery, each with separate personnel. Artillery is no longer so designated, but is now classed as mobile, fixed, anti-aircraft and trench.

At the Dardanelles the allied fleets reduced at will all old Turkish forts located near the seashore; guns hidden well back from the shore were never entirely neutralized. Italy made some use of mobile guns in the defense of her coast line. Germany, in her Belgian coast defense, finally ceased installing fixed mounts, using considerable numbers of large caliber railway guns in hidden and retired positions, with entire efficiency.

Fixed mounts were in elaborate emplacements; railway guns were successfully emplaced in entirely unprotected positions, concrete being sometimes used for their gun blocks and posts of command.

American railway artillery in the World War fired many rounds from open emplacements, but no guns were put out of action. All fire of this artillery was on the whole "truly remarkable. It was fully equal to that which can be expected of guns on permanent mounts." The rate of fire was slow, but this can be entirely remedied—can even be made to exceed that secured by our present fixed mounts.

Our army possesses a large number of 155-millimeter G. P. F. guns and 240-millimeter howitzers that can be advantageously used for intermediate coast-defense armament. The present heavy-caliber railway gun is limited in number, and was designed for land warfare. As a whole, however, it is a valuable addition in our present coast defenses. A more accurate 14-inch and 16-inch rifle will soon be produced, quite equal to those on fixed mounts.

The present coast defense is in reality harbor defense. The emplacements therein consist of well-designed elaborate concrete installations, but it is doubtful if they furnish sufficient protection to-day against modern guns. They are also located close to the sea, in a position that can be readily identified. Although very unsatisfactory, they are by no means obsolete, and can still be usefully employed.

In future, appropriations will be limited, and it will be an absolute waste of money to spend any of it on anything but 14 and 16 inch guns on railway mounts, where feasible, but no matter what type of mount is adopted, the position should be well back from the shore. Naval engagements will be decided at ranges above 15,000 yards in future; consequently, there is no advantage to be derived from placing guns in an exposed position simply to secure direct fire. The slight gain in range is more than counterbalanced by the increased accuracy of the hostile navy firing against these positions.

Guns emplaced on fixed mounts will probably still require elaborate protection even though located in such retired positions. Guns on railway mounts, on the other hand, do not need such protection, the railway tracks being established in time of peace without revealing their purpose. If the enemy should locate one of these guns, it will immediately be withdrawn to another position. It is, therefore, of the greatest advantage to have all mounts mobile, both tactically and strategically. In this way they can be moved from one strategic area to another, or from the Atlantic to the Pacific, in time to meet a probable attack. Even if all the fronts should be menaced at once, it would still be an advantage to have the armament in such shape that it can be redistributed as occasion demands in time of peace, as would be the case with railway mounts. Another advantage of these installations is that in case part of our coast should be evacuated, fixed emplacements would have to be blown up, whereas mobile guns could be moved, and if an important harbor is seized by the enemy, these guns could be turned upon the structures therein. These two considerations alone are sufficient to warrant the adoption of the railway mounts.

It is, however, in connection with the recently developed "Positive system of defense" that the railway guns' many advantages really become evident. The large-caliber guns will be of the greatest assistance in holding off forces that have obtained a footing, and when invasion has become a success these guns will destroy the lines of communication behind the invader, as was done at Verdun.

Of course, in order to use railroad guns, the railroads must be capable of transporting them; if they can not be so transported, they are of no use. This matter has not been fully investigated, but the 14-inch and 16-inch guns at least can be taken from the Atlantic to the Pacific Coast and can be used for the defense of all important points on the Pacific Coast and all of the important points on the Atlantic Coast north of Cape Hatteras; in fact, there are very few places on these two sections where they can not be used.

The question as to relative cost is important, and a detailed investigation indicates that the cost of fixed guns in fixed emplacements will be from 10 to 20 times as great as an equal number of emplacements for railroad mounts.

There should be provided as many of these railway mounts as of the fixed guns, because it is possible that we may some time have a war with all the rest of the world, in which case, they would be very useful. They will form the cheapest possible insurance in our system of national defense.

Summing up, it appears that one railway mount is strategically and tactically equivalent to and quite as cheap as several fixed guns, and that, therefore, fixed mounts should be limited to restricted and inaccessible positions, marking the end of the concrete fortifications in the course of time. However, mobile as railway guns now are, even their mobility is not sufficient, and it is desired to have "16-inch guns mounted in air vessels at the very earliest date possible."

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Discussion

J. C. Oakes
Colonel, Corps of Engineers

I have read with interest the article by Lt. Col. Homer R. Oldfield, C. A., on "The Passing of Permanently Emplaced Artillery." It is interesting as showing the extreme views held by some artillery officers, particularly as such views are so greatly at variance with the ideas held by most officers of the artillery previous to the World War. In the past the artillery has demanded the greatest possible protection for guns and crew, massive gun platform built separately from the remainder of the emplacement and accurately leveled, magazines, and casemates fully protected by overhead cover, machinery for handling ammunition and elaborate measures for range finding, plotting and communication. Apparently, now these ideas have passed, and the most casual type of position with or without gun block, parapet, magazines or other permanent structures, and improvised range-finding apparatus and methods of communication appear to be sufficient.

Colonel Oldfield makes many statements of fact in his article which I question, and many statements of opinion with which I differ. In discussing an article of this kind, it is very difficult to present tersely objections to statements made, and perhaps the best method to present my principal objections is to quote a statement from the article and follow immediately by discussion. Adopting this method, the statements from the article will be placed in quotation marks with my discussion immediately following.

"In this greatest of all wars there was no example of permanently emplaced guns giving a good account of themselves against the heavy mobile artillery of the land armies."

The German attack on Liege was made on the night of October 5, and the town was captured on the 6th. The Belgian troops retired, leaving a small garrison in each fort. These small garrisons prevented the advance of the German army for thirteen days, and it was not until superior heavy siege artillery, of a type which these forts were never designed to resist, had been brought up and by its long range and heavy caliber projectiles broke down the defenses, that the forts were captured. This halt of the German army for thirteen days had the very greatest effect on the war in general, and, in my opinion, is a very good example of what even an inferior land fortification can accomplish against overwhelming odds. Of course, it is not to be expected that medium calibered guns will be able to hold out indefinitely against an overwhelming superiority of guns of greater caliber, but if the Liege forts had been supplied with as heavy artillery as the German siege artillery, the advance along the Aix-la-Chapelle Liege Railroad would have been stopped much longer, and if a mobile army had been available to reinforce the garrison, the advance along that line would have been permanently stopped. Therefore, I do not think the above statement is a fair one. Certainly, a number of permanently emplaced guns are more than equivalent to the same number of mobile guns of equal caliber, without emplacements, parapets, permanent magazines, or other necessary permanent equipment.

"The old-style fortress that could defy an army due to its heavy guns and its heavy defensive protection of stone and concrete . . . is no longer able to resist a mobile army with its masses of heavy artillery."

This statement, of course, is correct, if the number of troops and the number of superior guns brought against the fort are overwhelming, but it is possible for a fort even with inferior guns to stop the progress of an army until the mobile forces can be mobilized and rushed to the defense of the position. Certainly the fact that France had good permanent fortifications at Toul and Verdun, even if they were "old-fashioned," had the very greatest effect upon the decision of the German general staff in making its plans for the invasion of France. If Toul and Verdun had not been fortified, the line of advance into France would have been the direct one from Lorraine and Luxembourg to Paris, instead of through Belgium.

"At the Dardanelles the allied fleets were able to reduce all of the old Turkish forts located near the seashore."

This is exactly contrary to the tenor of the report of the American attache to Turkey which I have recently obtained from the War Department. In that report it is stated that the principal armament in the five land fortifications consisted of five 15 cm. (6-in.) guns, nineteen 25 cm. (10-in.) guns and six 35 cm. (14-in) guns. Of these the only ones with telescopic sights were the 15 cm. guns. The bombardment which took place on March 18, 1915, by fifteen ships of the line, later increased to nineteen, at ranges of from 8 to 10 miles, did very little damage to the forts. The 15 cm. turrets were hit three times with no gun damage. Another fort had one carriage destroyed, with no gun damage, although the embankment was hit a number of times. One battery had two guns temporarily disabled. All other damage was slight and the fleet was driven off. It seems to me that the land batteries with their inferior guns, inferior personnel and without the necessary range-finding apparatus, performed their function very satisfactorily.

"Italy made use of mobile guns in the defense of her coast line."

I have been unable to verify this statement, and can not positively controvert same. I am informed, however, that the only mobile gun used for such purpose was a gun mounted on a barge, or boat, which, therefore, was more of a naval than land auxiliary.

"Germany in her defense of the Belgian coast finally ceased to install fixed mounts and used large-caliber railway guns in hidden and retired positions in lieu thereof."

It is true that railway guns were used, but I think they were not used on the railway mounts. The guns were brought up to the coast, dismounted from their trucks and placed on improvised emplacements with as much protection as could be given with the labor at hand. More permanent emplacements could not be provided on account of the time limit. The guns, therefore, were nothing more than temporarily emplaced guns, fixed in position exactly as the more permanently emplaced guns, and can not properly be considered as railway guns, except that they were taken to and from their positions by rail.

"American-manned railway artillery was under fire on the western front approximately 1,500 gun-days, and probably received about 25,000 large-caliber enemy shells." (No gun being put out of action.)

What is meant by "received?" Were 25,000 aimed shots fired at our railroad artillery? If so, the practice was evidently very bad. Does the author mean to convey the idea that while the enemy's practice was exceedingly bad our practice was better? If an enemy, having had four years' previous experience in the practical school of actual war, fired from improvised batteries and railway mounts 25,000 long-range shots at our batteries without effect, does the author think that is an argument in favor of the use of similarly located guns for our harbor defense? To me this statement proves the general inaccuracy of long-range fire and the need of carefully selected positions with guns placed on fixed platforms, and permanent range-finding

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systems, including everything that will increase the accuracy of long-range firing.

"A 14-inch 40-caliber rifle on an all-round fire railway mount has recently been fired at a moving target with most excellent results."

It would have been very interesting if greater detail had been given. I understand that this rifle was mounted on a concrete gun block, constructed by the Engineers, that the gun was dismounted from its railway trucks, placed thereon, and therefore was fired exactly as any permanently emplaced gun would be, except that the ammunition was handled by hand and the range-finding apparatus was more or less temporary. It would be interesting to know at what range this rifle was fired, how fast the target was moving, whether it was moving at uniform speed parallel to the shore, or whether its direction and speed were non-uniform to simulate the movement of a ship attacking a battery.



The Christie wheel-caterpillar mount adapted to the 155-mm. rifle. The latest development of tractor artillery

"It is asserted that it would be a waste of money as well as a serious mistake, from a military point of view, to permanently emplace any such mounts (*i. e.*, 14-inch and 16-inch) in any locality accessible to railway mounts."

I disagree with this assertion for reasons which I will state later.

"To-day, however, battle ranges will be nearly twice this great" (*i. e.*, 30,000 yards).

This statement might be correct, if any method of range finding had been devised by which the position of a ship 30,000 or more yards from the shore line could be determined. Up to the present time, however, ranging beyond 15,000 yards is practically impossible, except in the very clearest weather, owing to poor visibility. I know that the artillery proposes to spot shots by use of aeroplanes, but if a fleet be strong enough to seriously attack one of our harbors for the purpose of capturing same and making it a base of operations, the fleet will necessarily be extremely strong, and it must be assumed that the enemy commander will provide an overwhelming force of aeroplanes. It is not to be expected, therefore, that a harbor which will be attacked by surprise, and ordinarily, be found in a more or less partial state of defense, will have superiority in the air, and the result will be that our aeroplanes will promptly be dispersed and the enemy will have the advantage of the use of his planes. Another advantage the fleet will have is that certain landmarks will enable him to fire on areas marked on the map by simply determining his positions with reference to the landmarks and measuring his azimuth from such landmarks. In my opinion, therefore, it is doubtful whether the seacoast defenses will have very great success at ranges much more than 15,000 yards. Certainly, during the recent war the only determined attack upon land fortifications, that at the Dardanelles was made at approximately that range which would seem to mean that even for the Navy a serious attack on land fortifications must be fought under present conditions at ranges not greater than from 15,000 to 20,000 yards.

"Guns emplaced on fixed mounts will probably still require elaborate protection even though so located in such retired positions" (*i. e.*, retired from the shore).



The tractor will negotiate a 100 per cent slope. Maximum speed as tractor, 10 miles per hour; maximum speed on wheels, 15 miles per hour. Total weight, 44,000 pounds

I see no reason why fixed mounts need more protection than railway mounts. If the guns be located where it will be difficult to spot the shots, a fixed gun needs no more protection than a gun on a railway mount. Even if the enemy knows its exact position on the map, long-range fire under battle conditions is so inaccurate that there is little probability that a gun will be put out of commission. The test firing at Mobile a few years ago, where the battleships were given the exact range from shore and the exact spot

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hit before another shot was fired, and also the attack at the Dardanelles, prove this fact.

"If mobile guns are adopted, the total 150 guns (the total number available for coast defenses) can be assembled in one locality if the condition demands."

This is, in my opinion, one of the principal objections to change from our present system of fixed guns to the proposed system of having all guns on railway mounts. It is apparent that an enemy fleet can move more rapidly than guns can be transported by rail, and if the guns should be congregated at one locality for defense against an enemy attack, it would be extremely simple for an enemy fleet to feint at some important port, such as New York, carry on a bombardment until information was received that all of the railway artillery in the United States was being concentrated at New York, and then, leaving a few ships to continue the bombardment, the remainder of the ships could steal away and within a short time appear at Cape Henry, make its way into Chesapeake Bay and Hampton Roads practically without opposition. If we consider political conditions in this country, it is apparent that if the people of New York felt that a serious attack was being made at that point, the government could not resist the urgent demand for all of the artillery that could be furnished, and it is therefore apparent that all the mobile artillery would be immediately rushed to that port, leaving other ports at the mercy of the fleet, when the objective was suddenly changed. Consequently, in my opinion, a certain amount of artillery should be fixed at each important place, and considered as the absolutely essential minimum for the temporary protection of that place, and such artillery should never be moved under any conditions. Therefore, in my opinion, the less mobility such guns have the better they will serve the purpose for which they are emplaced.

"The collapse of the German defenses around Verdun was due in no small measure to the serious interruption of their railroad service because of the long-range fire of railway artillery. . . ."

This statement does not agree with my understanding of what actually occurred. It has been stated by numerous writers, and even by General Ludendorff himself, that the loss of men by the Germans in front of Verdun was so great that the German nation could stand it no longer, and the attempt had to be given up. It would be interesting to know just what damage was done by the railway artillery to the German lines of communication, not only at Verdun but at other places.

"This comparison showed that the mobile guns could be emplaced for slightly less than 5 per cent of the cost of the latest type of emplacement for fixed armament."

It would be interesting to see the estimates of cost upon which this statement is based. If the author means that the railway gun and its carriage, without appurtenances, will cost 5 per cent of a similar gun on fixed mount with all of the auxiliaries and complete protection to gun by parapet, and magazine and casemate thoroughly protected by overhead cover, the statement is perhaps approximately correct, but I believe that the author has left out of consideration the cost of the railway train and equipment that must be supplied with each railway gun of 14 and 16 inch caliber. Such a gun must be accompanied by a full train load of equipment and personnel. This means that there must be provided besides the gun on its trucks, an extra car for base rings, a locomotive, probably not less than six ammunition cars, a heavy crane (120 tons or more), rolling machine shop, a car for range finding apparatus, a car for engineering supplies and tools, and at least three cars for the personnel. The cost of extra track leading to gun positions, including extensive new construction to reach the seashore, must not be forgotten. The equipment must be furnished in time of peace and must be maintained at some base in full operating condition, else under the proposed method it would be impossible to defend the coast at any point.

Furthermore, the cost of maintaining a battery for defense is not dependent in the long run upon the cost of the gun and its emplacement alone, or the gun with its railway train. By far the greater part of the cost of such ordnance in times of peace is due to the maintenance of the personnel necessary for operating same. In my opinion, the fixed gun will require less personnel than the railway gun to maintain the equipment and to be ready to operate same Again, a practical method of reducing the expense of maintenance of our seacoast defenses is by the use of the National Guard, assigning guard companies or regiments from localities near seacoast defenses as reserve troops and have them understand that in time of war they will be used only to man these batteries. If this idea should be adopted, it would only be necessary to maintain at the fixed emplacements a small personnel to take care of the property and to act as instructors, and to fill the more important non-commissioned and commissioned positions during active operations. This suggestion would not be practicable if railway guns alone are used, because such guns with their equipment must be concentrated at certain bases for administrative purposes, and consequently, would be far removed from most of the National Guard troops that could be used for coast defenses in time of war. Nor would there be any assurance that the guns would be used in any specified localities.

Summing up in a few words my ideas on this subject, I feel that the article in question emanates from an enthusiast, who has lost sight of a number of practical considerations, and who pointing out the favorable characteristics of railway artillery has failed to point out at the same time the disadvantages of that type, or the advantages of the fixed guns as opposed to the mobile guns. It seems to me that there is and will be a distinct need for railway artillery; that it has a peculiar function to perform, and that there is no necessity for attempting in the discussion of the development of the railway artillery to make light of the peculiar functions of the fixed seacoast batteries on the one hand, nor of the mobile field artillery on the other. In my opinion, at each important point on the seacoast where good harbors exist that might be used for bases of operation by an enemy, or where important cities lie within long-range fire of naval vessels, a certain number of permanently fixed rifles of the largest caliber should be emplaced and should be provided with every protection, both to gun and to men, that is possible to give; that such guns will provide temporary defense which will delay the enemy and prevent his accomplishing his mission, until additional artillery can be concentrated sufficient to insure the enemy's defeat. This supplementary artillery must be transported to the point where needed by rail, and after the artillery reaches the point endangered, it may be temporarily emplaced on fixed platforms or fired from railway trucks, dependent on conditions as they develop. In any case, I believe that both fixed emplacements and railway artillery are needed, and that the latter will supplement the former and is an economical method of increasing the defense at threatened points, while the use of a minimum number of fixed emplacements insures the delay of the enemy sufficiently to enable the railway artillery to reach the point of attack.

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C. O. Sherrill
Major, Corps of Engineers

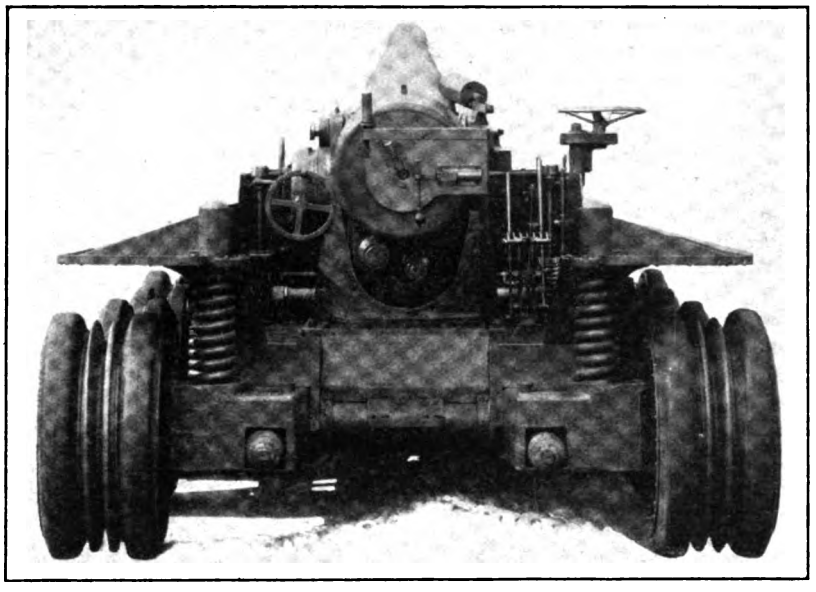
Colonel Oldfield concludes that railway artillery in open and unprotected emplacements must be the reliance for the coast defenses of the future as opposed to fixed emplacements. In arriving at this conclusion, he makes some fundamental errors which should be corrected. In the first place, he assumes that railway guns are easily camouflaged, whereas those on fixed mounts are difficult to camouflage. The contrary is really the case. A board of French officers, in planning works of defense for one of France's most important harbors, Toulon, recently came to the conclusion that fixed emplacements were preferable for a number of reasons, among others that they can be more easily camouflaged than can railway emplacements, on account of the impracticability of camouflaging the tracks leading up to the firing positions.

Colonel Oldfield states that many rounds were fired by railway guns during the World War, but that none were put out of action, and uses this as an argument for this type of armament. As a matter of fact, the reason these guns were not put out of action was because of their great distance back of the line, at which distance no target of so small a size as a single gun could be hit by hostile artillery, except by a remote chance. He also cites the accuracy of their fire as truly remarkable. The facts in this connection appear not to bear out his contention, for the targets upon which these guns fired were in practically every case large areas, such as cities, extensive railroad yards and supply depots; and even in these cases the actual damage done appears to have been very limited. Railway artillery with a field army is useful only in stabilized warfare, where it is fired by map at ranges in excess of 25,000 yards, under conditions making spotting impossible. So it is very doubtful if even for land warfare purposes these guns accomplish any useful purpose that can not be better and more cheaply accomplished by field artillery on wheel and tractor mounts, or by bombing planes.

Even if we assume that these guns were highly accurate and extremely effective in field warfare, it still would be unwise to deduce from that fact the conclusion which Colonel Oldfield arrives at, namely, that they will be highly effective against the rapidly moving targets presented by naval vessels. Nor has it yet been established that any type of mobile guns, including the 155 G. P. F. are as effective against rapidly moving targets as are guns on fixed and accurately adjusted mounts.

The suggestion that major-caliber guns on railway mounts will be serviceable, not only for the defense of our important harbors against naval vessels, but also as adjuncts of the mobile army in preventing a hostile army from landing on our open beaches, is believed to be fundamentally unsound. If major-caliber railway artillery should be found worthy of use in our army, it will be due solely to its utility as a harbor-defense gun, for it certainly has little value in connection with the mobile army against an invader, under conditions to be found on this continent. This matter is discussed at some length in comments by the undersigned on an article by Lieutenant Colonel Jarman, in the September-October issue of THE MILITARY ENGINEER, pp. 441-6.

Colonel Oldfield appears to draw some erroneous conclusions as to the late war, especially in reference to the vulnerability of fixed emplacements to naval fire, even in the case cited by him as to the fortifications at the Dardanelles. The official reports clearly indicate that even in the case of the inadequate, exposed and unsupported batteries at the entrance to the Dardanelles, although they were subjected to such a terrific fire that all front protection was destroyed, only one gun of the whole number was entirely put out of commission by the ships' fire, and this was caused by a lucky shot passing through the apron of the gun block and detonating there. Very little damage was done to the forts at the points nearest to the entrance, which were heavily attacked at a range of about 11,000 yards. The board reporting on this matter states "in no instance was the damage sufficient to keep any gun out of action permanently. The battery reported to have done the most firing was a 15 cm. battery. This battery had been heavily shelled, and the front slope was covered with shell craters. The only damage done to the pieces was by shell fragments."



Rear view of Christie mount for 155-mm. gun

While this was true as to the batteries entirely exposed to view and without protection, those batteries placed some distance away from the coast line were almost entirely undamaged. This result agrees completely with the experience along the Belgian coast, where the battery positions were located on and back of a small line of sand dunes, and although subjected to repeated shelling were scarcely damaged at all. This applies as well to the unprotected as to the protected batteries, whether fixed emplacements or railway guns. There were, in all, 113 guns installed on the Belgian coast for the defense of Ostend and Zeebrugge; of these 76 were visible to ships at sea and 37 were invisible behind the dunes. In spite of the fact that a majority were located thus, in plain view of the sea, and their positions exactly known from air photographs, yet they were practically undamaged by the most severe and protracted bombardments.

In this connection, it should be borne in mind that the railway guns, so called, on the Belgian coast, were complete fixed emplacements, requiring several months to construct,

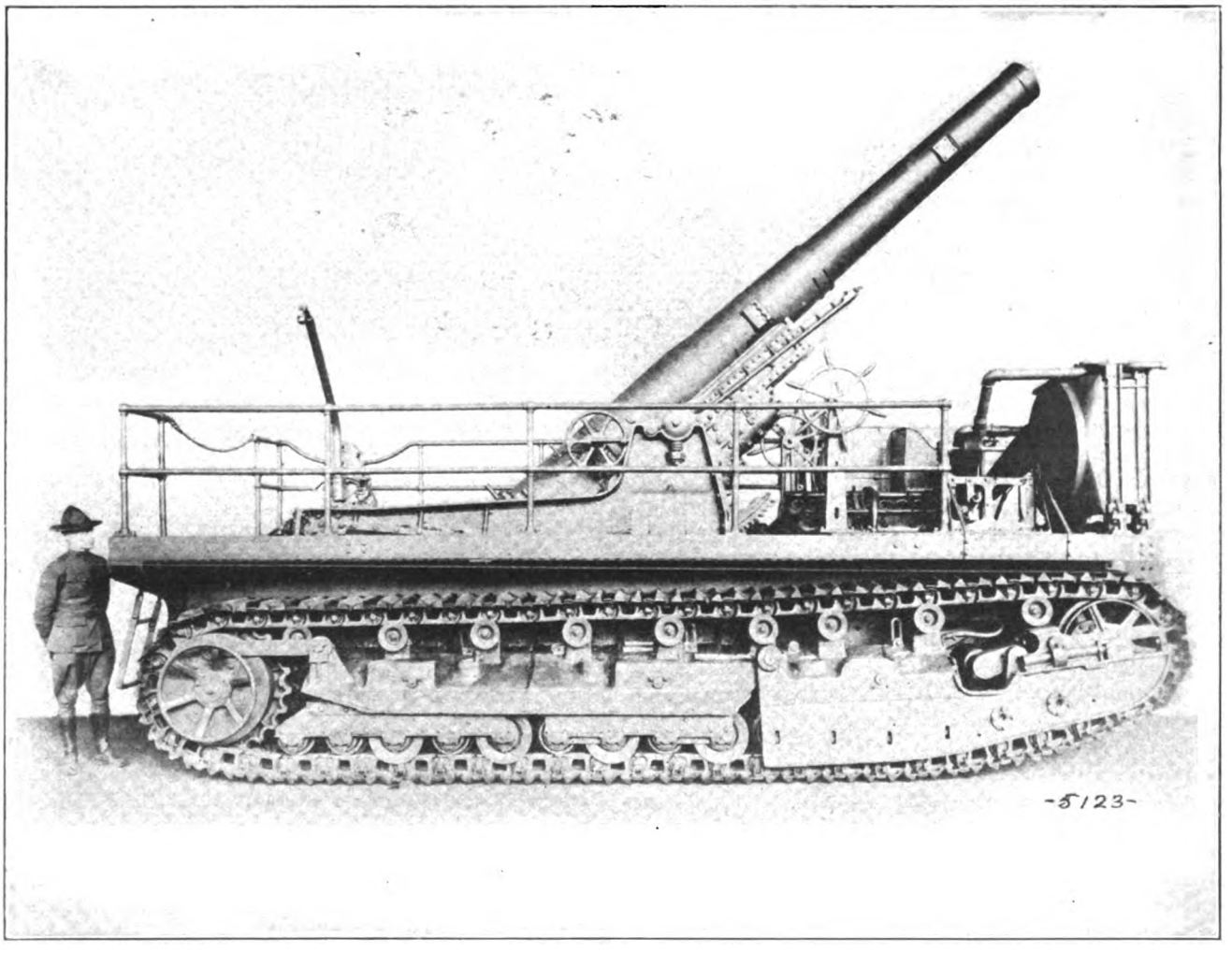
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and were elaborate concrete mounts upon which barbette carriages were installed by use of railway trucks. They can hardly be classed as railway mounts in the ordinary acceptation of the term, as used by Colonel Oldfield, ready to be moved at a moment's notice to a new position. Of the 113 guns employed only 8 were true railway mounts. In reference to his statement that Italy used mobile guns in her coast defenses, it should be noted that no major-caliber railway guns were so used. A board investigating the defenses gave a tabulated list of the artillery commonly employed in coast defense. This list shows *only one* mobile gun thus employed, and that one was *mounted upon a barge,* so that the statement that Italy made use of mobile guns in the defense of her coast line appears to be misleading.

Colonel Oldfield's cost data is based upon a comparison between the elaborate fixed emplacements heretofore used in our seacoast defenses, with all the bombproof auxiliaries, on the one hand, and the simplest type of railway mounting with only improvised auxiliaries, on the other. Even in this comparison, it is believed that he has failed to take into consideration all elements of the two cases, very much to the advantage of the railway guns. If, however, a comparison is made between fixed installations, approximating in character those used by the railway artillery, the relative cost is decidedly in favor of the fixed emplacement for a given amount of defensive power, on account of the many expensive auxiliaries required by the railway guns, such as locomotives, ammunition cars and personnel cars, in addition to the large expense of necessary railway construction.

There seems to be a determined effort on the part of some coast artillerists to develop a mobile railway service at the expense of an adequate system of fixed harbor defense, for the protection of our most important naval bases and cities, and it is my opinion that such an effort can lead only to disaster if carried to the extreme advocated by these enthusiasts. The adequate protection of our leading harbors and naval stations is of such vital importance to the country as a whole as to render these efforts to secure an inferior type of armament *that will fairly well serve both field army and coast defense purposes, a serious menace to the safety of our country.*

The urgent need of this country for adequate defense is an efficient Navy, free to act aggressively; a limited number of most powerful guns of not less than 16-inch caliber, on accurate fixed mounts, located at the right places for the protection of our important cities, harbors and naval stations. These, supplemented by a moderate-sized mobile army with adequate wheel and tractor artillery, and provision for rapid expansion of the mobile army in time of war, will assure our safety in any emergency.



A motorized 240 mm. howitzer. Note the comparison of size with that of the soldier

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C. L. Hall
Major, Corps of Engineers

Colonel Oldfield's well-written article presents three propositions of fact:

1. For the same number of guns, the effectiveness of fire at the critical point will be greater when the guns are mobile.

2. The advantage of invisibility due to the withdrawal of weapons more than balances the loss of range caused by such withdrawal.

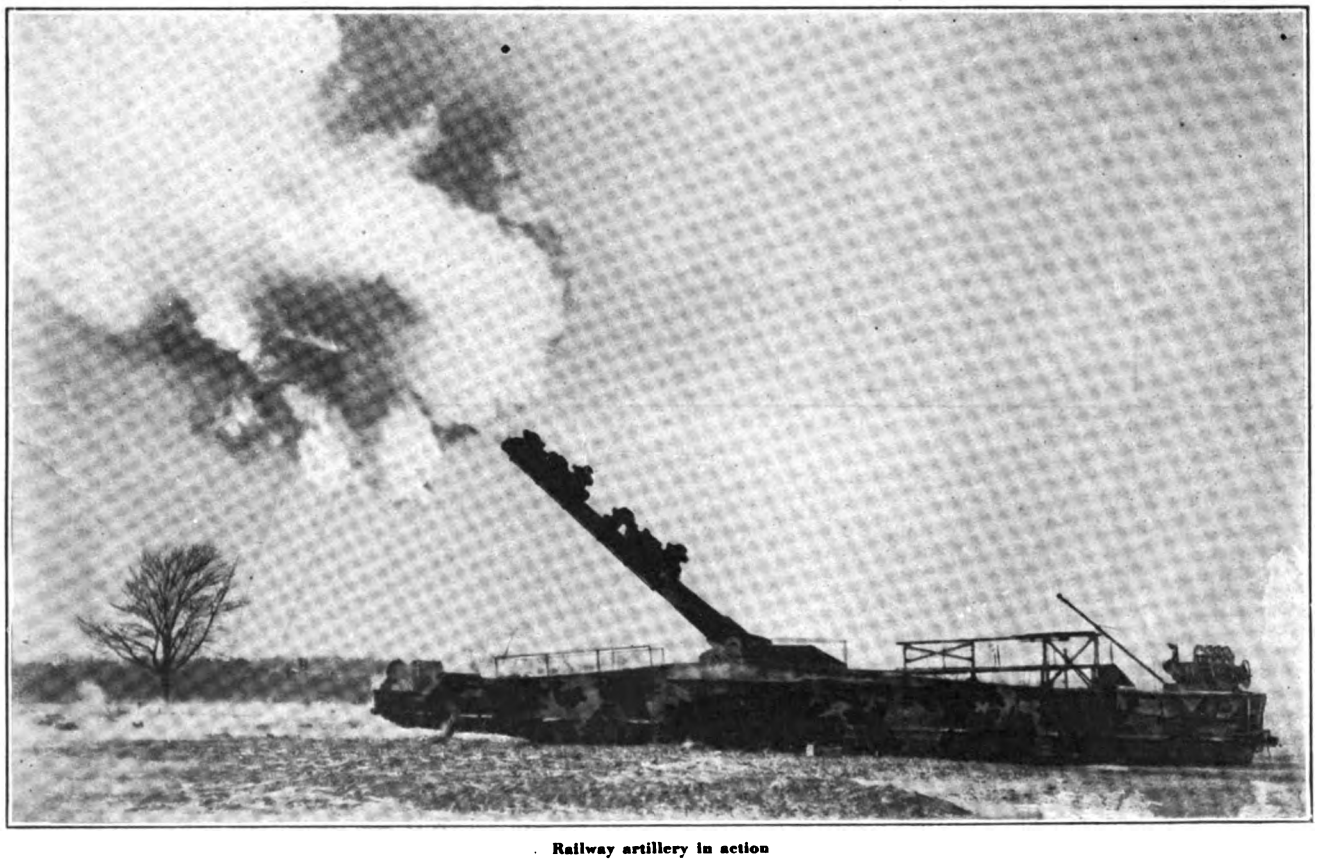
3. Permanent fortifications are obsolete.

The first proposition is merely a truism. Everyone knows that material of war can only be used at the place of battle. If the battle occurs at some place to which the fixed material can not be transported, the said fixed material will be of no value. If a critical point in a defensive system is of such overwhelming importance that it is advisable to defend it with the most powerful weapons known to science, and if these powerful weapons are not capable of transportation, it is nevertheless necessary to use fixed weapons.

The second proposition that the advantage of withdrawal of guns balances the loss of range, is at least arguable. This idea can be reduced to an absurdity, for, by placing the guns where the shells from them, fired at extreme range, would hit the 30-foot-depth curve, we can make them entirely immune to naval attack. At the same time the hostile fleet could get close enough to destroy the port structures.

The third proposition has been regularly advanced after almost every war in history, and has almost invariably been analyzed by the historian as merely indicating that if a fortification has not altered during a generation of peace, and the gun has improved during the same period, the war finds the fort out of date. If warfare were continuous, no one would ever hear of the proposition. If fortifications could be modernized every two weeks, as they were during the World War, everyone would concede their utility. The writer emphatically dissents from the notion that fortifications upon land are entirely obsolete. If we could be sure that tactical operations on a grand scale would take place in a terrain subject to fire from our forts and supplied by land routes of communication covered by the said forts, then all of us would shortly become partisans of permanent fortifications. In coast defense we are sure of just exactly that. The critical operations of ships against a coast must take place in front of a large harbor where captured shore facilities can be utilized by the invader and where the direct damage from ships' fire is appreciable. Such harbors are the places where coast defenses are now installed, and we would be foolish to throw away the enormous advantage which our possession of the ground for years in advance of hostilities gives us. If the forts are not modern, let them be modernized, not scrapped.

The lessons drawn by Colonel Oldfield from the Dardanelles campaign appear somewhat unusual. It has hitherto been the writer's opinion that the battle of the Straits, like the campaign of Santiago de Cuba, indicates that land fortifications have retained their moral and material ascendancy over sea power, and can only be taken in reverse.



Railway artillery in action

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The Campaign of Marengo

By

C. L. Hall

Major, Corps of Engineers; Assoc. M. Am. Soc. C. E.

[*Note.*—This article was originally prepared as the first lecture in a course in Military History at the Engineer School. The time available permitted but one short study of the battles of the great master of the art of war. Marengo was selected for study. It is a fine example of "open warfare" as conducted in Napoleon's day."—ED.]

NAPOLEON BONAPARTE returned from Egypt in the fall of 1799, and, in a few brief days, by the Revolution of 18th Brumaire, seized the political power of France, and, establishing himself as First Consul, became, to all intents and purposes, the nation's dictator. But the land of whose destinies he thus became the arbiter, was by no means the same land that he left in 1798. Then, as a result of his victories, French troops guarded the Cisalpine Republic of North Italy and the Parthenopean Republic of Naples. The Rhenish states supported French garrisons. But, during the two years of his absence, terrible disasters had overtaken the French arms. Everywhere the French troops had been driven back. The military frontier on the north was the Rhine. On the south, as we shall soon see, only a few thousand troops were left in Italy. Napoleon, by his very political success, had become a liquidator of disaster. His consular chair would last until the first great battle. If successful, he could exchange it for a crown; if defeated, for a guillotine.

During the winter the First Consul busied himself with negotiations for peace and plans for war. The former came to nothing; the latter were, indeed, crowned with laurels.

In the latter part of March, 1800, there were two main French armies in being. Covering the Rhine and holding the German-Swiss Passes, which had been preserved for France out of the wrecks of the preceding year, was Moreau, with the Army of the Rhine. Holding Genoa, a little fringe of the Appennines, and the Savoy passes, was Massena, with the Army of Italy. Moreau had about 120,000 men, and so did his opponent, Kray. Massena, who was probably the ablest of Napoleon's generals at that time, had about 40,000, of whom 10,000 under Suchet were guarding the Alpine Passes. Against him was the Austrian general, Melas, a man 70 years old, with about 100,000 men, of whom 80,000 were in Piedmont, and the other 20,000 on garrison duty in the west of North Italy.

It was certain that the French Republic could never retrieve the losses of 1799 with forces such as these. Accordingly, it was decided to organize an Army of Reserve in Switzerland. This, Napoleon intended for himself. However, as the new constitution forbade him to command troops in the field, Berthier, his old chief of staff, was designated as its commander, and the First Consul merely accompanied it. Of course, this was camouflage, Napoleon was the real commander.

Consider the sketch, page 532. It will be noted that between Moreau and Massena was what I have here called the Swiss Bastion, a mountainous land that the Austrians could not get into, and which they did not think the French could get out of. It was entirely in the hands of the French. Troops quartered in South Switzerland, near the lake of Geneva, could be used as re-inforcements for either army, either in attack or defense..

The Anti-French coalition was more or less committed politically to an offensive, but it could not be foreseen whether the main attack would come via the upper Rhine or via Savoy. Those who have seen the maritime Alps may smile at the idea of an offensive in that direction, but it must be remembered that the British controlled the seas absolutely; and that southern France was a hotbed of royalism, where the invaders could find many friends.

Napoleon had no intention of awaiting the coalition's moves, however, and planned to strike first, as he always did. His first idea was to combine Moreau's and Berthier's armies under his personal command, strike from Lake Constance, against Kray's communications, and, after defeating Kray, move on south and cut off Melas.

In the execution of this move he ran into a snag. Moreau disapproved of the plan and refused to be a party to it. In the rather shaky political situation, Moreau could not be relieved; moreover, his talents were so high that it was difficult to replace him by a professional equal.

So a different plan was evolved. Before explaining it we may examine the tactical and topographic situation of the moment.

It was wholly impossible to keep secret from the Austrian spies the creation of the Army of Reserve. But the army itself was concentrated around Lake Geneva, whereas it was given out that it was organized near Dijon. Great publicity was given to a review of the Army of the Reserve by the First Consul in person, which was held at Dijon, a locality familiar to many Americans. For this review there were turned out three or four thousand men, all either superannuated or recruits. The spies immediately reported the non-existence of the Army of the Reserve, and Napoleon was able to attack with an army whose existence was unsuspected.

From Switzerland Napoleon had three or four passes, all very difficult, though not exactly impossible, as Hannibal had proved. They were, however, impossible as lines of supply, and the French armies would have to live on the country. Melas had the broad valley of the Po as his line of supply, and did not think that elements, whose very existence he doubted, could debouch from the Swiss Passes.

Napoleon's modified plan of campaign was as follows:

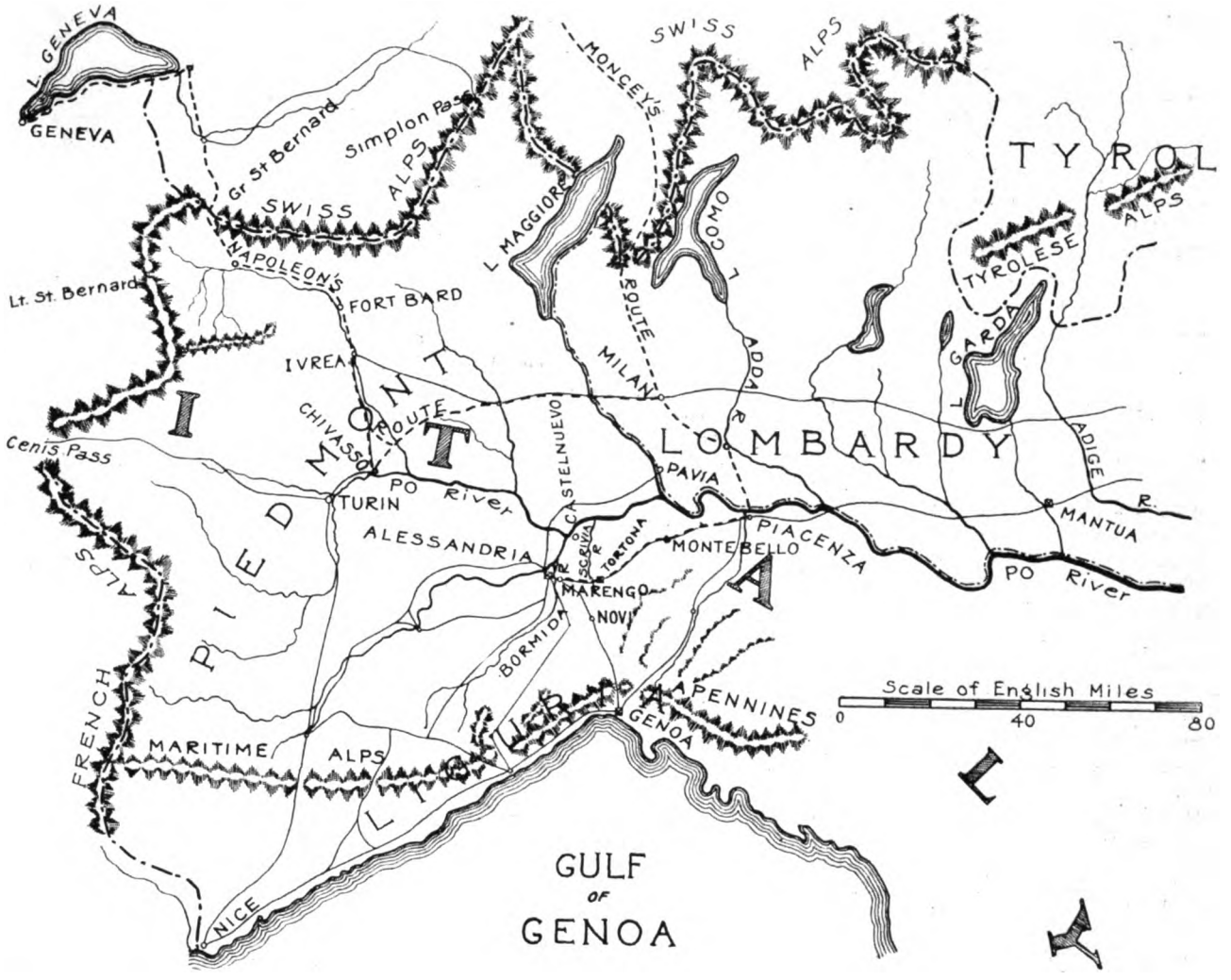
(*a*) To cross the Alps via St. Gothard or Simplon Pass.

(*b*) To move thence on Turin, forming a junction at that point with Massena (if possible).

(*c*) With his forces combined with 25,000 men whom Moreau had promised him, to attack Melas and drive him out of north Italy.

On April 7 Massena was sent his orders. These directed him to remain strictly on the defensive until the Army of

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the Reserve debouched into Switzerland. Then he was to attempt to form a junction with its right wing at Turin.

In the meantime Melas had taken the offensive on his own account (April 6). He adopted the very style of fighting which Napoleon had foreseen, namely, he advanced concentrically, enabling Massena to attack him an element at a time. His forces were, however, so superior that Massena, in spite of most brilliant troop-leading, was invested in Genoa on April 18. Of these events Napoleon received only sketchy information, as Massena's communications with France were soon cut off. However, he concluded that the Army of the Reserve could not lose a minute. Hence, the great St. Bernard was chosen instead of the more easterly passes. This was the first change in the plan of campaign.

On May 1 Berthier arrived at Geneva. On May 6 Napoleon left Paris and reached Geneva two days later. On May 10 the Army of the Reserve was organized into an advance guard under Lannes, two corps under Duhesme and Victor, and the cavalry under Murat. Its total strength was 42,000 men. At the same time Thurreau, who held the Cenis Pass, was transferred out of Massena's Army. Moreau's contribution of 15,000 men under Moncey was marching toward St. Gothard.

Malas' army was for the most part either besieging Massena or trying to enter France from Nice. The rest of his men were scattered all over north Italy, including 8,000 men watching St. Gothard.

On May 15 Lannes crossed the pass. The journey was very difficult, but Napoleon had made all possible arrangements to supply the troops en route, and they were exceedingly cheerful as "Successors of Hannibal."

Lannes had hardly crossed when he was delayed by the impregnable post of Fort Bard. It was impossible to take it directly, but a foot-path was found to get the infantry around it; and the artillery stole by at night. Lannes continued forward, and on May 22 attacked Jurea, but without success. Two days later more artillery had been brought up, and the town was taken by assault. On May 26 Napoleon entered the town himself.

The opening maneuvers had been brilliantly successful. Napoleon had placed a first-class army, by pure surprise, on the flank of Melas' line of communications, and had made the invasion of southeastern France an impossibility. He now took a very bold attitude and adopted the following plan of campaign:

1. To abandon Massena to his fate.

2. To march on Milan, seize the crossings of the Po, thereby cutting off Melas, and attack and defeat him in detail. An army defeated at its rear is, of course, no army at all.

The abandonment of Massena was a master-stroke. For even if he surrendered (as he later did) so many more Austrians would be absent on the critical day. If the Austrians abandoned the siege, he was released any way.

On the 27th of May Lannes, after some fighting, reached

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Chivasso. Moncey crossed the St. Gothard on the 26th and 27th. Leaving Lannes as rear guard, the French on June 1 entered Milan. On June 3 Lannes entered Pavia. Suchet, who was in command of the troops in southeastern France, had, in the meantime, driven back the Austrians in his front.

By the night of May 31 Melas became aware of his critical situation, and ordered a concentration at Alessandria. Ott, in front of Genoa, was negotiating with Massena for its surrender. The latter was, of course, wholly unaware of his prospective relief, his supplies were exhausted, and he surrendered with all the honors of war on June 4. His defense ranks as a classic of military history, and proves that the most hopeless defense, protracted to a sufficient extent, may have far-reaching influences on the success of a campaign elsewhere; Stoessel, at Port Arthur, 105 years later, had apparently forgotten this. Ott, on June 6, withdrew toward Alessandria.

The same day Moncey entered Milan. Lannes and Murat had crossed the Po. Ott had received orders to move on Piacenza instead of Alessandria. Lannes met him on June 9 at Montebello and drove him back to Castelnuevo.

We should pause here and observe the tactical situation. Ott, with the beaten advance guard, was at Castelnuevo about a day's march west of there. Napoleon had 34,000 men south of the Po ready for action, 23,000 too far away to be of immediate use.

According to the books, Napoleon should have concentrated his 34,000 and prepared for immediate battle. Most authorities are agreed that this is what he ought to have done.

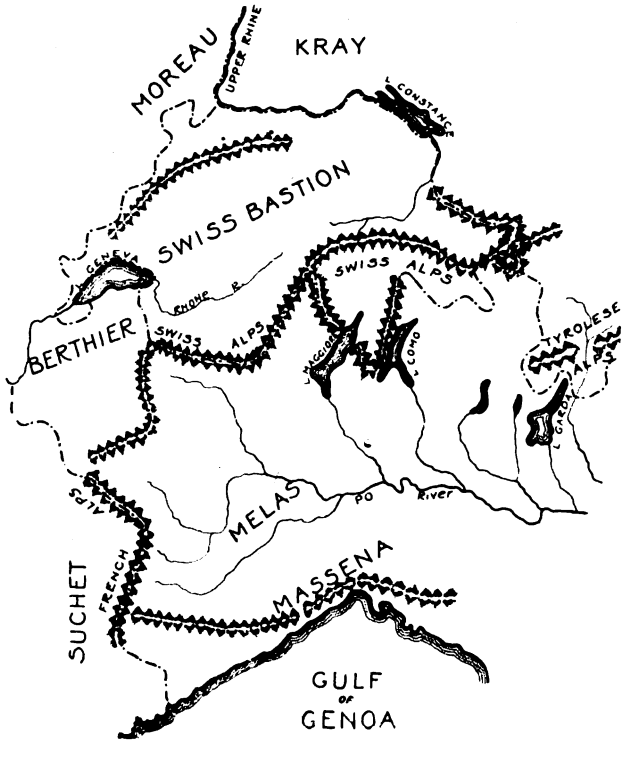
His estimates of the enemy's intentions conceded him three plans:

(*a*) To cross the Po and move to the north of, and parallel to Napoleon's line of communications back on Mantua.

(*b*) To retire, via Genoa, to friendly Tuscany and prolong the campaign indefinitely.

(*c*) To attack.

To meet the first plan, two divisions were sent to the vicinity of Chivasso. On the 12th, the French advanced on Alessandria. On the 13th, the French crossed the Scrivia. Here, finding no enemy, Napoleon became worried that the Austrians might adopt the second plan, and sent Desaix, who had just joined from Egypt, to Novi to cut off Melas' retreat. The first and second of the enemy's plans were, indeed, well discounted, but the First Consul was badly weakened if the enemy should attack.



Late on the afternoon of June 13 Victor encountered the Austrian rear guard at Marengo and drove it back to the Bormida bridgehead. This made Napoleon safe in case of a prospective retreat, and he slept in peace that night.

Melas' troops crossed the Bormida early in the morning of June 14 and attacked Victor's advance troops. Napoleon was completely surprised and sent post haste for Desaix at Novi. Desaix reported that he would arrive at 4 o'clock. In fact he started without orders as soon as he heard the fire of guns. All of Napoleon's efforts were thus bent on gaining time. The attacks of the Austrians were more and more successful, and by noon the French were almost routed. At this time the aged Austrian general became physically exhausted and turned his command over to the chief of staff. The latter formed the army into one great column and marched on down the high road.

At 5 o'clock Desaix came up. The fugitives were rallied, the French lines re-formed. Marmont managed to turn some reserve artillery on the Column, Desaix attacked the right front, and Kellerman, with a cavalry brigade, the left rear. The Austrians, thus threatened, broke and ran, and that night all but their rear guard crossed the Bormida. On the morning of June 15 Melas sent a flag of truce and the Marengo Campaign was finished.

Let us sum up some features of this great campaign.

Napoleon chose a line of communications, which would preserve his own line of retreat in case of failure, but which would cut off the enemy entirely in case of success.

He deliberately abandoned a portion of his army (Messena's), which he could have relieved, but only by forfeiting his chances of a smashing victory.

His dispositions were so taken that if the Novi detachment had been led by a lesser man than Desaix, his violation of the principles of concentration for action would have been fatal.

Melas, however, committed about every known mistake. The successful defense of Fort Bard gave him every chance to cut off Lannes before the rest of the army could get over the St. Bernard. Had he concentrated all his troops, even as late as May 30, he could certainly have prevented the disaster which overtook him.

The campaign which opened when Napoleon crossed the Alps on May 15 and ended when Melas' parlementaire appeared on June 15, settled the fate of north Italy and gave permanence for fourteen years to a Bonapartist dynasty. It has been studied and restudied by every staff officer in Europe. If Napoleon's principles were not followed in the Great War, it was not for lack of effort.

American shipbuilding during 1919-1920

During the fiscal year ending June 30, 1920, according to the U. S. Department of Commerce, the total shipping built in the United States and officially numbered by the Bureau of Navigation, aggregated 2,241 vessels of 3,860,484 gross tons as compared with 2,158 vessels and 3,734,741 gross tons for the preceding fiscal year. The peak of production was reached in the autumn of 1919 and the following winter when, from September, 1919, to February, 1920, the output was at the rate of 4,250,000 gross tons per year.—*Eng. News-Rec.*

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The Mental Processes of the Military and the Non-Military Mind

As Applied to the Design of Army Wagons

By

Ernest Graves
Major, Corps of Engineers

[*Note.*—The spirited attack by Colonel Graves and the active defense by Major Keesler are most encouraging signs, as indicating the virility which characterizes our Society and all the members thereof. Our readers will much enjoy these comments, which combine technical information and human interest in so graceful a manner.

In his letter submitting these comments, Major Keesler says: "While I do not know Colonel Graves personally, I know he enjoys the reputation of being a good engineer officer and accustomed to speak his mind plainly, which I consider more praiseworthy than otherwise." And again he says, by way of warning: "I could submit much more favorable comment, but the attack does not force me to call out *all* of my reserves at this time."

This lively discussion on the "processes of the military and non-military mind" seems in a manner to epitomize the aims and purposes of our Society of American Military Engineers. For the defense of our country the best thought of both the military and non-military mind is needed. To bring the military and non-military mind together on a common ground and for a common purpose, to profit by the best that each can do, to let each perceive by contrast with the other its own strength and its own weakness, and finally to adjust differences of opinion and cause the two to pull together as an unbeatable team, is the reason for our Society, and for its Journal.—ED.]

IT has been frequently stated that civil and military engineering are identical, or nearly so; that military engineering is merely an application of the civil art. Aye, but there is the rub—in the application. The details of practice are very similar to be sure, but the fundamental principles differ widely. The term "military engineer," as here used, does not mean simply a person who carries a title as military engineer. It means one who really follows military mental processes, or, in other words, thinks on a military basis.

The civilian engineer receives from a client an idea of what is desired, and he figures to design and erect a structure that shall fulfill those desires. His mission is to satisfy his client. As a rule, appearance, facility of operation, convenience, first cost, etc., are the most important considerations. There must be produced a finished product which is all that the client desires as to efficiency and ease of operation. The engineer has the markets of the world at his disposal and, within reason, such time as he needs to accomplish his results.

The conditions under which the military engineer operates are as different from this as possibly could be, in almost all respects. What is demanded is a structure to accomplish certain necessary results in a minimum of time. The engineer first takes stock of his materials, supplies and labor, and then decides how the bare necessities of the case can best be met with the facilities available. His designs are based upon, in fact entirely subservient to the resources available. Time is always limited. The engineer has generally to accept anything that can be used, regardless of whether it is really suitable to his purposes.

During the great war most of the failures of the engineers resulted from designing ideal structures, and then sitting back and waiting for somebody else to supply the facilities with which these ideal structures were to be erected. This somebody else never appeared. Usually the engineer in charge did not even put his most efficient assistant to the task of obtaining supplies. This point of view is all wrong. Anybody can build an ideal structure when somebody else furnishes him all the labor and materials that he requires, but it takes a real man to provide necessities on time with nothing to work with except what he "rustles" for himself; to feed a multitude with 5 loaves of bread and 3 fishes. Military engineering is a thoroughly practical art. There is little time for theorizing.

The real military engineer has only two essential things to do. He must fit his designs to the facilities he thinks he can obtain, and he must be the chief instrumentality in obtaining these facilities. In other words, he must go out and get what he wants. Most of the time, brains and energy, even of the chief engineer, must be devoted to supply of material. He should familiarize himself with the available resources and methods by which they may be exploited. His designs must be adapted to the situation. Not infrequently their features will be determined chiefly by the available labor. To prepare such designs may look like rough and ready work—actually it requires a nimble and resourceful mind, which must be able to determine promptly which designs are most economical as applied to given conditions, as to available materials and labor.

The mental processes to which we refer are not limited to the engineer. They are characteristic, or should be characteristic of all those directing all classes of military operations. For example, if a movement by road is contemplated, the military mind will select the motor trucks that will probably keep going on the roads that must be used for the movement; the non-military mind is too apt to become befogged with a number of incidental matters, such as economy of operation under ideal conditions, trusting that somebody else will create the ideal conditions. This somebody else is usually conspicuous by his absence.

The foregoing remarks find some application to the question of proper equipment for troops, and in particular to an article in a recent issue of THE MILITARY ENGINEER by Capt. A. A. Keesler, of the Watson Wagon Co., with reference to a design for a wagon for engineers.

It is believed that incorrect mental processes resulted in the evolution of our present wagon for engineer tools, and that these were the processes of non-military minds.

Without doubt Captain Keesler is a capable man in his own line, which is the designing of wagons, but he is not a professional soldier, and therefore not as familiar as

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a professional soldier with military needs. During the war he was engaged in studies which resulted in the design of a wagon, but the result proved quite conclusively that he had not sufficient supervision by military experts. He understood only half his problem, worked on false hypotheses, and if his wagon is adopted, the army will be saddled with an abortion.

Captain Keesler states, "it is generally true that to do a special task most efficiently you must have a special tool therefor. The task may be done with a general purpose tool, but can be done quicker, better and with immensely more satisfaction to one's self and one's superiors with the proper tool designed for that particular work." This is not correct. In engineering, both civil and military, it is extremely undesirable to be saddled with special tools. These have their use in factory production, but in engineering, and especially military engineering, special tools should be avoided. We must not allow ourselves to be led astray by any such specious arguments as this.

In attacking this problem the practical military mind would first be concerned with the question as to whether the vehicle *can be kept in operation*. The next question would be whether a fairly efficient wagon could be obtained. The limber and caisson type requires two drivers and a man to operate brakes, or three men; it uses four to six horses; it is easy to obtain access to its contents; it will undoubtedly travel over very rough roads; and it can be divided into two carts. However, it is believed that this device does not fulfill as well as a wagon the prime military requisite that it can be *kept in operation*, because it wears out horses which, in any event, are harder to keep going than mules, and because in campaign broken tongues, bolts, wheels, etc., could not be quickly and easily replaced. Another serious defect is that such a wagon is not adaptable to general hauling. It might be satisfactory for tools, but if something more bulky were to be hauled, it might prove quite unsatisfactory. The engineer is called upon to haul all sort of things in his wagon, and he has need of a general purpose wagon for general hauling.

The military mind would reason this thing as follows: "If I have an escort wagon, one man does all the driving, including operation of the brakes; I have mules, harness and wagons that can be easily replaced, either in whole or in any broken part, anywhere that there are other troops, because this equipment is standard throughout the army. If I have a limber and caisson wagon, possibly I can reach a certain tool therein a little quicker; but if a piece of harness, a tongue or a wheel breaks, I probably will have to leave behind the wagon with all my tools. If this should happen to an escort wagon, I simply go to the nearest quartermaster, and while I am requesting his help, if he does not give it to me, one of my enterprising soldiers will steal the necessary spare part from some wagon train in the locality.* In any event I shall keep my tool wagon moving."

On the punitive expedition into Mexico a wheel on one of my tool wagons broke down. A sergeant stayed up all night wiring it together with wire from a nearby fence. Knowing this would not hold for long, I sent an officer back to Columbus to get a wheel. Next day on the road I passed a wagon train leaving behind a wagon with a broken wheel. When I stopped that night I sent a pack mule to get the good wheel of this broken wagon. My lieutenant also obtained a wheel in Columbus, put it in a truck and started toward the outfit. As he neared the broken wagon some officer took the wheel away from my lieutenant, but even so the quartermaster's wagon had only three wheels. I proceeded with four good wheels. If I had had a limber and caisson wagon, I should have been forced to leave my tool wagon behind.

Practical questions like these are of far more importance than theoretical efficiency. Practical military equipment can be designed only by practical military men. That they should have the assistance of expert civilian designers is, of course, desirable, but the military mind and not the civilian mind is qualified to fix the requirements, and make certain that they are met by any device it is proposed to adopt.

*[This merely indicates how results *may* be achieved. Major Graves believes that such practices should not be wanton, nor even habitual. They should be limited to cases of really dire necessity. But in such cases the end justifies the means, and an *undetected* theft becomes a really commendable act.—ED.]

Comment

A. A. Keesler
Major, Engineer Reserve Corps

Colonel Graves seems to be so much in earnest that I rather hesitate to disagree with him, but after a careful perusal of his article I can not help but wonder whether he has ever had occasion to give *any* type of engineer tool wagon a fair test under actual service conditions. I might add that I have been advised that no such test was made with the Pershing Expedition to Mexico as that expedition very soon became a test of motor equipment.

He makes the point that there is a great difference between military engineering and military hauling, and civilian engineering and civilian hauling. In both cases, I take it, the idea is to move certain material of various kinds from the place where it is to the place where it will be wanted. In both cases it must be done often under adverse conditions as to weather, vehicles and motive power.

I admit that twenty-five years of designing, building and supervising the use of haulage vehicles of all kinds, from a two-wheel cart to a seven-ton truck, may not have fitted me adequately to compete with Colonel Graves in designing vehicles, but over two years' service in the army, which included the inspection of and remedying of defects in horse-drawn transportation, from Camp Green to Coblenz, gave me a fair opportunity to judge the quality of design which military minds of the Regular Army turned out.

It may be true that the civilian mind does not function in a way to allow it to understand the military mind, if judged solely by the product of its brains, as shown by the horse-drawn vehicles in use. In a lifetime association with general contractors who have developed this country from one ocean to the other, in building roads, dams, irrigation systems and railways, wherein they must haul supplies of every conceivable nature that is or could be handled by the army, I am convinced that I could not induce them to use the vehicles which army men are forced to use for their transportation.

If "incorrect mental processes" resulted in the evolution of the proposed general service limber and caisson wagon, then I wonder what would be said of the mental processes of the military mind which conceived the Brill type of engineer tool wagon. I will leave the characterization of that military mind to any of the officers or men who trained with it in this country or used it overseas. It is certain that if this is a type of the working of the military mind in designing vehicles, then it would be better to intern all engineer officers while they were being provided with transportation equipment.

Undoubtedly, Colonel Graves must consider that "suffi-

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cient supervision by military experts" must mean his own supervision. The officers under whom the writer served during the designing of the wagon in question were all Regular Army officers who had had all of the usual experience of the Regular Army officer and some of whom had had extended overseas experience and had been returned, that the benefit of their service overseas might be obtained in the equipment of the army. If the officers and men of the 1st, 2d and 3d Divisions were not experienced military experts, I fear the army is without them. When the wagon as designed and presented was remodeled on the Rhine, under the supervision of the Chief Engineer, 3d Army, the division engineers, 1st and 2d Divisions, and after conference with several higher and experienced engineer officers who had served as corps engineers, the experience of the officers who served throughout the war in these Regular Army divisions was taken advantage of, as well as the criticisms of the non-commissioned officers and men. If this is not sufficient to produce a wagon which meets with Colonel Graves' approval, at least it was sufficient to produce the high recommendation of many able officers who have commanded troops in the field and met the problems which Colonel Graves refers to. I will quote from reports which I suspect were not far from Colonel Graves' elbow at the time he was slinging ink on my poor little wagon and using such epithets as "incorrect mental processes" and "abortion":

"The wagon as it stands modified will take the platoon equipment anywhere two animals can go. Once there, a usable piece of transportation is available, ready to go for rations, additional tools or a load of rock."

"This limber and caisson type wagon, as modified, is considered by far the best unit of its kind yet developed. With the two changes indicated below, its adoption is strongly recommended."

"I believe the wagon as brought to Europe by Captain Keesler is a great improvement over any tool wagon I have ever seen. As modified by him, I believe it to be well nigh ideal for engineer uses."

"Subject to above comments, the new type of wagon has my enthusiastic endorsement."

It is deemed regrettable that the Colonel should excavate in his own fertile imagination rather than in the records on file in the office of the Chief of Engineers, but that possibly may be the manner in which his military mind functions.

I do not mention the names signed to these reports because I know these officers are amply capable of defending their own opinions. They are brilliant officers of the greatest fighting divisions of the Regular Army.

As to the matter of special tools for a special task, if nothing but a general purpose tool must be used, I should like to ask Colonel Graves why it is that the equipment table for the engineer tool wagon provides for several hundred different tools. Probably wire may be cut with an axe, which is a general purpose tool, but the wisdom of some one has provided wire-cutting pliers.

As to the point he makes, "However, it is believed that this device does not fulfill as well as a wagon the prime military requisite that it can be kept in operation, because it wears out horses which, in any event, are harder to keep going than mules, and because in campaign, broken tongues, bolts, wheels, etc., could not be quickly and easily replaced," it must be pointed out that the breakage on the limber and caisson type would be considerably less than on the stiff reach type and that if adopted, spare parts would be as easily obtained.

As to the statement "another serious defect is that such a wagon is not adaptable to general hauling," it is pointed out that this wagon is adaptable to all kinds of general hauling and is capable of carrying any material, with the exception of lumber or timbers, which can be carried in a stiff reach wagon, It will go over country without damage where it is impossible to take the escort wagon, and under certain circumstances, it has the great advantage of becoming two vehicles, thereby doubling the efficiency of the transportation for certain purposes. If a company commander wanted picks and shovels and also wanted a shell hole filled, it is quite possible that he might have to go in different directions.

As to the complaint that it requires four horses, while the escort wagon requires two, I am astonished that Colonel Graves has not noticed that the four horses were to pull a load. I am surprised to find that he is the kind of military engineer who has overlooked the fact that the motive power, namely, horses or mules, is the most valuable part of his equipment, and that the commonest fault in the army is overloading. It is less necessary to use four horses on the proposed limbered wagon than it is on the escort type.

In conclusion, it is believed some discussion should be had regarding the uses, the excellent points and the defects of both the limbered type and the stiff reach type of wagon, in order that a correct decision might be arrived at. There must be points in favor of the limbered wagon, or else the British Army was entirely mistaken in their equipment. If the stiff reach type is adopted exclusively, the writer would be glad to assist in helping to redesign it, so as to eliminate some of the defects of the escort wagon in order to make it more serviceable and easier of procurement.

Highway bridges inadequate for motor truck traffic

Eng. News-Record points out that one of the weakest elements of our road system is the insufficient strength of highway bridges under motor truck traffic. The number of commercial motor vehicles in America is increasing rapidly. Five years ago there were 70,000 on our roads, to-day there are 7,000,000. Even the smaller of these vehicles often attain a gross weight (truck and cargo) of 5 tons, whereas the larger attain to 15 or even 20 tons. All are free to pass over any of our highways. A survey made by one state highway department during the war revealed the fact that a large number of highway bridges could not carry a load beyond one ton without exceeding what are ordinarily regarded as safe limits of stress. Accordingly the dangerous combination of a weak bridge and a heavy truck is daily becoming more frequent.

Until our bridges can be reconstructed a close regulation of truck loads and speeds will be necessary if frequent accidents or failures are to be avoided. This is a more critical matter than that of wear on road surfaces.

Incentive is so fundamental to success wherever human effort counts, that to provide this incentive must be regarded as the third commandment.—Railway Age.

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Should Engineer Troops Be Trained in Peace As They Are in War?

By

H. A. Finch

Major, Corps of Engineers

THE discussion of the article, "Some Practical Points on the Training of Troops," in the May-June (1920) number of THE MILITARY ENGINEER developed an interesting difference of opinion that is believed to be worthy of further investigation. This difference of opinion is that concerning the best system of providing for the engineer instruction of our troops.

In the original article an argument was made in favor of the principle of providing expert, specialized instructors or supervisors for the engineer training (other than general pioneer instruction) of the various platoon units throughout our regiments—these instructors being drawn from the officer personnel of the regiment. This method was followed with success in our preparation for participation in the World War. In the discussion of the article referred to certain officers of long experience took the ground that this method of instruction had been forced upon us through necessity for hurried preparation for war; that the need of such a system no longer exists, and that we should therefore revert at once to the method of holding the company officers directly responsible for the complete instruction of their units.

In the original article this subject was treated very briefly, and the writer may have failed to make clear that he advocates holding the company officers accountable for the general pioneer instruction of their organizations (recommended for the entire regiment), and for all infantry training, except perhaps rifle practice. However, the statements made verbally and through correspondence by certain engineer officers indicate that they would be much better satisfied to have the captain and his lieutenant assistants assume the burden and the responsibility for all instruction of whatever nature given the men under their charge.

At the outset the writer is forced to confess that he has never met a company officer versatile enough to meet all the demands that such a system imposes upon a captain of engineers and his lieutenants. Therefore, with due deference for the opinions of the advocates of "direct responsibility," the writer submits that much may be said in favor of providing special supervision over much of the technical engineer training given any unit of an engineer regiment.

Perhaps the best method of approaching this subject is to establish first, as clearly as may be, the object of a training schedule for engineer troops. If, as some officers hold to be the case, the training of troops in the American Army has as its main, if not its sole object the development of competent officers and non-commissioned officers; if the instruction of the men in the ranks is a matter of secondary importance in that they are to be handled or mishandled simply in order that officers and non-coms may learn by making mistakes—if this theory is accepted, then more may be said for the system of making the efficiency of the company entirely dependent upon the ability and versatility of its officers. But there is another conception of the purposes of military training in our army which must be considered on its merits. This is the theory that the object of all our army training is to provide correct military instruction for as many men as possible in this "unmilitary" nation, to the end that each man turned back on the country may have benefited to the fullest extent through his army experience. This idea contemplates that discharged privates shall leave our service, not with a muddle-headed wondering of "what it was all about," but with certain clearly defined lessons in mind—lessons that will prove of benefit to the country in time of stress whether or not the man ever rises higher than the grade of private.

The writer believes that in the future, even more than in the past, will it be difficult to fill the ranks of our regiments unless the army can be shown to provide worth-while training, vocational as well as military, for the eligible young men of this country. To the writer's mind this implies that, far from placing the training of 100 to 200 young men in the hands of a captain and his lieutenants, who by reason of limited experience can not be expected to do full justice to the immense engineering field to be covered, it is much wiser, as a general policy, to provide the very best technical and vocational training that it is practicable to obtain by utilizing any expert knowledge that may be possessed by any of the regimental officers, or that may be developed in these officers in schools established for the training of instructors. It is believed that not only may this be done with marked benefit to the men in the ranks, but also to the officers of the company who, as observers, learn the correct methods of imparting instruction in various subjects in which they were not fully grounded.

It seems certain that men will not in the future enlist for military service in sufficient numbers to fill our peace-time quota unless the army can be brought to mean something desirable to the man who wants to serve and at the same time is ambitious to learn, but who does not find the chances of his being promoted to a non-com's grade sufficiently attractive to tempt him into the army. But even if recruits were plentiful, the writer holds that the field of engineering instruction is now so wide that the average captain, busy as he is drilling, disciplining and administering his company, can not be expected to do justice to all the subjects in which instruction is required. And this does not mean that the average young officer is believed to be incompetent, but simply that he is *bound* to be inexperienced in some of the many lines of instruction over which he (under one theory) must exercise control. It takes time and study to

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become a competent instructor, and the captain and his assistants have not the time to qualify in all subjects. The best they can hope for is to graze superficially over what they don't know until by observation of some one who *does* know they gain knowledge enough to act as real instructors. And unless that "some one" is provided by the system under which they work they may go for years in their ignorance. This is said from experience. Such a system may accustom an officer to assuming responsibility, but it is more likely to habituate him to bluffing his way—until the day when his bluff is called, as it nearly always is. In any case this system fails to furnish correct instruction for the privates in the ranks while their officers themselves are learning.

The writer speaks feelingly on this point because he has the handicap of a memory that will not forget the many mistakes he has made while floundering around with the millstone of platoon or company responsibility about his neck. Too often has he scratched his head (and watched others do likewise) over the distribution of a company for engineer instruction, only to end after all other practicable training was provided for, by consigning the twenty or thirty remaining men to "Knots an' lashin's." (It would be an interesting but perhaps a distressing task to calculate the number of years in actual elapsed time that have been devoted in our engineer service to the grand old game of "Knots an' lashin's," and to compare this figure with the benefit derived from such instruction.) Too often, as a captain, has the writer wished that he could find the time and that some one would produce the knowledge to clear up his hazy ideas as to the correct method of teaching *soldiers* to make a quick and worth-while road sketch. As for rifle shooting, there is no forgetting the hours wasted on inefficient methods and useless drills designed to teach this all-important subject—methods hammered out separately by groups of company officers acting without expert guidance from their superiors. Perhaps these senior officers did not realize that only one out of four companies was fortunate enough to include a competent rifle practice instructor among its officers, or perhaps they believed that there was no better way of developing instructors in this line than by insisting that each company group struggle for its own salvation; but contrast this haphazard, "direct responsibility" experience with the system which provides an expert possessing exact knowledge and enthusiasm for his subject to supervise the target practice for an entire division. Under this system the expert, such as Colonel McNab, assembles an entire regiment at one time for a series of talks on rifle shooting. From these talks both officers and men learned the purpose of the course, and they also learned what is to be emphasized and what to be ignored in the well-padded pamphlets issued by the War Department. A representative of the general supervisor is attached to each regiment to direct the instruction of each company in turn, the company officers being developed as instructors (so far as their other duties will permit) and employed as subordinate assistants. The writer has seen this system applied in several regiments and always with success—if teaching men to shoot be counted a success. It has proven itself. In no case were company officers allowed to "get away with mistakes." Nor have temporary officers been the only ones to secure benefit from the course, for it is a matter of record that under such a system many officers of the Regular Army with years of service learned for the first time the *real* way to implant a knowledge of rifle shooting in the head of any soldier.

Economical Loading of Seagoing Dredges

By

G. S. Phelps

U. S. Assistant Engineer, Cleveland Engineer District

The correct determination of the relative amount of time to be spent in dredging and in running to and from the dumping grounds is a matter of some importance. It may be investigated from a theoretical standpoint, and the ideal practice for particular cases determined, but judgment is essential when it comes to applying practically some of the theoretical conclusions.

Investigation was made as to the number of loads per day which should be dredged at Cleveland Harbor with the seagoing hopper dredge *Burton*. At this harbor dredged material running overboard with the overflow is a waste of money, as it settles within the dredged area. The material was a fine silt, which settled slowly in the bins. Time required for one round trip to the dumping grounds, about 30 minutes. The total time available for dredging and dumping is assumed at 9 hours per day. Two loads per day could be dredged with a pumping time of 4 hours each, which with the two trips to the dumping grounds consumed the 9 hours. While the dredge worked on that schedule, it was found that a fairly constant average of about 720 cubic yards of settled material in the bins was secured with each load, or at the rate of 3 cubic yards of settled material per minute of dredging time. Capacity of the bins was 935 cubic yards. The dredging time per load was varied from 30 minutes to 4 hours, and it was found that the amount of settled material in the bins was practically constant at 3 cubic yards per minute of dredging time, irrespective of the length of the dredging period. Thus when 6 loads per day were taken, the total time dredging was 6 hours, 3 hours were spent going to and from dumping grounds, and the quantity of measured settled material in the bins was about 1,080 cubic yards for the day, still 3 cubic yards per minute of dredging time. The question arose as to whether the solids held in suspension in the water above settled material in the bins were sufficient to justify the greater number of loads per day. The settled material had fallen from 1,440 to 1,080 cubic yards per day. It is apparent that volume of dirty water carried to the dumping grounds was increased from 2 (935)—1,440=430 cubic yards with 2 loads per day, to 6 (935)—1,080=4,530 cubic yards with 6 loads, an increase in volume of water carried of 4,200 cubic yards. The loss in settled material was 360 cubic yards. If the water contained 8.76 per cent solid material held in suspension, then the loss in settled material was exactly balanced by the gain in suspended solids; if less than 8.76

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per cent, 2 loads per day gave the greater total of settled and suspended material; if more than 8.76 per cent, the shorter dredging period and greater number of loads were better.

It appears then that in this case, 8.76 per cent is the critical percentage of suspended solids at which economy definitely demands a change from a policy of full loading of bins to one of many loads per day, the more the better, limited only by the time required to fill bins with muddy water. Satisfactory sampling of the water held in bins has not been made, since the dredge left the work before this was done. It is believed, however, that in a great many cases where the material consists of fine silt, the solids held in suspension will considerably exceed this critical percentage, and that in such cases the dredge would better become a "water wagon" and take as many loads as possible of water to the dumping grounds, in spite of the humorous criticisms of those who assert that we spend the government's money dredging water, and reporting it as solids.

Plate No. 1 shows graphically, for varying number of loads per day, the total yardage which would be obtained under conditions as outlined for Cleveland dredging, with varying percentages of suspended solids. The importance of taking this suspended matter into account, when considering the total quantity of material carried, is strikingly illustrated by this diagram.

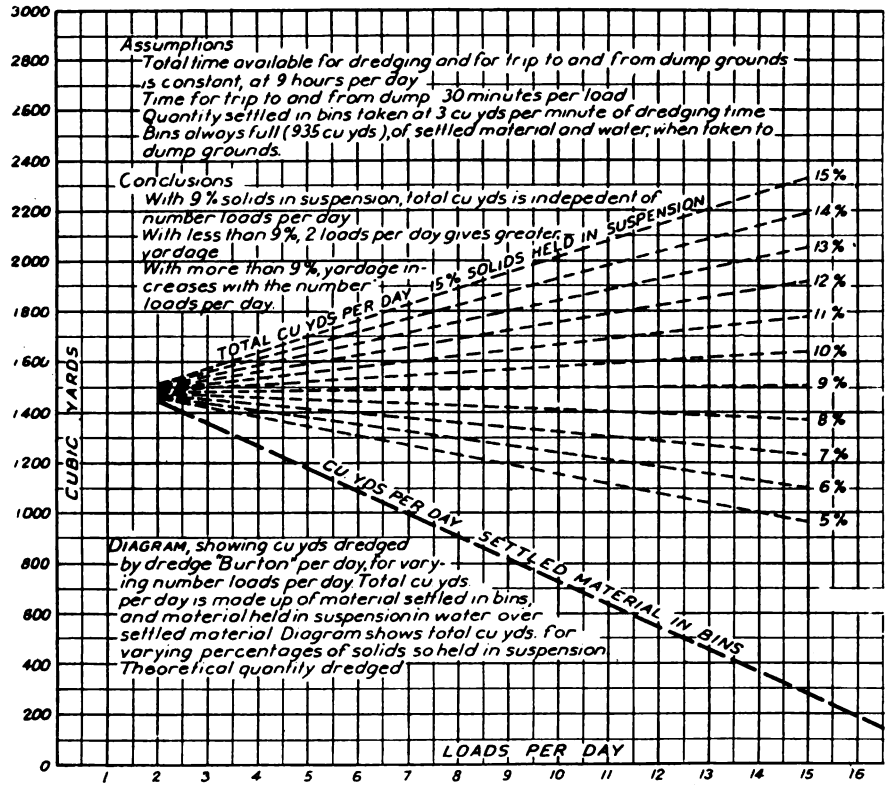


Plate 1

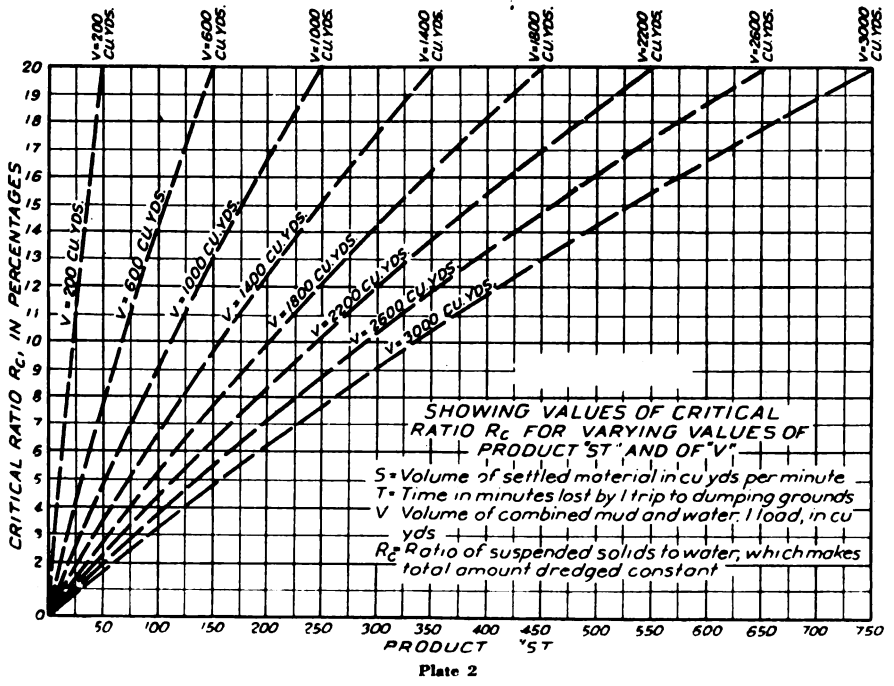


Plate 2

A more general solution of the problem is now to be considered. If V=Volume of bins in cubic yards, S=Cubic yards of settled material per minute of dredging time, R=ratio of suspended solids to volume of muddy water, Rc= critical ratio at which total yardage is constant, and T=Time in minutes consumed by one trip to the dumping grounds, then

$$Rc = \frac{ST}{V+ST}$$

The quantity ST is the cubic yards of settled material which might have been obtained in the bins by dredging for T minutes, or, expressed otherwise, the amount of settled material lost by taking time off for one trip to the dumping grounds. The denominator, V plus ST, is the increase in volume of water carried, caused by increasing the number of loads by one. It is evident that Rc (V plus ST) must equal ST, in order that the increase in suspended material may equal the loss in settled material and the total remain constant. The product of S and T, together with the capacity of the bins, V, determine this critical ratio Rc. The time required for one trip to the dump grounds and the rate of settlement in the bins per minute of dredging time are each of equal importance. If one is doubled and the other halved, the result is the same. Plate 2 shows graphically the critical value Rc, expressed in percentages, for varying values of the product ST and the quantity V.

The foregoing is all predicated upon a constant rate of settlement in the bins, per minute of dredging time, and no credit or account taken for agitated material not car-

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ried to the dumping grounds. The general principle holds true even though these conditions do not obtain. If the quantity S is a variable for different stages of loading, and decreases as loading progresses, T a known constant and R determined for the class of material being dredged, the loading might economically be stopped at that stage where the product ST would give a value for the critical ratio Rc as low or lower than R. If the material agitated but not retained in the bins is of value, due to currents which may carry part of it away, the increased volume of suspended solids must balance not only the loss in settled material but also the loss in agitated material, in order to justify reduction of total dredging time by more frequent trips to the dumping grounds. If A represents the estimated valuable portion of the agitated material not retained, expressed in yards per minute, then

$$Rc=\frac{T(S+A)}{V+ST}$$

The numerator is the amount of both settled and agitated material "lost" by one trip to the dumping grounds. The denominator, as in the first case, is the increased volume of water carried by increasing number of loads per day by one. It is very probable that any reasonable value assigned to A, would so increase Rc as to be above any probable value of R, and would show that in this case economy lies in large loads and reducing the time lost by trips to the dumping grounds to a minimum.

It is assumed that capacity loads of settled material and water are taken out on every trip. Since the bin gates are not water tight, this involves the deposit of sufficient settled material to seal the gates. The quantity V is the total volume of mud and water actually carried away.

No account is taken in the foregoing discussion of other factors which might enter into the problem, such as relative consumption of coal while dredging as compared with that while running to and from the dump grounds, difficulty in disposing of the entire load of muddy water, changes in amount of time lost from causes other than going to dump grounds, difficulty in closing bin gates frequently, etc. It is believed, however, that a theoretical analysis of a given case will indicate at least in which direction the greater efficiency may be obtained.

Territorial reorganization of the Army

Under the provisions of the Army Reorganization Act of June 4, 1920, the former territorial departments of the army are replaced by nine corps areas, as shown on the accompanying map. The headquarters of each area is also indicated. These corps are also grouped into armies, as follows: 1st Army, 1-2-3 Corps; 2d Army, 4-5-6 Corps; 3d Army, 7-8-9 Corps.

Electrification of railroads

Electric manufacturers believe that there will be a pronounced movement toward electrification of railroads. Railway men say they are striving to accomplish two things, before turning their attention to this—relief of the shortage of rolling stock and the restoration of former operating efficiency.

Manufacturers of electrical equipment are endeavoring to make the railroad companies realize that it would be far better to start a program of electrification right now, as operating efficiency can undoubtedly be greatly increased thereby and the railroads also would not be obliged to scrap new, though obsolete, equipment.

Reasons for the tremendous impetus which will be given electrification as soon as the money situation is easier are:

Success of installations now in operation despite troubles which attended the experimental stage.

Gradual realization on part of efficiency engineers that the days of the reciprocating steam engine are numbered where electrical operation is practicable.

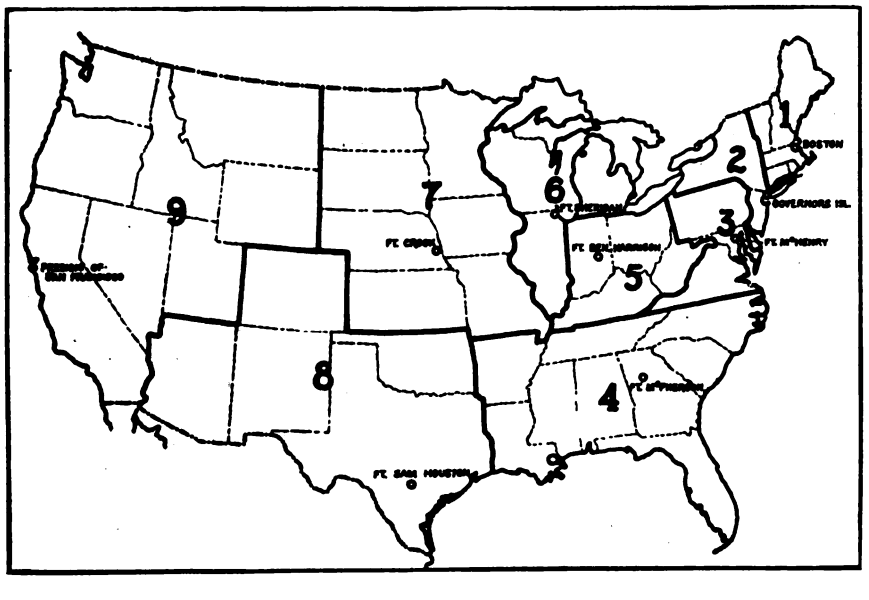
Present enormous coal consumption, the need for reducing which has been made doubly pressing by the critical fuel situation now confronting the industries of the country.

Recent passage of the Jones waterpower bill which opens the way to intensive development of all available waterfall on both navigable and non-navigable streams.

Statistics relating to the possibilities of electrification, compiled by electrical engineers, show:

Of total ton-miles of all railroads in 1918, amounting to 1,215,400,000,000, approximately 12 per cent or 146,000,000,000 would be totally eliminated with electric haulage, due to elimination of tenders, a large amount of railway coal and a portion of the non-driving weight of steam locomotives.

Of total coal used by all railroads in 1918, amounting to 176,000,000 tons (after reducing oil consumed to equivalent in coal), saving by electrification would have been 122,500,000 tons, according to result of General Electric Co.'s study of Chicago, Milwaukee & St. Paul. This saving amounts to one-quarter of total bituminous production in the country.—*Business Digest.*



New amphibious airplane

A new type of amphibious airplane, manufactured by Vickers, of England, and known as the Viking, was shown at the International Aeronautical Exhibition at London. The plane when fully laden weighs 4,545 pounds and is designed to start from or alight on either land or water. To this end the body resembles that of a flying boat, and is fitted with landing wheels that can be drawn up to the side when the machine is being used over water. The engine is a 360-horsepower Rolls-Royce "Eagle," and drives a pusher type airscrew. Accommodation is provided within the body for five people, but by removing three of the seats seventy-six cubic feet of space are made available for commercial freight. The machine has an overall length of thirty-two feet and an overall height of thirteen feet. Its span measures forty-six feet, the gap between the wings seven feet, and the chord of the wings six feet.

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The Military Engineer

Dedicated to the National Defense

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VOL. XII NOVEMBER-DECEMBER, 1920 NO. 66

List of Charter Members of the Society of American Military Engineers published in this issue

THE growth of our Society has been so rapid that we have heretofore been unable to publish a complete list of our charter members. In this issue, however, such a list appears.

This list of *charter* members was held open up to the instant of going to press, by decision of the Board of Directors. It is therefore a complete list of charter members, except for such as may have been inadvertently omitted.

The list is divided into two sections—first, those whose applications have been passed upon by the Committee on Membership, and who have been elected; second, all applicants whose applications were received prior to the closing of the list, but have not yet been reviewed by the committee. *All members whose names appear on this second list will become charter members as soon as their applications are passed.* A preliminary examination indicates that practically all are qualified for membership.

From this list our members may judge the high quality of our membership and identify friends and comrades who have joined the Society.

It is intended to publish as soon as possible a "year-book" of our members, giving their complete addresses, their present business connections, a brief of their military or civil records and other pertinent data.

In handling so large a number of names it seems almost inevitable that some omissions should occur. We ask the indulgence of our members in this matter, and request that we be promptly notified as to any names inadvertently omitted. Such errors will be corrected by a supplemental list in our next issue.

Action on applications for membership

SOME concern having been expressed by certain members regarding the delay in acting on applications and issuing membership cards, the following is published "for the information and guidance of all concerned."

Due to the fact that all the officers of the Society have been exceedingly busy with their own affairs or official business, and to the fact that the growth of the Society has been very rapid, we have been unable to complete action on all applications thus far received. More than half the applications have been passed upon by the Committee on Membership, and membership cards in such cases have been issued by Captain Weart, Secretary of the Society. The remaining applications are receiving attention as promptly as possible. The applications have not been reviewed exactly in the order in which they were received, which will account for apparently unreasonably long delays in certain instances.

All applications on hand have been given a preliminary examination, which indicates that the number of applicants who are not qualified for membership is practically nil. All may feel therefore reasonably assured that they will soon receive their cards of membership.

In order to relieve the minds of such members as have not received formal notification of their election, we are publishing in this issue a list of all members to date.

Why you have received so many circulars

THE immediate aim of our Society up to the present time has been to increase our membership to such a point that our financial success would be assured, and with it the perpetuation of our Society and its ability to carry out the purposes for which it was organized. We feel sure that all of our members will appreciate the tactical importance at this time of building up our membership, as the first prerequisite of success.

Accordingly during the summer and fall we have been conducting an almost continuous "membership drive." During this period there have been sent out something in the neighborhood of 100,000 letters and circulars. All must appreciate that it was impossible that these should have been personal communications, as such a task would have been manifestly beyond the capacity of our very inadequate office force. The work has been done by machinery as far as possible. In sending out, for example, a lot of 12,000 circulars to former emergency officers of Engineers, the clerical labor that would be involved in culling from this list all those who had already joined the Society, would have been almost as great as the labor of preparing the 12,000 circulars. Accordingly, the circulars have been sent to *all*, regardless of whether they were already members. In some instances this has naturally aroused some doubts on the part of charter members of comparatively long standing who thought that it indicated that there was no

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record of their membership. It is hoped that this explanation will clear up any such misunderstandings.

The excellent results that have been obtained will compensate all of our members for any incidental annoyance to which they may have been subjected. As this goes to press the number of paid subscribers to THE MILITARY ENGINEER exceeds 3,500, which means that our Society is now on a sound financial basis, and its growth still continues. Thirty-five hundred members, all of them men of standing and influence, joining our Society in a space of nine months is a most remarkable result, and plainly indicates that the aims of the Society are heartily endorsed by the American engineering profession.

Society of American Military Engineers has successful year. A message from our President to all members

THE PLAN FOR ORGANIZING A SOCIETY OF AMERICAN MILITARY ENGINEERS to perpetuate the friendships and profit by the experiences of the World War, and to assist in the promotion of "preparedness," was conceived in the fall of 1919. The first positive steps in the organization of the Society were taken in February, 1920, during which month a few members joined.

The active campaign for membership opened in March, 1920. At that time it was decided that 3,000 was the smallest membership that would justify the existence of the Society and enable it to achieve the objects of its organization. At the close of September the number of paid subscribers to THE MILITARY ENGINEER, the great majority of whom are also members of the Society, was 2,872, and the number was increasing at a more rapid rate than ever before.

In seven months of active campaigning, therefore, our "first objective" is already attained. By the close of the year our membership will be well in excess of 3,000—a strong and influential body. Our "second objective" is accordingly placed at 5,000, which it is hoped to attain before next summer.

But it is not the number of our membership so much as its quality which affords us great satisfaction. The list of our charter members, published elsewhere in this issue, is splendidly representative of the American Engineering profession. It includes the names of men of national, even international prominence in engineering affairs. Every branch of engineering is represented. We number in our membership officers and former officers of nearly every branch of the service, including the United States Navy, the Construction Division, the Quartermaster Corps, the Air Service and Tank Corps, the Geological and Geodetic Surveys, and the Forestry and Reclamation Services, etc. As to former rank in the Army our membership ranges from private soldier to major general.

So representative, able and distinguished a body of men cannot be otherwise than a power for good in national and human affairs. The voice of the Society of American Military Engineers will receive respectful attention in all matters pertaining to the national defense and the public welfare. Membership in such an organization is a privilege, a distinction and an honor. More and more as time goes on will our members be identified by connection with the Society, as the best class of patriotic citizens.

Beginning in June, of this year, the organization of local posts, chapters or sections, was inaugurated, and at the present time our Society has flourishing branches in most of the larger cities of the United States.

It is hoped also that THE MILITARY ENGINEER may become the medium through which the members of many former military organizations which have added lustre to the time-honored emblem of the Engineers (the castle), shall keep in touch with one another, thus maintaining the spirit of comradeship born of privations shared and perils met and overcome.

With the issue of November-December, 1920, the journal of our Society, THE MILITARY ENGINEER, closes its first successful year. Born under conditions most discouraging and difficult from a financial and other points of view, it has been a worthy organ of our Society, a strong bond of union between our members. Probably more than any other single influence it has contributed to the healthy growth of the organization. Its columns have included handsomely illustrated articles on a wide variety of civil and military subjects, of great interest to all engineers. The contributors to its pages have included many men who won undying fame in the World War, as well as many who have achieved national distinction in civil engineering. But in particular our journal has fulfilled its mission and earned the praise of all who have seen it, because it has truly interpreted and represented the *spirit of service* of the engineer to his country. Its columns have breathed enthusiasm and devotion to duty. No periodical can have a higher aim than this.

That advertisers have appreciated the influence of THE MILITARY ENGINEER is indicated by the growth in the number of its advertising pages from thirteen in its first issue to thirty-five in the issue of November-December, 1920.

All of our members, whose support alone has rendered possible our progress, should feel a just satisfaction and pride in the excellent results thus far achieved and the bright outlook for the future. Less than one year from the time when our Society first took form in the minds of a few men, finds it a strong and flourishing organization of some 3,500 members, supporting and publishing its own journal, solvent financially, with local sections established in most of the leading cities, and growing at a rapid and steady rate. Truly this is a most satisfactory result for so short a period. I offer my heartiest congratulations to all our members, and I look confidently forward to greater progress during the coming year.

W. M. BLACK,
Major General, U. S. Army (Retired)
President, Society of American Military Engineers.

Improvements in our floating bridge equipage

IN an early number of THE MILITARY ENGINEER will appear two illustrated articles descriptive of the experimental work being carried on in both the French and American Armies, with a view to effecting improvements in the ponton equipage, based on the lessons of the War.

These articles will be written by the officers best qualified to present the information, and being on a subject of great importance to the engineer service can not fail to interest our readers.

Following the policy of this Journal it is desired to publish with the articles a discussion by others having knowledge of the subject. Any of our readers who may desire to comment on our equipage and its development, from any point of view, are requested to advise the editor by letter, when advance copies of the articles will be sent them for that purpose.

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APPOINTMENT OF RESERVE CORPS OFFICERS HAS BEEN RESUMED

THERE is no limit by law to the number of officers in the Engineer Reserve Corps. Accordingly there is a place for every engineer who wishes to join and who fulfills the requirements.

Recently the issuance of commissions in the Reserve Corps was temporarily suspended pending the enactment of new legislation and not subsequently resumed because of the pressure of work incident to filling vacancies in the Regular Army.

This suspension of procedure was the cause of a good deal of uneasiness among engineers desiring to join the Reserve Corps, as evidenced by the large number of letters of inquiry that have been received. There is, however, no occasion for concern.

On June 4, 1920, the President signed the Act of Congress amending the National Defense Act, June 3, 1916. Certain provisions of the new law with respect to appointments in the Reserve Corps differ from those of former legislation and until recently no definite information on these matters has been available.

In a letter dated October 4th, however, the Chief of Engineers is directed to appoint a board of officers for the purpose of considering applications for commission in the Engineer Reserve Corps. This board has now been appointed and is proceeding to pass upon applications already on file.

All engineers desiring appointment in the Reserve Corps should submit their applications promptly in the form of a letter to the Chief of Engineers, setting forth briefly the qualifications which entitle them to appointment. Any additional data required will be called for.

Under the new regulations there are four classes eligible for appointment, as follows:

1. All persons who served in the United States Army at any time between April 6, 1917, and June 30, 1919.

2. Former officers of the Regular Army

3. Officers of the National Guard in Service on June 4, 1920.

4. Graduates of Reserve Officers' Training Corps at educational institutions.

Appointment of former officers may be made in the grade held at the time of discharge, or in any lower grade. No appointments will be made in the case of applicants whose average rating under the new rating rules falls below 53.

How Reserve Corps Officers may keep in touch with the Service

ONE of the desirable, if not the best, means by which Engineer Reserve Officers may keep in touch with the activities of the active engineer forces is THE MILITARY ENGINEER. The first endeavor of this magazine is to bring them together and to keep them together. News of the active engineer forces is printed freely, and important items of the inactive forces are of great interest to those who are in active service. The rendering of monthly reports by mail by officers on the inactive list is not required, excepting those that may be called for from time to time in connection with the correspondence courses conducted by the Engineer School at Camp A. A. Humphreys, Va.

Steel centers for concrete arches of Georgetown Bridge over the Potomac River

The views herewith illustrate the method being used in erecting steel centers for the concrete arches of the Georgetown Bridge, D. C. (formerly called the Key Bridge and described in the January-February issue of THE MILITARY ENGINEER).

The spans of the bridge are: Channel spans, one 208 foot, two 204 foot, two 187 foot; shore spans, one 152

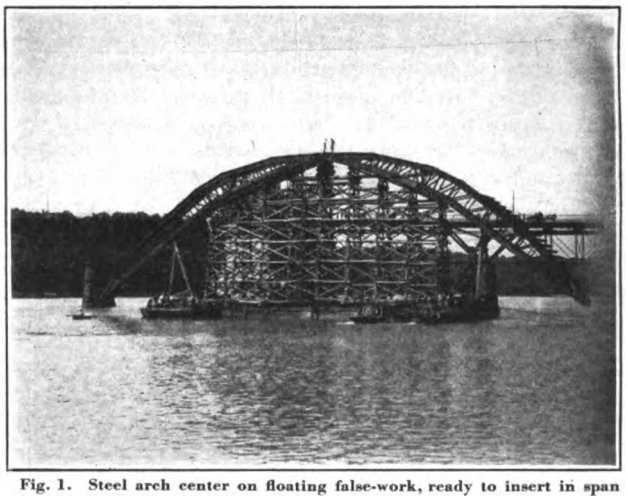


Fig. 1. Steel arch center on floating false-work, ready to insert in span

foot over Water street, one 85 foot over the C. & O. Canal. Each span consists of three arch ribs, spandrel columns and arches and reinforced concrete deck. The center arch rib of each span is 22 feet wide while the up and down stream ribs are each 11 feet wide.

The steel centers were furnished by the Blaw-Knox Co., of Pittsburgh, shipped to the site in sections and are bolt connected on the field by the construction force. For the 208 and 204 foot spans all sections are required, but for the shorter spans certain sections are omitted. Each set of centers will support one of the narrow ribs; for the center rib both sets are required.

The illustrations show one set of centers erected for the 208-foot span. Fig. 1 shows steel erected on floating false-work prior to being placed in span. Fig. 2 shows steel in place before falsework was floated out. Fig. 3 shows false-work removed, and Fig. 4 is a close-up view of shoes, wedges and supports.

The false-work is carried by three barges securely fastened together by steel beams and tie rods so as to distribute load uniformly. The center barge lies lengthwise

Continued on Page 544.

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The Sword of Peace

By

HERBERT KAUFMAN

MERE PAPER CHAINS CAN NEVER BIND THE WORLD TO PEACE! Steel will slake its thirst as long as men itch for power and force advises opportunity.

National necessity, international jealousy and racial ambitions will be served regardless of agreements.

The struggle for markets is the first skirmish of conquest. Trade fights with a calculation sheet, then powder and ball. Wherever commerce crosses a frontier, regiments wait to follow. The wars of business and the business of war are inspired by the same motive — the aggrandizement or defense of power.

Might and Must eternally write red history.

We are now universal providers; our ships are headed toward every port, and wherever American wares are sold, America's strength will some day be challenged. We shall have tranquil dealings just as long as we are able to enforce tranquillity. Ruthless and rowdy states will respect our determination to evade difficulty only as far as they may expect reprisal for violating our rights.

If we insist upon living pacifically, we must be ready to discourage affront. In this sudden, resourceful century, it is impossible to predict when and from what quarter the next hostile will strike. We could once measure the human content of a country, count its arsenals, shipyards and barracks and fairly estimate its combative quality.

But to-day when every test-tube nurses a potential devastator and every obscure inventor's laboratory possibly houses a resistless engine of holocaust, we dare take nothing for granted.

We are no longer safe within walls or behind fleets. Caution screams at us ceaselessly to search imagination for stronger weapons than others can bring to bear against us.

Years soon forget their scars. Coming generations will recompose present alliances. Shishak and Xerxes and Alexander and Bonaparte and the Hun shall rise again from the dust to foray and plunder. Hate and greed and fanaticism and autocracy will have their grudge.

The nations that can rely upon their arms can alone rely upon their treaties. Peace must wear a longer sword than war.

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Continued from Page 542.

of span, the two end barges across the span, so that the float is very steady. The range of tide is about three feet. One set of centers weighs about 200 tons and puts the float down one foot more that its light draft. High tide gives about one foot clearance of shoes above supports, and low tide gives about one foot clearance between steel and falsework.

It is proposed also to move the steel from one location to another on the work by this method.

The bridge is being constructed by hired labor and government plant by the Washington Office. Captain L. E. Oliver, Corps of Engineers, is in immediate charge of the work.

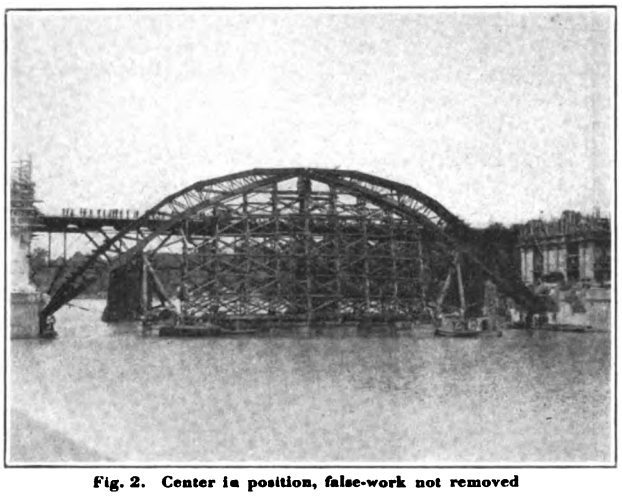


Fig. 2. Center in position, false-work not removed

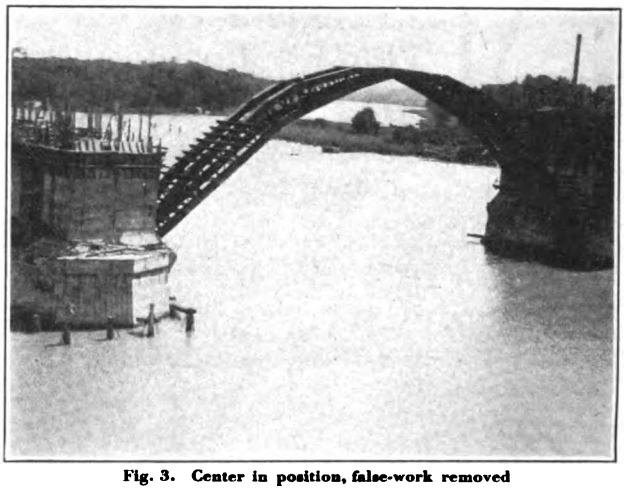


Fig. 3. Center in position, false-work removed

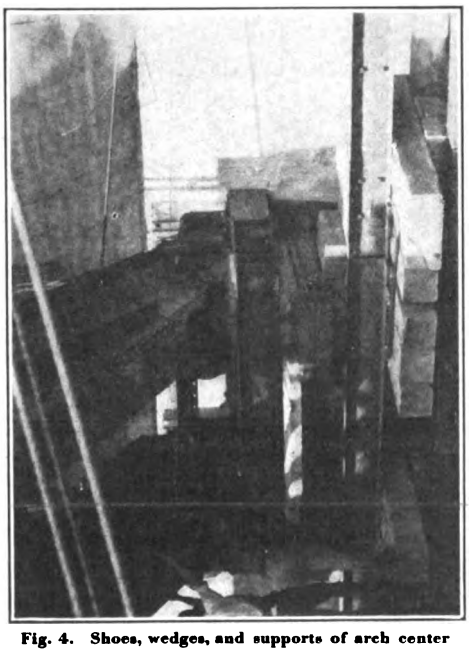


Fig. 4. Shoes, wedges, and supports of arch center

Bridge vs. tunnel for the proposed Hudson River crossing at New York City

That eminent authority on all things pertaining to bridges, Dr. J. A. L. Waddell, in *Proceedings Am. Soc. C. E.*, favors the profession with an entertaining discussion on the relative advantages of bridges and tunnels.

Dr. Waddell considers this matter not only from point of view of cost, but from every other point of view, in particular the convenience, comfort and pleasure of the traveling public. He states that for some years it has been his opinion that the best economic solution is to carry all street car and subway traffic under water and all strictly highway traffic above, and that his recent investigations have confirmed this opinion.

With reference to the cost of operation, the tunnel requires a dip of 90 feet below high water, whereas the bridge requires a rise of 180 feet above, accordingly, so far as expenditure of energy is concerned, the tunnel is decidedly preferable. Dr. Waddell points out that this is a matter of considerable moment in the operation of street cars, but of much less importance to motor trucks and practically none at all to the pleasure automobile. The automobilist seldom considers the cost of gasoline in climbing a long, heavy grade; on the contrary he enjoys the climb, whereas the electric railway officials endeavor to reduce this item of expense to a minimum. Another important consideration is the pleasure of traveling. People, especially the ladies, who now have the vote, usually prefer travel over a bridge affording a good view of the surrounding country, to shooting through an underground tube. Nevertheless, they have become quite accustomed to the latter so far as the street cars are concerned, but a pleasure automobile will certainly always prefer a bridge affording good air and light and a fine view, to a long, cramped, dingy tube.

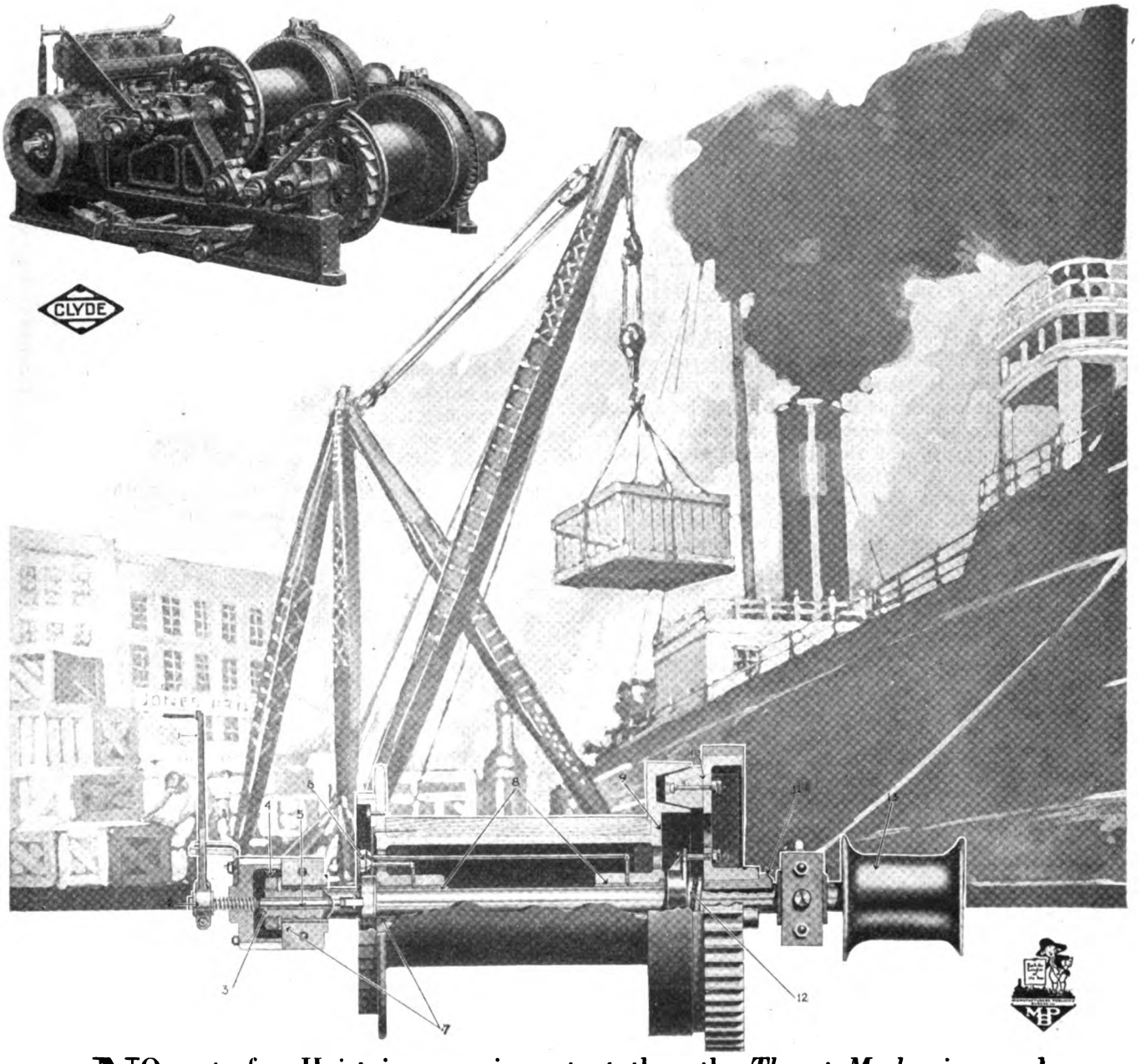
With reference to the question of public health, the tunnel is as satisfactory as the bridge so far as street cars are concerned, but the proper ventilation of a tube carrying automobile traffic, says Dr. Waddell, is yet an unsolved problem. Even should ventilation be feasible it would certainly be very expensive. Regular daily passage through such a tube would tend to undermine one's health; a blockade in the traffic would result in an excessive quantity of gas being discharged in the tunnel and might result in a holocaust. Nevertheless, Dr. Waddell believes the experiment of automobile transportation through long tunnels worth the making inasmuch as such traffic will probably be necessary, and the experiment would give information of great interest and value to the engineering profession and to the public. If the tunnels prove unsatisfactory they could still be used for electric railway cars.

It is interesting to note that while modern practice in long span bridges appears to have tended toward the cantilever type, Dr. Waddell has adopted the suspension type for his estimates. The maximum length of the main span which he contemplates exceeds that of any cantilever bridge yet constructed. For such very long spans the suspension type is the only one practicable.

From the point of view of cost the tubes lend themselves particularly to electric railway traffic, whereas the bridge favors highway traffic. This conclusion, confirming that arrived at from the foregoing considerations of policy, must have been very pleasing to Dr. Waddell. The reason for this is that two single-track tubes, whether for highway or electric railway traffic, are cheaper than one double-

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track tube. A single track tube is entirely satisfactory for electric railway traffic inasmuch as the breakdown of a vehicle blocks only one line and is thus no worse in a single-track tube than it would be in a double track, except that it is possible that a longer time might be necessary to remove a broken-down car. But when we come to automobile traffic, the breakdown of a single vehicle in a one-track tube may entirely block traffic, whereas in a two-track two-way tunnel the breakdown of an automobile would delay but not block traffic, therefore the double-track or four-track tunnel is essential for highway traffic whereas the cheaper one-track tunnel may be used for electric railways.

The figures at which Dr. Waddell ultimately arrives, assuming a main span of 2,900 feet for the North River Bridge, are as follows:

Highway bridge	$32,500,000
4 highway tunnels	49,000,000
Electric railway bridge	34,500,000
4 double-track electric railway tunnels	48,000,000
8 single-track electric railway tunnels	30,000,000

This indicates a saving in favor of the highway bridge of $16,500,000 and a saving in favor of single-track electric railway tunnels of $4,500,000. While the cost of right-of-way and property damages for the bridge will be somewhat greater than those of the tunnel it will by no means equal the above figure. Accordingly, concludes Dr. Waddell, from every point of view it would appear that the bridge is to be preferred for automobile traffic and single-track tubes for electric railway traffic.

The lowest price at which a combination of bridge and tunnel for both kinds of traffic could be built he estimates as follows:

Highway bridge	$32,500,000
2 single-track tunnels	7,500,000
Total	$40,000,000

These estimates do not include right-of-way, property damages, or administration. The author concludes with the sage observation that in view of these considerations some further study may be advisable before committing the public to the policy now contemplated.

Germany returns to piecework rates

Stronger incentive to work than mere sense of duty appears to be needed.

One of the first economic effects of the German revolution was the refusal of German workers to work at piecework rates, and the consequent general decrease in output. At first the abolition of piecework was warmly welcomed, as it was thought that in a state in which all the people were imbued with a sense of duty there would be no necessity for any other incentive to work. Now the disappointment is great when it is realized that the sense of duty is not equal in all sections of the community. It seems that a change of mind has taken place with regard to piecework. *Vorwarts*, the organ of the Social-Democratic Party, advocates piecework and a bonus system, not only as an expedient measure in the railway shops, where decline in output was a big factor in last fall's coal crisis, but as an industrial principle. It states:

Piecework, if reasonably applied, is the most just method for determining wages.

In addition to the piecework system, consideration should also be given to the bonus system, which has been opposed in Germany while in Russia it has been advantageously adopted.

And *Soziale Praxis* stated as long ago as last September that:

In some instances workers are returning voluntarily to the piecework system. One firm, Bergmann in Suhl, had given notice of dismissal to all its salaried employees and workers because the diminution of output had made it questionable whether operation could be carried on at a profit. The notices were, however, withdrawn because the workers declared that they were prepared to accept the piecework system.

A new piecework system in operation in a government railway repair shop is described in *Vorwarts* of October 4, 1919, as follows:

A new system, which is of the nature of profit sharing, has led to increased production in the government's railway repair shops at Golm-Mark. A commission, composed of a works manager, a delegate of the workers, and a railway official, calculates the number of hours necessary for the performance of a certain piece of work, on the basis of actual experience and average production.

While aiming at the highest possible technical perfection, the workers try to carry out the prescribed task in the shortest possible time. By a special scheme the saving in cost resulting from the difference between the actual number of hours worked and the calculated number is shared between workers and employers. Each individual worker is paid according to output and capacity on a scale arranged between the management and the workers.—*Business Digest.*

The largest concrete ship

The concrete ship is evidently no longer an experimental device. On June 12, the *Cuyamaca*, 7,500-ton concrete oil-tanker, was launched at the yards of the Pacific Marine and Const. Co., at San Diego, Cal.

This vessel is 420 feet long, 54 feet beam, and 36 feet deep. The hull is entirely of reinforced concrete up to the quarters on the bridge deck. It is described as beautifully proportioned, with lines as clean as those of a yacht.

The concrete has a burned clay aggregate which saves 40 lbs. weight per cubic foot. The shell is from 4 to 5 inches thick. There was required for construction 9,400 bbls. of cement, 2,800 cu. ft. of baked clay, and 1,500 tons of reinforcing steel. The deadweight of the vessel is 5,800 gross tons, and its carrying capacity 50,000 bbls. of oil.

This vessel was built on designs prepared for the Engineering Fleet Corp., six vessels of this type being constructed.—*Concrete.*

The possibilities of our oil shales

Will they ever be able to take the place of oil wells as a source of petroleum supply?

That the oil shale which is found in large quantities in Colorado, Utah, Nevada and Wyoming will eventually have a large commercial value is the opinion of the British *Board of Trade Journal.* For not only are all our underground reserves of oil being rapidly exhausted but the demand is as rapidly increasing year by year. Increased consumption in old industries and the discovery of new uses to which it may be put, make it certain that the manufacture of oil from shale is destined soon to assume a more prominent place than it now has.

Use of Oil in Motor Transport

The consumption of mineral oil and its derivatives is increasing rapidly. In the automobile industry alone it was estimated that there would be 7,602,000 automobiles, either passenger or commercial, officially listed in this country on December 31, 1919, which would be an increase of about one and a quarter million above those of 1918. The

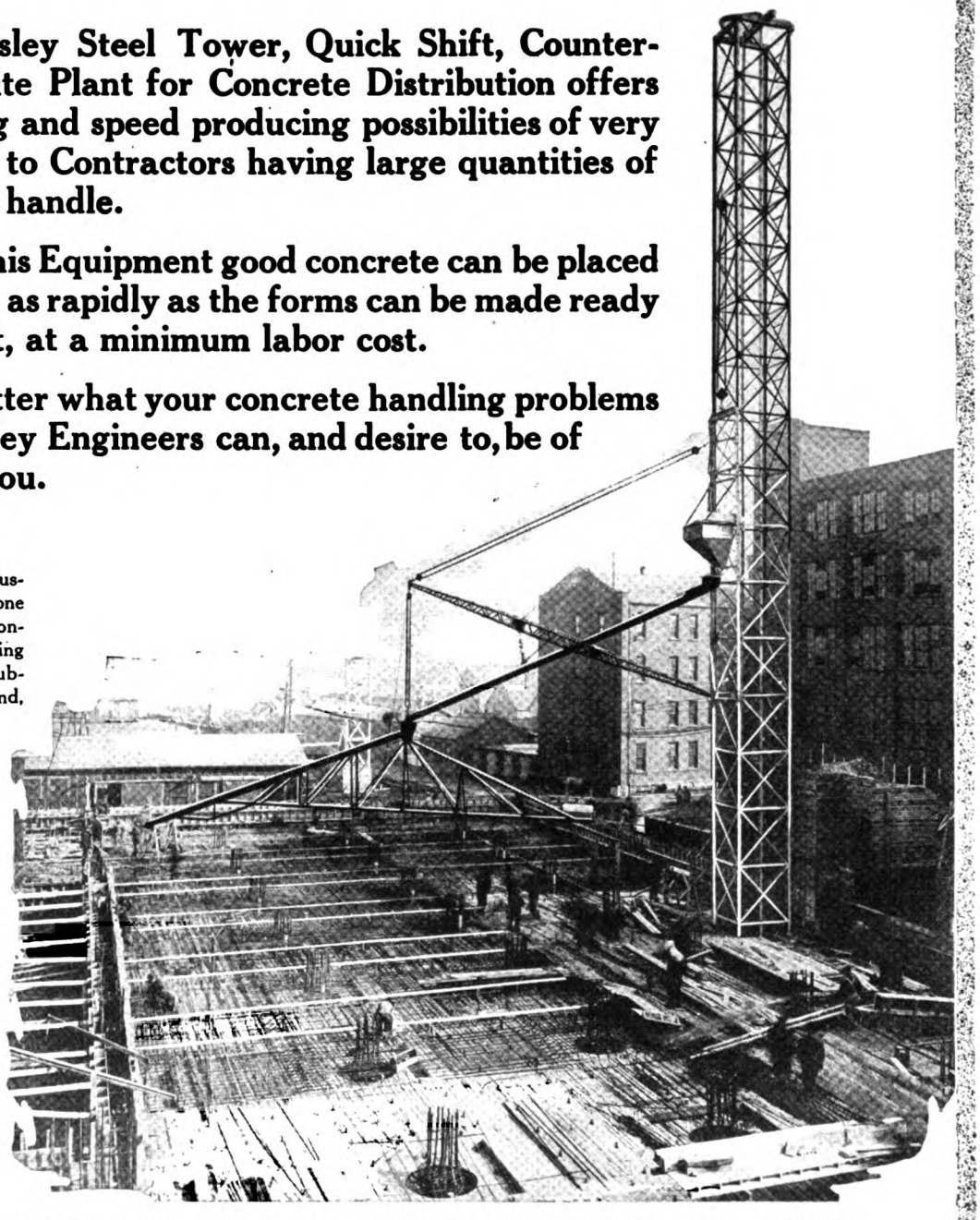
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number of motor trucks is estimated between 600,000 and 700,000.

Conversion of Ships to Oil-Fuel Consumption

In addition to the use of oil in motor transport, we must take into account the extent to which it will be used by ships, as a motive power in factories, farm-tractors, motor-boats, etc.

According to the *Annalist* of November 17, 1919, the use of oil as fuel for ships is also rapidly increasing. The United States Shipping Board has abandoned the coal-burning ship, and 636 out of 720 vessels under construction for the Emergency Fleet Corporation will be oil-burning. Almost all vessels now building for private or government account in the United States are to burn oil, and it is estimated that one-third of the tonnage on British ways will not be entirely dependent on coal. The United States Government has quite recently acquired or opened oil-fuel storage centers for its navy at Panama, St. Thomas, Azores, Biserta and Manila, whereby its numerous warships, almost all of which are oil-burning, will have fuel stations independent of the available supplies and bases of other nations.

Probable Date of Exhaustion of American Supplies

The United States Bureau of Mines states that the underground reserves of the United States are 40 per cent exhausted and that production from drilling has probably nearly attained its maximum.

It is also estimated that the demand will reach 800,000,000 barrels per annum by 1927, and all known, and probably all existing underground reserves in the United States will be exhausted in 1928.

Shales in the Western States

The probability that the oil-bearing shales of the United States will serve to take the place, in due time, of the oil wells which are now responsible for the entire output of this country is emphasized by the action of our government in reserving 132,000 acres of shale country in Colorado and Utah for naval purposes. These shales, including those of Wyoming and Nevada, are richer in recoverable oil and more easily mined than those of Scotland.

The oil-bearing stratum in Colorado is estimated by the United States Geological Survey to be, on an average, 1500 feet thick, although one cannot assume that this is all commercial shale. "Commercial" shale is counted as producing about one barrel of oil to every ton of rock, and shale capable of producing on this basis has been variously estimated to range from 30 feet to several hundred feet in thickness, though a conservative average would probably be around 50 feet. This would mean that each acre would contain 110,000 tons of commercial shale, equivalent to the same number of barrels of oil.

How Oil is Produced from Shales

None of these shales, which are known as the Green River Formation, contain free liquid oil. They contain altered organic matter from which the crude oil must be produced by heat, the process known as destructive distillation. The oil leaves the shale as a boiling liquid rapidly passing into the form of vapor, which must quickly pass out of the retorts, otherwise there would be an undue formation of permanent gas at the expense of oil, owing to decomposition of the latter.

The distillation must be carried on at the lowest temperature consistent with the complete eduction of the oil and its conversion into vapor, so as to ensure the maximum amount of oil and the minimum of fixed or permanent gas.

Ammonium sulphate will be a valuable by-product—probably about 10 pounds per ton from some of the shales—and it is expected to use the spent shales (the disposal of which has always been a difficulty in Scotland, and an item of expense) as fertilizer, as they contain from 0.5 to 6 per cent of nitrates and small quantities of potash and phosphoric acid.

All this, however, is in the future, for the matter has never passed the experimental stage, and there are not at present any commercial oil-shale plants operating in the United States.—*Business Digest.*

Cost of hauling gravel with motor truck

In a paper presented recently at a meeting of the Provincial District Engineers of British Columbia, Mr. G. B. Whitehead, District Engineer, gave the following particulars of his experience in hauling gravel with motor trucks.

The truck operated in District No. 3 this past season was of 3½-ton capacity with 4-yard gravel box. This truck worked in conjunction with hired trucks. As it arrived late in the season, as the driver was only getting used to it at the end of the work, and as the road traveled over was not in the best shape, the cost will probably be bettered next season.

The trucks were loaded from bunkers and eight hours constituted a day's work. The initial haul was 2.3 miles, on which 10 trips a day were kept up until 2.9 miles were reached, making an average return trip of 5.2 miles a day. From 3.4 to 3.7 miles eight trips were obtained, the average return trip being 7.1 miles, or a total of 56.8 miles a day. From 3.7 to 4.5 miles seven trips were obtained with an average return trip of 8.3 miles or 58.1 miles a day.

The costs given below will be based on the work of this truck for 15½ days on an average haul of 4.15 miles or 8.3 miles return trip.

Driver's wages, 15½ days at $6	$93.00
Gasoline, oil and grease	93.30
Minor repairs	20.00
	$206.30

Material hauled, 432 cubic yards, field cost per yard hauling, $0.48.

These figures do not go into interest charges, depreciation of truck, or renewal of tires; but are simply data gathered as a basis for the contracting of gravel work next season.

This season $26 a day was paid for the rented trucks, everything found. The rented trucks had a capacity of only 2½ yards, and on the average haul of 4.15 miles the material delivered cost $1.48 per cubic yard, as against $0.48 with the district truck. The difference of $1.00 is too much as a charge for depreciation and profit and is due to two reasons, one of which can be rectified. First, the capacity of the trucks; second, the fact that the other truck owners felt that when they made the same number of trips as our slower and heavier-loaded truck they were fulfilling their contract. This could have been overcome in the rental agreement by calling for the speed for which the particular truck is catalogued.

Care should be taken to balance the number of trucks used so as to insure economical loading. For example, at one time it was found that the bunkers could not be supplied with one slip team, but that in employing two teams they both stood idle about a third of the day. By putting on two extra trucks both teams could be kept busy and the extra trucks worked without extra loading cost.

The difference in time between mechanical dumps and hand dumps averaged about 3 minutes. On short hauls this would become a factor that would have to be considered.—*Eng. and Cont.*

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Annual Election of Officers of the Society of American Military Engineers

Under the provisions of Article VIII, Par. 4, of the Constitution of the Society, the Nominating Committee met in October and nominated a President, two Vice-Presidents and eighteen Directors for the year 1921. The annual meeting for the transaction of business and the election of officers will be held in Washington on Friday, January 14, 1921, when ballots will be opened and canvassed.

The following provisions of the Constitution and By-Laws of the Society of American Military Engineers (see Vol. XII, No. 62, page 233, THE MILITARY ENGINEER) govern the election of Officers and Directors of the Society.

ARTICLE IV.

Government.

1. The government of the Society shall be vested in a Board of Directors consisting of a President, a First and a Second Vice President, and eighteen active members. The President and the two Vice Presidents, all of whom shall be directors, shall be elected to serve for one year and until their successors shall have been duly elected: Provided, That no one of the three officers herein first named shall be eligible to immediately succeed himself in office.

The eighteen directors, other than the three officers above named, shall be elected to serve for three years: Provided, That six of their number shall be chosen from the regular army, six from the other military forces of the United States subject to active service, and six from the active members at large, exclusive of the foregoing two sub-classes of members: Provided further, That the term of office of two directors of each such group of six shall expire each year.

2. The Board of Directors shall elect from its own number a Treasurer to serve for one year and shall elect from the active members, though not necessarily from its own number, a Secretary whose term of office shall be one year.

ARTICLE VIII.

3. The President, the two Vice Presidents and two directors in each group of six representing the three sub-classes of the active membership, to wit: the Regular Army, the other military forces of the United States and the membership at large exclusive of the foregoing two subclasses, shall be elected by a written ballot at each annual meeting of the Society to serve for the appointed time of office or until their successors shall be elected: Provided, That a plurality of all votes cast shall be necessary for election, and Provided further, That at the first meeting of the Board of Directors after the first election held under the provisions of this constitution, two directors of each group shall be selected by lot to serve for one year only, two others of each group to serve for two years only and the remaining six to serve for the full term of three years.

5. In addition to the nomination so made by the committee, nominations may be made by a 'nominating letter" signed by not less than ten active members: Provided, That such nominating letter shall be received by the Secretary not later than the first day of December. The Executive Committee shall verify the eligibility of all nominees and their acceptance of nominations, and all nominees found eligible for election shall be included in the printed election ballot which shall be mailed to all active members between the first and fifteenth days of December. The names of candidates for each vacancy shall be arranged in alphabetical order with such data as to place of residence, civil and military record of each candidate, a the Board may deem pertinent or desirable: Provided, That no person shall at any one election be a candidate for more than one office or position.

The nominees for director herein listed, are grouped according to the class in which they belong, i.e.: Regular Army, active or retired; Reserve Corps and Membership at Large not of the foregoing classes.

NOMINEES

For President

Maj. Gen. W. M. Black, U. S. Army, Retired. Formerly Chief of Engineers; at present engaged in civil practice with Black, McKenney & Stewart, Washington, D. C. Born in Pennsylvania, December 8, 1855. Graduated U. S. M. A. in 1877. Stationed at Willets Point, N. Y.; Washington, D. C.; Havana, Cuba; Portland, Me.; New York City. Served in Spanish-American War and in the World War. Retired October 31, 1919, on his own application after 46 years of service. (See frontispiece.)

For First Vice-President

Colonel William Barclay Parsons, E. I. C. Served as senior member of Railway Commission in England and France. Commanded 11th Regiment of Engineers during the War. Also served as Brigadier General of the New York National Guard in Spanish-American War. Graduate of Columbia College, New York, A. B. degree and C. E. degree. Engaged in mining and civil engineering since 1881. At present senior member of Parsons, Klapp, Brinckerhoff & Douglas, Engineers, New York City. (See frontispiece.)

For Second Vice-President

Colonel Charles Keller, C. of E., U. S. Army. Born in New York February 13, 1868. Graduated from U. S. M. A. 1890. Brigadier General National Army during World War. Stationed at Montgomery, Ala.; Rock Island, Ill.; Charleston, S. C.; Portland, Me.; St. Louis, Mo.; Grand Rapids, Mich.; Manila, P. I.; Detroit, Mich.; Mobile, Ala.; Washington, D. C. At present member of River and Harbor Board, Washington, D. C. (See frontispiece.)

For Directors

Regulars

Maj. Gen. W. C. Langfitt, U. S. Army, Retired. Born in Virginia, 1860. Graduated from U. S. M. A. in 1883. Stationed at Cincinnati, Hawaii, Fort Stevens, Ore.; Portland, Ore.; Havana, Cuba; Washington, D. C.; Savannah, Ga.; etc. During the War he was the Chief Engineer, A. E. F. Retired May 31, 1920, after more than 40 years of service. At present located in New York City.

Col. Mason M. Patrick, C. of E., U. S. Army. Born in West Virginia, 1863. Graduated from U. S. M. A., class of 1886. Stationed at West Point, Cincinnati, Washington, D. C.; Havana, Cuba; Norfolk, Va.; Detroit, Mich.; Fort Sam Houston, Tex.; New Orleans, La. During the War he was Chief of the Air Service in France with the rank of Major General; director of Construction and Forestry and of Engineer Construction, A. E. F. Present station, Office of the Chief of Engineers, Washington, D. C.

Colonel William V. Judson, C. of E. Born in Indiana, 1865. Graduated from U. S. M. A. in 1888. Brigadier General in National Army during the War. Stationed at Rock Island, Ill.; Galveston, Tex; New York City; Porto Rico; Milwaukee; Montgomery, Ala; Canal Zone; with Russian Mission in 1917; Washington, D. C.; present station Chicago, Ill.

Col. Harley B. Ferguson, C. of E. U. S. Army. Born in North Carolina 1875; graduated from U. S. M. A. in 1897. Brigadier General National Army during the War. Stationed at Charleston, S. C.; West Point, N. Y.; Manila; China; Fort Leavenworth, Kans.; Montgomery, Ala.; Havana, Cuba; Washington, D. C.

Lieut. Col. Gilbert A. Youngberg, C. of E. Born in Minnesota, 1875. Graduate from West Point 1900. Principal stations Fort Leavenworth, Kans.; Chicago, Ill.; Havana, Cuba; Washington, D. C.; West Point, N. Y.; Charleston, S. C.; in France from August, 1917, to June, 1919. General Staff, A. E. F. Assistant Chief Engineer, A. E. F. Highest Rank Colonel in National Army. At present in Washington, D. C.

Major Richard Park, C. of E., U. S. Army. Born in Massachusetts, 1883; graduated from West Point in 1907. Stationed at Boston, Mass; Vancouver Barracks, Wash; Washington Barracks, D. C.; Manila, P. I.; San Francisco, Cal.; Ft. Leavenworth, Kans.; Camp Humphreys, Va. Rank of Colonel N. A., during the War. Present station, Portland, Ore.

Reserves

Major Percy E. Barbour, E. R. C. Served with 150th and 212th Engineers during the War. Born 1875 in Portland, Me.; graduate of Worcester Poly. Inst.; 17 years mining experience; 2 years on the editorial staff of "The Engineering and Mining Journal," New York City. Assistant Secretary American Institute of Mining and Metallurgical Engineers. Mexican Border service. At present in New York City.

Lt. Col. J. H. Finney, E. R. C. Born in Virginia 1863. Served during the War 105th Engineers, on joint Army-Navy

Continued on page 556

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A Trench Raid

As demonstrated at the Infantry School, Camp Benning, Georgia*

THE raid described herein was recently demonstrated at the Infantry School at Camp Benning, Ga., before the Staff Class from the Service Schools, at Fort Leavenworth, Kans.

It was conducted by a company of infantry, supported by machine-gun one-pounders and trench mortars upon the system of trenches constructed on the reservation, as shown on the map herewith.

While raids were of very frequent occurrence during the World War, there were many officers who never participated therein, and this demonstration of exactly how such an operation is conducted will be of interest to our readers. Such raids are mysterious and confusing affairs to any who have not taken part therein, and possibly even to the majority who have.

There is a very general impression that raids were conducted in a more or less haphazard fashion, and consisted of a grand scramble into the enemy's trenches while he was asleep and out again before he could recover from his surprise. This is far from being the case, at least for raids as large as the one herein described. They were actually planned in advance in the minutest detail and thoroughly rehearsed by the troops who were to take part therein. Very often a piece of ground was selected in rear of the lines where existing or simulated trenches similar to those actually to be raided were utilized, and the participants were drilled like the chorus of a ballet.

These raids were conducted for very definite purposes. They, of course, served the general purpose of keeping up the interest and morale of the troops; they were also intended to harass the enemy and interfere with his rest. But in addition to these general purposes, the raids had each a very specific purpose, such as the capture of prisoners and documents for the purpose of identifying the hostile units in line and obtaining information as to their plans. Sometimes the raids were executed for the purpose of wiping out troublesome machine-gun nests, or to seize certain localities in preparation for operations on a larger scale.

Such raids are characteristic of modern war under the conditions that obtained in Europe, and accordingly training in them is essential. Engineer troops nearly always take part in raids of any magnitude, for the purpose of removing obstacles and destroying enemy works. It is of the highest importance that engineer officers should be familiar with the methods of conducting such operations.

Raids being highly active operations are very much to the liking of American troops. Even the Germans will admit that the Americans developed considerable skill in raiding. This raid, planned by well-informed officers, may be said to be based upon our experiences in the late war. In the absence of any proof to the contrary we must assume that it would have been a very successful raid.

The following brief "Primer of Raids" will serve to make the demonstration more intelligible:

Definition—

A raid is an entrance into the hostile position, usually for a brief period of time by a relatively small force; in other words, overcoming the enemy locally and temporarily.

A raid and an attack are similar in that they are both offensive in character; but the attack differs in that it aims to hold its gains, whereas the raid ordinarily does not.

Raids are incident to a situation where the opposing forces are in close contact, and are thus distinct from reconnaissances made to discover the enemy, or regain contact which has been lost.

Object—

As a rule, raids are primarily to gain information; secondarily, in some cases, to effect destruction and cause losses, to perfect or maintain training, and to raise the morale of our own troops and lower that of the enemy. However, it may be noted that *unsuccessful* raids have the reverse effect, especially when duly "camouflaged" in the daily communique.

Classes—

a. Unsupported raids, in which the raiding troops operate without fire support from the special weapons, such as machine guns, trench mortars, tanks, artillery. These are sometimes called "silent raids."

b. Supported raids, in which the raiding troops are supported by some or all of the special weapons.

Unsupported raids usually are conducted at night, supported raids by day; although this is not always the case. Supported raids may be launched with or without a preliminary fire preparation.

Unsupported raids—

When the object of a raid is simply the capture of prisoners, our experience indicates that the small patrol is the most effective method. Ordinarily, a few prisoners suffice as well as a greater number. A small patroling operation well planned and skillfully executed, will usually accomplish the desired result; and the method is simple, direct, rapid and economical in point of effort and men.

Supported raids—

If the situation requires that the raid be carried out by a force of infantry stronger than a small patrol, such a force can hardly expect to find protection in concealment. If it is discovered early enough, it almost certainly will sustain heavy losses, and will risk failure in its mission. Accordingly, these larger raids are supported by the auxiliary arms.

The supporting weapons are used, in general terms, to neutralize as completely as possible all of the defensive power which the enemy can bring to bear on the raided point, either in the form of men or fire power. Under this protection the raiding troops carry out their mission and withdraw. If the protection is complete, as it should preferably be, the raiding troops operate with relatively little fighting and with slight losses.

It was a raid of this type that was sustained by the 1st Division on November 3, 1917. The raiding troops numbered 200 to 250 men, with 5 officers. They were sup-

*Contributed by Maj. R. A. Wheeler, Corps of Engineers.

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The positions filled during July saved members $35,000 which commercial agencies would have charged to place them in the same positions. This is more than two times the total monthly dues of the 21,000 members of the Association. Furthermore, the department did not fill all the positions on its list. It has 200 vacancies a month for mechanical engineers.

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ported, according to reports, by 16 batteries of artillery. They were in the American position about 10 minutes. The Americans lost, 3 killed, 5 wounded and 12 prisoners; the Germans, as far as known, lost 1 killed and 1 wounded. A board of officers, convened to investigate this raid, stated in part as follows:

"Such a raid, elaborately prepared, made by picked troops and supported by heavy and accurately placed artillery fire, will almost certainly succeed in obtaining some prisoners."

As between the patrol raid and the supported raid, it can be stated only that the former is preferable when it will accomplish the desired results; some officers maintain that this always will be the case. The supported raid, however, has been found necessary in the past, and it hardly seems warranted to assume that there will be no occasion requiring its use in the future.

General situation—

The Red system of trenches is as shown on the accompanying map.

The Blue outpost is shown by the broken line near the bottom of the map.

The two forces have been stabilized for about a week.

Special situation, Blue—

The following is known of the enemy's dispositions: A platoon garrisons ABCIJ. A platoon holds the trench CDE. A platoon, probably intended as a garrison for HKFG, is in the trench GHI. A support platoon occupies the head of the draw 300 yards northeast of HKFG.

The Blue battalion commander of the sector has ordered Company A, 29th Infantry, which is in battalion reserve, to raid the closed sector of red trenches the afternoon of July 22, 1920, for the purpose of capturing prisoners and gaining general information.

Plan of raid—

I. Demonstration by Artillery.

Along entire division front from H—5 to H+30.

II. Neutralizaton by Artillery.

From H—5 to H+5.

(1) The trench FGHIJA.

From H—5 to H+30.

The battalion reserve line for ½ mile on each side of Gilbert Creek.

(2) The adjacent hostile works on each flank of the sector to be raided.

III. Neutralization by machine guns.

From H to H+30.

(1) The large hill northeast of sector to be raided.

(2) The Red Bone Road west of 403 for 800 yards.

(3) The east side of Gilbert Creek opposite the sector to be raided.

(4) The ravine east of the sector to be raided.

From H to H+5.

The trench EDCBA.

IV. Chemical Warfare Service (4-inch Stokes.)

(1) From H—5 to H+30, smoke demonstrations along division front.

(2) From H—5 to H+30, smoke screen on the area shaded on the map.

(3) From H—5 to H+5, smoke screen on area to be raided.

V. Light mortars.

(*a*) From H—5 to H.

(1) Make gaps in wire at B, D and E—one mortar to each gap.

(2) Remaining mortars of regiment shell forward area of sector to be raided.

(*b*) From H to H+5.

All mortars shell trench FGHIJ.

(*c*) From H+5 to H+30.

1. Two mortars shell Gilbert Creek where it crosses battalion reserve line.

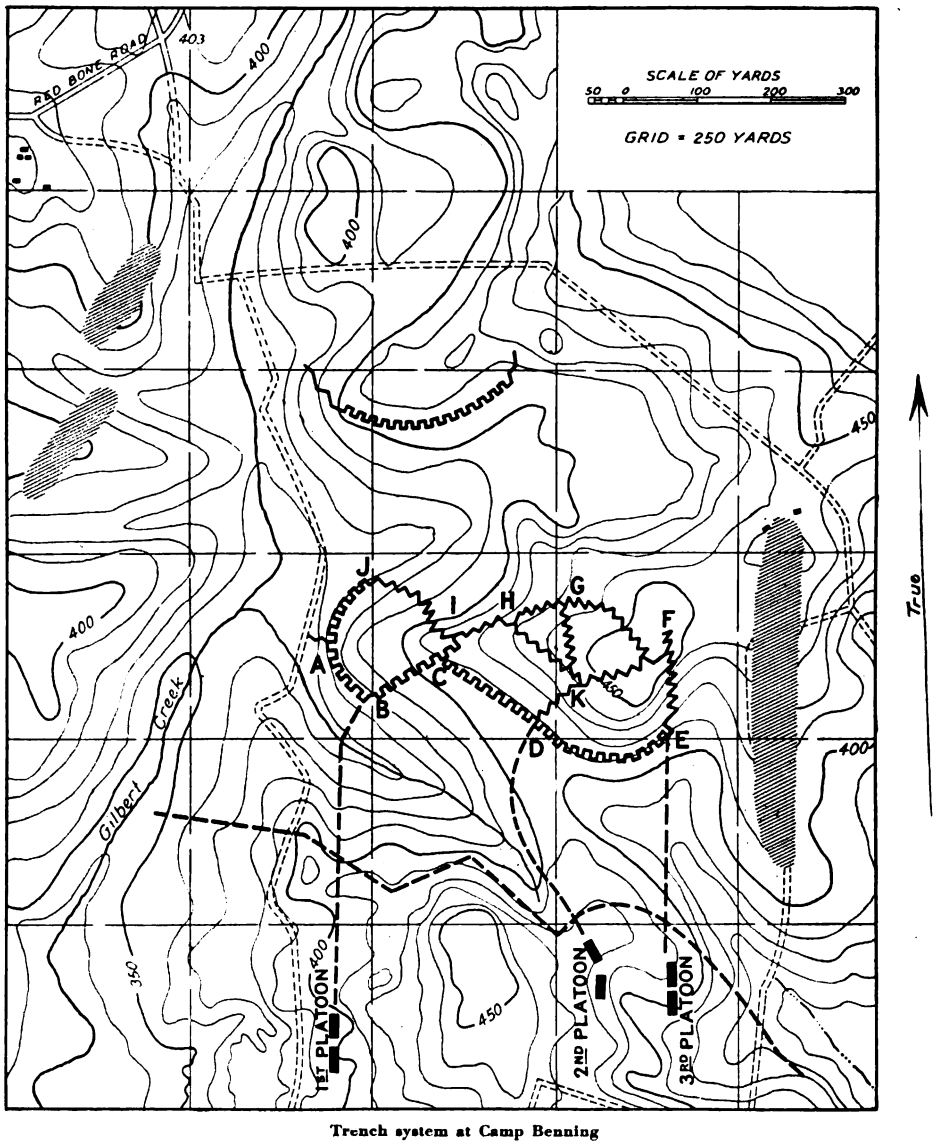
2. Remaining regimental mortars maintain a barrage on a line 200 yards northeast of and parallel to trench FG from house to northwest for 200 yards.

VI. One-pounders.

Fire on known hostile machine-gun emplacements and machine guns discovered during the raid.

VII. Infantry plan.

1. The 1st platoon will raid the area ABCIJ.



Trench system at Camp Benning

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(*a*) The platoon will be formed at H—5 in the woods 150 yards southwest of hill 450 in section column, in two waves without distance. The front rank men of the 1st squad will be equipped with wire cutters. The rear rank of the 1st squad will be at the tail of the platoon.

The 2d and 3d squads will be equipped as bombing squads.

(*b*) At H hour the platoon leader will lead his platoon north down the small draw on the west end of hill 450, crossing No Man's Land at a double time, to the gap at B.

(*c*) The front rank of the 1st squad will complete the gap begun by the light mortar. It will then remain at the gap, collect prisoners and conduct them to the rear.

(*d*) The 2d squad will clean up trench BAJ.

(*e*) The 3d squad will clean up trench BCIJ.

(*f*) The 2d section will deploy after passing through the gap B and advance over the top of the ground to the rear of the area to be raided with its center marching on J.

(*g*) The rear rank of the 1st squad will take post at A and protect the left flank.

2. The 2d platoon, re-enforced by the 1st and 2d squads of the 4th platoon, will raid the area CDKGHI.

(*a*) The 2d platoon will be formed at H—5, 100 yards east of hill 450, in section column in two waves without distance. The front rank of the 1st squad of the 4th platoon, equipped with wire cutters, and the 2d squad of the 4th platoon, equipped as a bombing squad, will be formed in the order named at the head of the 2d platoon. The rear rank of the 1st squad of the 4th platoon will be at the tail of the 2d platoon.

(*b*) At H-hour the platoon leader will lead his re-enforced platoon down the first draw to the east of hill 450, crossing No Man's Land at a double time to the gap at D.

(*c*) The front rank of the 1st squad, 4th platoon, will complete the gap begun by the light mortar. It will then remain at the gap, collect prisoners and conduct them to the rear.

(*d*) The 2d squad, 4th platoon, will clean up trench DE until it meets a squad coming in the opposite direction from E.

(*e*) The 1st squad, 2d platoon, will clean up trench DC and IH.

(*f*) The 2d squad will clean up trench DK and KF until it meets a squad coming in the opposite direction from F.

(*g*) The 3d squad, 2d platoon, will clean up trench KG.

(*h*) The 4th squad, 2d platoon, will clean up trenches KH and HG.

(*i*) The 2d section (less 4th squad) will deploy after passing through the gap and advance over the top of the ground to HG with its right on trench DKG.

(*j*) The rear rank of the 1st squad, 4th platoon, will report to its corporal at the gap D to assist in collecting prisoners and conducting them to the rear.

3. The 3d platoon, re-enforced by the 2d section of the 4th platoon, will raid the area DEFGK.

(*a*) The 3d platoon will be formed at H—5, 200 yards east of hill 450, in section column in two waves without distance.

The front rank of the 4th squad, 4th platoon, equipped with wire cutters, and the 5th squad, 4th platoon, equipped as a bombing squad, will be formed in the order named at the head of the 3d platoon. The 6th squad and rear rank of the 4th squad, 4th platoon, will be formed in the order named at the tail of the 3d platoon.

(*b*) At H-hour the platoon leader will lead his re-enforced platoon down the second small draw 150 yards east of hill 450, crossing No Man's Land at a double time, to the gap at E.

(*c*) The front rank of the 4th squad, 4th platoon, will complete the gap begun by the light mortar. It will then remain at the gap, collect prisoners and conduct them to the rear.

(*d*) The 5th squad, 4th platoon, will clean up trench ED until it meets a squad coming in the opposite direction from D.

(*e*) The 1st squad, 3d platoon, will clean up trench EF and establish a block 25 yards north of F.

(*f*) The 2d squad, 3d platoon, will clean up trench FK until it meets a squad coming on the opposite direction from K.

(*g*) The 3d squad, 3d platoon, will clean up trench FG.

(*h*) The 2d section, 3d platoon, will deploy after passing through gap with its right at E, advance over the top of the ground and occupy FG.

(*i*) The 6th squad, 4th platoon, will take post north of E and protect the right flank.

(*j*) The rear rank of the 4th squad, 4th platoon, will report to its corporal at the gap at E to assist in collecting prisoners and conducting them to the rear.

(*k*) The section sergeant of the 1st section will organize the two squads which meet about half way between D and E as a support wave for the 2d section.

Signals.

"Position occupied," yellow smoke rocket, by each platoon leader, as soon as his position is occupied.

"Withdraw, first phase," star red rocket, by captain.
"Second phase," green very light, by platoon leaders.

Plan for withdrawal.

At the signal (1 star red rocket) the first phase of the withdrawal will be executed

First phase—

Squads and sections will return independently under their leaders to their own trenches with the following exceptions:

1. The half squad at A will remain in position.

2. The leader of the 2d section, 1st platoon, will designate one squad to remain at J.

3. The leader of the 2d section, 2d platoon, will designate one squad to remain at G.

4. The squad at F forming the block will remain in position.

5. The squad at E protecting the left flank will remain in position.

6. The groups at the gaps will remain in position All the squads left in position are to protect the first phase of the withdrawal.

Second phase—

As soon as the part of his platoon designated to withdraw at the signal one star red rocket have cleared the gap in the wire, each platoon leader will signal the second phase (green, very light). At this signal the squads left in position to cover the first phase of the withdrawal will return independently under their leaders to their own trenches.

Company headquarters.

At the gap in wire at D.

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Continued from Page 550.

Airship board; War Plans Division; course at War College; office of the Chief of Engineers. Member Amer. Inst. Elect. Engrs. and Amer. Electro. Chemical Society. Manager of Aluminum Company of America, Pittsburgh.

Col. Chas. A. McKenney, E. R. C. Born in Washington, D. C., 1870. Graduated from Princeton University in 1892. Member A. S. C. E.; 20 years with the Engr. Dept. at Large and D. C. Engineer Dept. Private practice; with Black, McKenney and Stewart, Engineers. Served during the War with the General Staff in the P. S. and T. Division.

Lieut. Col. Harris P. Ralston, E. R. C. Born 1880. Graduate from Univ. Michigan in 1904. Ten years experience design, construction and engineering. Served with the 312th Engineers, 533d Engineers, and 104th Engineers. First commissioned in 1917. At present located in New Orleans, La.

Col. Perley F. Walker, E. R. C. Born in Maine, 1875. Graduate of University of Maine, B. M. E. degree. Masters degree at Cornell. Member American Society of Mechanical Engineers. Professor of Mechanical Engineering at University of Maine and University of Kansas. First commissioned in 1917. Served with the 314th Engineers, 109th Engineers, 219th Engineers, and finally student at Army War College. Present address Lawrence, Kans.

Maj. Joseph H. Wheat, E. R. C. Born in 1868. Thirty-two years' experience with the Geological Survey, topographic experience. First commissioned in April, 1917. Overseas from September, 1917, to July, 1919. With the 29th Engineers. Instructor at the Engineer Schools, A. E. F. Commanded the 141st LeMans Prov. Bn. Present location Washington, D. C.

Civilians

Col. F. G. Jonah. Born in Canada, 1864. Served during War with the 12th Engineers as Chief Engineer of Light Railways; 31 years in active practice; 1100 miles of location in railway work; 600 miles of supervision. Director of Amer. Society of Civil Engrs.; and President of Engineers Club of St. Louis.

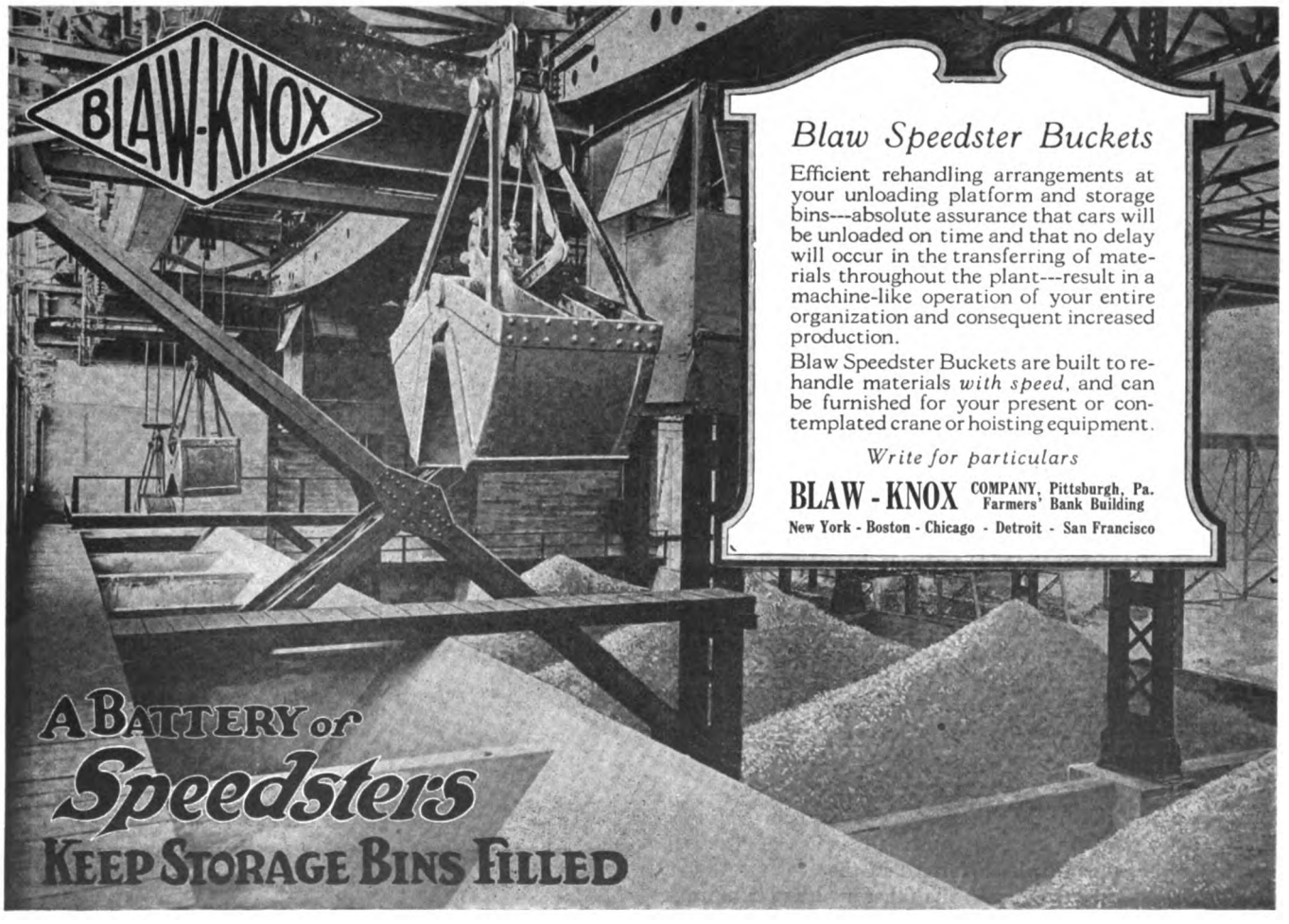
Col. F. A. Molitor. Born 1868. Cornell University, class of 1888. Twenty-seven years as consulting engineer with numerous railroads; supervising railroad expert with the Philippine Government; at present engaged in private practice in New York City. During the War he served as director of Military Railways Section. Office of Chief of Engineers: served in France with the 22d Engineers.

Maj. George O. Totten, jr. Born 1876. Graduate of the School of Mines, Columbia University. Attended Plattsburgh and Camp Lee, Va. Architectural student in Paris for two years. Private practice of Architect for 20 years. First commissioned in 1917. At present located in Washington, D. C.

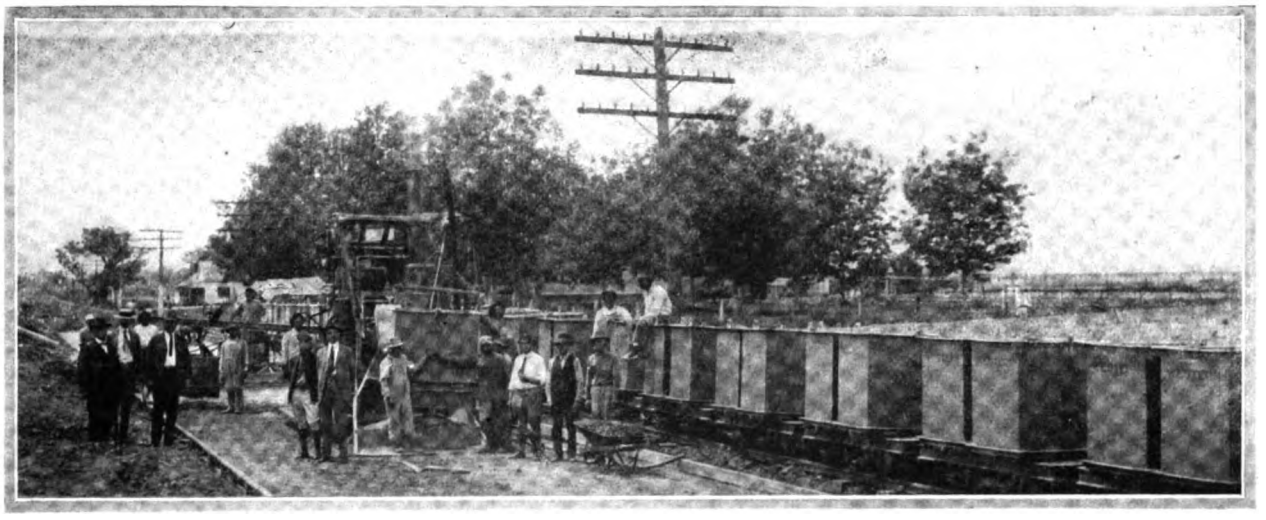
Col. C. H. Birdseye. Served during the War at Washington, D. C.; Fort Adams. R. I.; overseas with the 1st Brigade, C. A. C. Born 1878. Attended Oberlin and Ohio State Universities. Sixteen years with the U. S. Geological Survey. Chief of Rocky Mountain Division. At present located in Washington, D. C.

Maj. W. O. Tufts. Born 1880. Student of Civil Engineering. Seventeen years' experience with the Geological Survey. Member Washington Society of Engineers. First appointed in April, 1917. Served with the 25th Engineers, 29th Engineers. Served with the Intelligen· Section, G. S., and as Instructor in the Army Engineer School. At present located in Washington, D. C. (See frontispiece.)

Col. Christopher Van Deventer. Born in Iowa, 1874. Graduate of Columbia University with degrees of Electrical Engineer and Master of Arts. Two years mining, four years sales engineering and research investigation, twelve years electrical experience. First commissioned in 1917. Served at Fort Leavenworth, with 309th Engineers, with 515th Service Bn Served overseas with the Chief Engineer A. E. F. At present located in Chicago, Ill.



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Upward Pressure on Floor of Lock on Porous Foundation

By

Malcolm Elliott

U. S. Assistant Engineer; formerly Lieutenant Colonel, Engineers
M. Am. Soc. C. E.

THE following gives the results of observations as to upward water pressure, with and without relief holes, on the floor of a lock built on a porous foundation. The observations were taken on an actual structure and are therefore not subject to the criticisms which may be made against such observations when based on a small scale model and artificial conditions. More observations with more complete data would have been obtained but for the fact that this would have interfered with important construction work at a time when labor of all kind was difficult to obtain, and a rising river was threatening to submerge the work.

The observations were made at Lock No. 43, Ohio River, 26 miles below Louisville, Ky. The lock is built on a porous foundation, the material being a mixture of firm sand and gravel reasonably free from silt. The concrete lock walls and floor are supported by piles. Rows of sheet piling surround the area inclosed by the lock walls and miter sills.

Considering the river wall as a dam excluding the water from the lock when the latter is pumped dry, it was believed that the flow through the porous foundation under the wall would endanger its stability unless some protective measures were taken. The ordinary means for protecting dams on porous foundations consist of long aprons, either upstream or downstream from the dam, and sheet piling so as to increase the distance traveled by the water percolating from the upper to the lower levels. In this way the velocity of the percolating water can be "killed" or reduced to a point where it will have no eroding action.

The above principle was applied to the river wall of Lock No. 43. Upstream from the dam the outside of the wall was protected by a crib, 20 feet wide, and a blanket of riprap, 12 feet wide. Downstream from the dam the crib was omitted, but the riprap was used. Rows of sheet piling, 25 feet deep, were placed under the inner and outer edges of the wall. A concrete floor was placed in the lock.

When this type of construction was adopted it became important to know what would be the upward pressure on the floor and what means should be provided for resisting it. If the floor were watertight, it was believed that the lock would be practically the same as a boat, and that the upward pressure head on the floor would be equal to the height of the river above the bottom of the floor. In this case, when the river reached a certain stage, the upward pressure would lift the floor unless measures were taken to reduce the pressure or hold down the floor.

It was apparent that this excessive pressure could be greatly reduced by providing holes or vents in the floor. The flow through holes would convert part of the excessive static head into velocity and friction heads, thus relieving the pressure on the floor. One 6-inch diameter hole for each 100 square feet of floor surface was provided. As an added precaution the floor was made 4 feet thick, counteracting about half of the maximum head, and was anchored with hold-down piles with enlarged butts at the rate of one pile for each 25 square feet of floor surface.

Figure 1 shows a typical cross-section of the lock. Due to accidents of construction and perhaps to unusual hurry to get the floor in before the lock was flooded by high water, most of the holes in the floor were omitted. Some of them perhaps became stopped up by collecting silt. At any rate, when the lock was pumped out only a very few of the holes were open. Some of those that were open "boiled" vigorously, but the water did not bring any appreciable amount of sand or gravel into the lock, indicating that the flow had no eroding action. The holes which flowed most freely are shown in Figure 2.

During the fall of 1919 the lock was pumped out for the purpose of installing the lock gates. It was decided to take advantage of this opportunity to measure the upward pressure on the floor and determine, if possible, the reduction in same effected by the holes. Iron pipes, 3 inches in diameter, were set in three 6-inch holes (P-1, P-2 and P-3, Fig. 2), and the annular spaces between the outsides of the pipes and holes were plugged with wooden wedges and oakum, as shown in Figure 3. Very tight joints were obtained.

The height of water in the pipes was sounded daily for a period of over a month. The readings in the pipe and the gauge readings in the river are given in the following table and plotted in Figure 4. During the entire period the movable dam was down, and there was a difference in elevation between the upper and lower pools of only two or three inches. The heights in the pipes and the river are referred to the bottom of the lock floor, elevation 358.0 above sea level. The observations covered a period of one month (Sept. 16-Oct. 16).

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Elevations of water surface above bottom of lock floor in feet

Date, 1919	River	Pipe P-1	Pipe P-2	Pipe P-3	Remarks
Sept 16	13 15	12.98	----	6.80	Hole H-1 closed.
17	12.20	12.56	----	6.20	
18	11.84	12.23	----	6.12	
19	11.75	12.05	----	5.92	Hole H-1 opened.
20	11.85	5.38	----	----	
22	11.88	5.29	----	6.42	
23	12.05	5.48	----	6.51	
24	11.86	5.26	----	5.65	
25	11.84	5.26	----	5.80	
26	11.65	5.16	----	5.80	
27	11.82	5.43	----	6.53	
29	12.45	5.51	----	6.30	
30	13.70	5.96	----	6.15	
October 1	15.06	6.09	----	7.89	
2	14.19	6.21	11.14	6.97	
3	13.09	5.99	14.32	7.05	
4	11.82	12.21	11.58	8.05	Hole H-1 closed.
6	11.56	11.84	11.11	6.55	
7	11.38	11.63	10.78	6.30	
8	11.41	11.71	10.81	6.55	
9	11.36	11.71	10.66	6.30	
10	11.78	11.71	10.74	6.30	
11	11.96	11.96	11.00	6.30	
13	13.80	13.19	12.22	7.47	
14	15.70	14.21	13.49	9.37	
2 P. M. 14	16.45	5.61	12.22	7.72	Hole H-1 opened.
15	20.90	6.30	13.99	10.55	
2 P. M. 15	21.75	14.21	14.32	10.80	Hole H-1 closed.
16	22.6	14.21	14.32	11.13	

Figure 4 shows clearly how the pressures were influenced by the fluctuations of the river and the relief afforded by opening adjacent holes. The observations were started September 16, 1919, on which date pipes were placed at P-1 and P-3. The initial reading in pipe P-1 was 0.17 foot less than the elevation of the river. During the next two or three days the river fell slowly, and the pressure head in the pipe also decreased, but not so rapidly as the elevation of the river. On September 17, 18 and 19 the head in the pipe was slightly greater than the height of the river. It is probable that the pressure in pipe P-1 came from the ground water rather than from the river.

The height of the river, of course, controlled the height of the outlet of the ground water, and thus the head in the pipe would follow more or less the fluctuation of the river, even though the water causing same came from a spring in the bank. The theory that the water in hole P-1 came from the bank is supported by the fact that the flow left traces of discoloration about the edge of the hole, due to iron content of the water, similar to that caused by the water from a well that had been driven on the reservation adjacent to the lock. To make sure that the head in the pipe was actually greater than the head from the river, the pipe was bailed down well below the elevation of the river surface. It promptly filled up again to the original elevation as soon as the building was stopped.

The effect of placing the pipe in hole P-1 was, of course, to stop the flow of water through the hole and thus increase the static upward pressure on the floor in the vicinity of the hole. This effect was shown on September 19 when the hole H-1, 15 feet away from pipe P-1, started to "boil" vigorously. Previous to this there had been no evidence of flow through hole H-1. Evidently some obstruction which had prevented flow through the hole was removed by the increased pressure due to placing the pipe in hole P-1. The static pressure in P-1 immediately fell after hole H-1 began to flow, as shown by the abrupt drop of the curve P-1 (Fig. 4), on September 19. Hole H-1 continued to flow after it had once started, notwithstanding the decreased pressure head. The opening of hole H-1 did not produce any visible effect on the pressure at hole P-3, which is 225 feet downstream from H-1.

On October 3, hole H-1 was stopped with a wooden plug and well calked. As was expected an immediate rise occurred in pipe P-1. The observation on the morning of October 4 showed a height in the pipe 0.4 higher than the river. The purpose in closing hole H-1 was to increase the pressure and start more holes flowing, if possible, so as to increase the number of observations. The immediate effect, however, was merely to start percolation through several of the floor construction joints near by, but this percolation continued only a few hours and then stopped, probably by drawing sand and silt in the joints. No new holes were

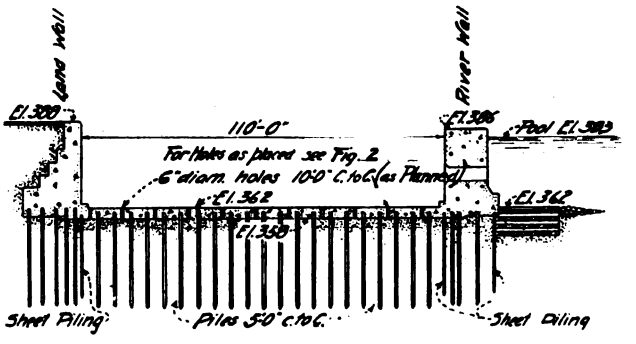


Fig. 1. Lock No. 43, Ohio River. Typical cross-section.

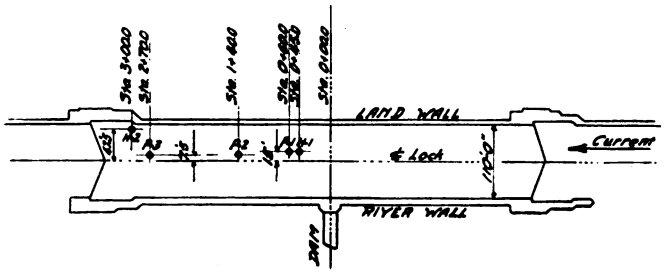


Fig. 2. Lock No. 43, Ohio River. Plan of lock showing location of pipes and holes. Holes P-1, P-2 and P 3 were fitted with pipes for measuring pressures. Holes H-1, H-2 were not fitted with pipes.

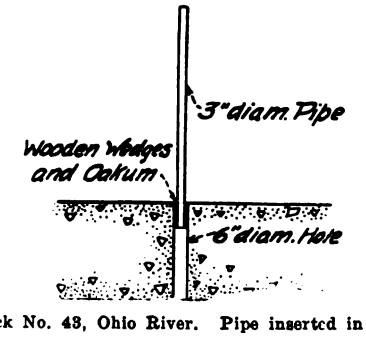


Fig. 3.—Lock No. 43, Ohio River. Pipe inserted in hole in floor.

started. Contrary to expectations, the closing of hole H-1 caused an increase in the pressure in pipe P-3, 225 feet away, as shown by the abrupt rise in curve P-3 on October 4.

On October 2 a pipe was placed in hole P-2. There had been a very slow flow of water through this hole, indicating almost complete stoppage. Efforts were made to clear the hole, but these did not result in increased flow. It was apparent that the hole could not be opened without drilling. When the pipe was inserted it filled slowly until on the morning of October 3 its head showed a pressure over a foot greater than the head in the river. Thereafter the

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head in pipe P-2 followed the fluctuations of the river quite closely until October 14.

On October 14 hole H-1 was purposely opened, and there occurred an immediate drop in pipes P-1, P-2 and P-3. The drop in pipe P-3 was greater than that in pipe P-2, notwithstanding that the former was more remote than the latter from hole H-1. On October 15 hole H-1 was again stopped, causing an immediate rise in pipes P-1, P-2 and P-3. The water now began to run over the tops of pipes P-1 and P-2, and it was impracticable to extend the pipes to continue the readings. It is believed that if the pipes had been long enough, the readings would have paralleled closely the height of water in the river. On October 16 the water was still running over the tops of pipes P-2 and P-1, and the reading in pipe P-3 was 11.13 feet, corresponding to a river elevation of 22.96 feet. At this point the lock was flooded, and the readings were discontinued.

The readings in pipe P-3 were always considerably less than the heights of the river. This was due, no doubt, to the relief effect of hole H-2, about 60 feet distant from pipe P-3. This hole, flowing freely, was in a pump directly under one of the pumps used for unwatering the lock, and it was not possible to close the hole without more expense than was considered justifiable under the circumstances. It is believed that if hole H-2 had been closed, the pipe at P-3 would have shown a head about equal to the height of the river surface.

These observations agree with theory as ordinarily applied to the design of locks and dry docks on porous foundation; for example, the theory that upward pressure, if not relieved, will correspond to the full head acting on the outside of the lock and that substantial relief from this upward pressure can be obtained by providing vents in the floor. Sheet piling has little, if any, effect in reducing the pressure if vents are not used, but probably cuts off considerable pressure and flow into the lock when vents are used. With this particular foundation the effect of a vent is felt at a distance of over 200 feet, indicating that the number of holes need not be large. For a less permeable material perhaps closer spacing of holes would be required. It is advisable, however, to use no more relief holes than the number required to relieve the pressure, because a surplus of holes increases the amount of water entering the lock and adds to the expense of pumping.

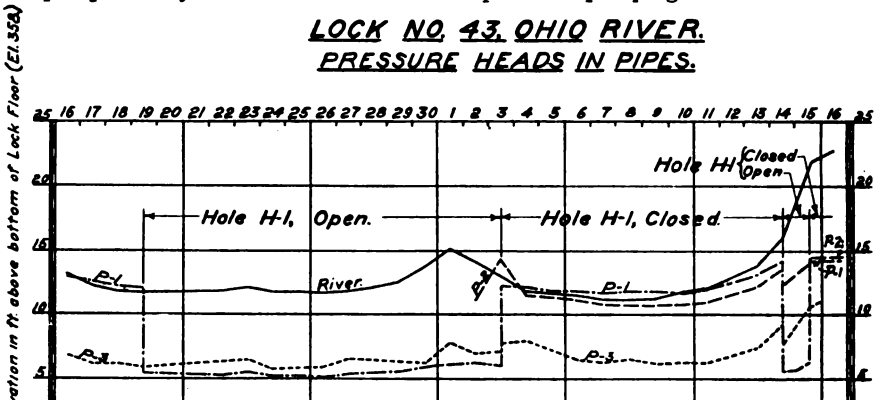


Fig. 4.

Changes in Personnel in the Corps of Engineers

Contributed by Mr. J. A. EGAN, Office of the Chief of Engineers.

Col. FREDERICK W. ALSTAETTER has been retired from active service, effective August 21, 1920, due to physical disability incident to the service. He remains on active duty as district engineer, Savannah, Ga.

Col. HERBERT DEAKYNE has been assigned to duty as division engineer, Pacific Division, and district engineer, 1st San Francisco District, thereby relieving Col. E. Everth Winslow, who has been ordered to Governors Island, N. Y., for assignment to duty as engineer, 2d Corps Area.

Maj. FREDERICK B. DOWNING has been granted sick leave for three months. Maj. Creswell Garrington will act as district engineer during the sickness of Major Downing.

Maj. JOHN J. KINGMAN has been granted a leave of absence for two months, effective on or about October 1, with permission to leave the continental limits of the United States.

Capt. EVERETT B. MURRAY has been relieved from duty at Yale University, Sheffield Scientific School, where he had been serving as assistant professor of military science and tactics, and ordered to duty as assistant in the Galveston, Tex., Engineer District.

Maj. FRANCIS B. WILBY has been detailed as a member of the board of officers appointed for the purpose of examining the records of applicants for appointment to the grade of warrant officer, and to assist in arranging an eligible list for that grade.

Capt. HOEL S. BISHOP has been relieved from duty at Camp A. A. Humphreys, Va., and assigned as assistant professor of military science and tactics at the University of Alabama, University, Ala.

Capt. EDWARD G. BLISS has been relieved from duty in the office of the Quartermaster General, this city, and directed to report in person to the Chief of Inland Waterways Service for duty in his office.

Capt. THOMAS D. FINLEY has been transferred, at his own request, to the Infantry Arm, Regular Army, in accordance with the provisions of the Act approved June 4, 1920.

Capt. BENJAMIN F. VANDERVOORT, Engineers, has been assigned to duty as constructing quartermaster, Savanna Proving Ground, Savanna, Ill.

Capt. ARTHUR P. VON DEESTEN has been relieved from duty with the 4th Engineers, Camp Lewis, Wash., and assigned to duty as assistant to the district engineer, 1st Portland, Ore., Engineer District.

Capt. CHARLES S. WARD has been assigned to duty as secretary and disbursing officer for the Board of Road Commissioners for Alaska, with station at Juneau, Alaska.

Capt. JOHN W. STEWART, having been found physically disqualified for active duty, his retirement is announced in War Department orders.

1st Lieut. THOMAS NORTH, Engineers, has been relieved from duty at Headquarters, American Expeditionary Forces, this city, and assigned to duty with the 81st Field Artillery, Camp Knox, Ky.

The following-named officers of the Corps have been ordered to report to the Commanding General, American Forces in Germany, for assignment to duty:

Capt. Edwin A. Bethel
Capt. Hugh J. Casey
1st Lieut. Henry G. Lodge
1st Lieut. Randolph P. Williams.

Capt. JOHN S. BRAGDON has been assigned to duty as assistant professor of military science and tactics, Carnegie Institute of Technology, Pittsburgh, Pa.

Capt MERRIFIELD G. MARTLING, recently returned from overseas, has been assigned to duty in the office, Chief of Engineers. Capt. Martling has since been appointed in the Corps of Engineers, Regular Army, with the rank of first lieutenant.

Capt. LEHMAN W. MILLER has been relieved from duty at Camp A. A. Humphreys, and assigned to duty at West Point, N. Y.

Capt. WILHELM D. STYER has been assigned to duty in the Militia Bureau, this city.

Col. WILLIAM J. BARDEN has been assigned to duty at Florence, Ala., in charge of the construction of the Wilson Dam.

Col. HENRY C. NEWCOMER has been assigned to duty as Division Engineer, Gulf Division, vice Col. Hubert Deakyne.

Maj. EDMUND L. DALEY has been detailed as professor of practical military engineering, at the U. S. M. A., West Point, N. Y.

The following-named officers of the Corps have been promoted to the grade of major:
Capts. Philip B. Fleming, David McCoach, Jr., Joseph C. Mehaffey, Paul S. Reinecke and Raymond A. Wheeler.

Maj. J. FRANKLIN BELL has been assigned to duty as district engineer, Pittsburgh District.

Col. WILLAM W. HARTS has been assigned to duty as division engineer, Central Division, vice Col. M. L. Walker.

Maj. HARRY F. CAMERON and Capt. Edward N. Chisholm, Jr., have been assigned to duty as assistants to the district engineer, Florence, Ala., in connection with the construction of the Wilson Dam.

Maj. CHARLES W. COCHRAN has been ordered to Camp Benning, Ga., for assignment to duty as camp engineer.

Maj. RICHARD T. COINER has been assigned to duty as district engineer, New Orleans, La.

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The Fundamentals of Staff Control

(Continued from Page 508)

Discussion

Fox Conner
Brigadier General, U. S. Army; formerly Chief of Staff [G-3] G. H. Q., A. E. F.

The article, "Fundamentals of Staff Control," is valuable not only intrinsically as a simple and clear exposition of the relations which should exist between staff and bureaus, but as symptomatic of the gradual "getting together" of staff and bureaus, which is essential to efficiency.

The general staff in our service is comparatively new, and it is natural both that it should have encountered much criticism, and that a great deal of this criticism should have been well deserved.

After the Spanish-American War it was evident that our military organization was vitally inefficient because of the impossibility, for the higher command, of exercising efficient control under the then existing system. A few of our officers and a few distinguished civilians saw that the only remedy for the chaos which had existed lay in the establishment of a general staff. But this staff had hardly been conceived when the embryo encountered the most violent opposition from the old established bureaus. This was but natural, for our bureaus had grown accustomed to the idea that they were supreme and that the remainder of the army existed at and for their convenience. Now, however, in the establishment of the general staff the bureaus saw this supremacy menaced by the creation of a body which, whether in the War Department or in the field, would have more immediate access to the ultimate authority than had they.

This attitude on the part of the bureaus was strengthened, and to some extent justified, by the early functioning of the general staff. While a few officers had correctly conceived the principle, we had, when the general staff was created, no officers who were properly trained in general staff duties, and we were therefore unable to install a working system which would put into effect the correctly conceived principles. An earnest attempt was made from the beginning to select efficient officers for the general staff, but since we had had no general staff experience, there was no criterion for such selection, and the choice too often fell upon men whose only qualification was success in duties pertaining to some one of the established bureaus. Confronted by the hostility of the bureaus, forced to fight for its existence, and knowing little beyond ordinary routine, the general staff turned to what has not inaptly been described as pernicious meddling with the internal working of the bureaus. Notwithstanding constant development, especially in the schools for instruction of future general staff officers, it was patent to all that our general staff was not fulfilling legitimate general staff functions. Consequently, it was not surprising that shortly before our entry into the World War the quarrels between staff and bureaus found their way to the Congress, with the result that drastic legislation was enacted with the avowed object of clipping the wings of the general staff.

The intent of the law of 1916 was good, but in enacting it, no account was taken of the fact that the fundamental difficulties were the lack of qualified general staff officers and the absence of the essential conception that both the general staff and the bureaus are the servants of the commander in the supply, development and employment of the line of the army, which alone wins battles, and is thereby alone entitled to special consideration.

The experience of the A. E. F. did much to bring about a proper realization of this fundamental conception and of the proper relationship between the bureaus and the staff. Although a few traces of the old quarrels remain in the late reorganization of the Army, we may hope that the hitherto insurmountable difficulty in the development of a capable general staff will soon be removed by the enactment of a law which will require adequate training as the *sine qua non* of the general staff eligible. Once this training is assured, and with our A. E. F. experience behind us, our general staff development will be rapid, and bureaus and line will join in securing the repeal of any remaining fragments of unnecessary legislative restrictions.

Restrictions on the duties and powers of general staff officers can only be put into effect by the proper training, experience and selection of general staff officers. The general staff is not only the *adviser* of the commander, but above all it is the *mouthpiece* of the commander, and the body which formulates and issues in the name of the commander the orders and instructions necessary to carry out his policies and his decisions. In advocating a purely advisory general staff we would forget the lessons of history, and we would in effect be seeking to establish a staff modeled on the lines of the Aulic Council; and one which would be as useless and as much of a nuisance as was that body. The general staff must issue orders and make decisions, and it must be reiterated that only by the adequate training and proper selection of general staff officers is it possible to settle the daily questions as to where general staff functions should properly cease. Training, experience and proper selection (and not the incorporation in unalterably rigid rules of words such as "administer" and "coordinate"—which may and often do have diametrically opposite meanings when applied to concrete cases) will soon place proper and effective limitations on the exercise of general staff functions.

The development of the general staff will certainly be along functional lines. There must of necessity be a certain "overlapping" between the sections of the general staff just as there must be an "overlapping" of general staff functions over the duties of bureaus. Thus the functions of the general staff as a whole embrace the broader phases of all those things which affect the employment of troops in battle, and the exercise of those functions must entail authority over a limited amount of detail when such detail affects more than one arm or service. The principle that the general staff should interfere in no matter of detail which pertains solely to a single bureau is unquestioned, but we must recognize that there is a twilight zone in which it is not always easy clearly to distinguish between legitimate general staff functions and meddlesome interference.

The internal organization of a general staff body along functional lines is essentially the same in all armies. That this is true has perhaps not always been grasped by those to whom words mean more than ideas. In the English service, for example, staff functions are assigned virtually as they were in the A. E. F., and yet the British terminology has given many people quite a contrary opinion. In the British Expeditionary Forces the term "general staff" included our G-2 and G-3 sections only, but the English title "Quartermaster General" properly connotes G-4, and not at all an individual with duties similar to those of our own Quartermaster General; similarly the British Adjutant General had duties practically identical with our G. H. Q. G-1. To carry this point to the *reductio ad absurdum* it may be noted that the fact that Ludendorff bore the title

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of "First Quartermaster General" does not indicate that he issued either beans or socks, or that he was especially trained for those important duties.

Functionally divided, the duties of the general staff, in all armies, then, classify themselves naturally: (1) Personnel; (2) Intelligence; (3) Operations and Training, and (4) Supply. Special conditions in the A. E. F. made it desirable to separate Operations and Training, but such a separation should not exist in developing a permanent system. On the other hand, one of the most important lessons to be drawn from our A. E. F. experience is that, following our terminology, the system of the four G's is necessary at every headquarters from the battalion to G. H. Q., inclusive. Each of these headquarters should therefore be organized with a chief of staff and the four G's; in the smaller units the G-4 might fulfill the actual functions of issue and accountability. The same thread of organization would thus be preserved throughout; we would avoid some confusion which existed in France, and each lower echelon would be constantly preparing officers for higher staffs.

It should be observed that while the classification of general staff duties into personnel, intelligence, operations and training, and supply makes a most distinct functional division, there are, as already mentioned, "twilight zones" which can only be suppressed by such a hearty co-operation between sections as existed in France. In one thing I can not agree with the author of this article; his apparent assumption that it is necessary to continue the present Adjutant General's Department. It is believed that a much more economical and efficient organization would result by merging the officers of The Adjutant General's Department with the General Staff Corps and the creation of a Central Records Service whose only duties would be concerned with the care of dead records, individual records of soldiers, routine reports and returns, etc. Under such a system each bureau and each section of the g neral staff would keep its own live records, and correspondence would be addressed to the office which must initiate action with a consequent saving of time, money and effort.

Geo. V. H. Moseley
Brigadier General, U. S. Army; formerly Assistant Chief of Staff [G-4] G. H. Q., A. E. F.

Order is the basis of military efficiency, and this is true whether it be order in troops on the march or deploying for battle, or order in the arrangements of staff organization. Disorder in the office of the commanding officer or his staff is reflected all the way down the line and shows itself finally in the way troops operate against the enemy. All successful business is organized into certain orderly sub-divisions with a control post over each, and in this way administration is decentralized and responsibility fixed. Successful industrial enterprises have these control posts called vice-presidents, directors, general managers, etc., and every good army must have them also, and it matters not whether they are called general staff officers, adjutants general, executive officers, or what not, provided the organization has been well laid out fundamentally. In a military organization, order is a characteristic of a high state of discipline. Disorder is a characteristic of raw, undisciplined, or defeated troops.

America, noted for its efficiency and enterprise in business organization, has also been equally noted for its inability to establish sound military organization. Why is this? In business, all are united upon the accomplishment of the single mission of making money. In a peace-time army, there is not the common mission of defeating the enemy, so that many adopt the mission of their own ambitions. In business, the inefficient or disloyal can be discharged, while in the army they generally have to be carried along, often in high places, much to the embarrassment of their superiors. Again, in business, the control posts are filled by men hired for their particular talents, while too often in the army, these positions have been held by men not properly educated for their tasks, or perhaps inherently incapable of rising to the high standard necessary.

Some of our successful commanders have been criticized because they wanted a certain group of assistants around them. But this is perfectly natural, for they want men who have been tried out and found fit, and they do not want some substitute detailed by roster and reported "just as good."

The system of staff control discussed in the article on "Fundamentals of Staff Control" is practically that which formed the basis of the organization of the A. E. F. in France. It proved to be sound throughout, and it well withstood the stress of modern war. In going to France, we had the advantage of starting with a clean slate. The A. E. F. was given a sound fundamental setting and a framework or organization was adopted which could absorb, in an orderly manner, the various units as they arrived. Each such unit had a logical place in the machine which it took upon arrival. Efficiency governed and not political considerations or peace-time conditions. A "wet ditch"—the Atlantic Ocean—protected the A. E. F. from harmful interference. The setting was for team play and not individualism.

On the other hand, at home, there were enormous difficulties to be overcome. Archaic systems had to be uprooted, often involving the removal of men who were well intrenched. To-day, the victory at home is not generally understood or fully appreciated. Considering the handicaps which were overcome at the outset and the scarcity of trained general staff officers, the results obtained by the War Department were no less than miraculous.

Little is to be gained, as the author of this article points out, in quibbling about whether the general staff should have the power only to co-ordinate or advise or control, or what not. In any system we must start first with a trained general staff officer fully qualified professionally and temperamentally for the position in which we are going to use him. No machine can be made so perfect as to be independent of the human element. Men with the proper qualifications must be assigned to all critical points. Each general staff officer in charge of a subdivision of the work, must have the *power* to make all decisions necessary and to require the proper agencies of the government to execute his will; but after his decisions have been made they should be executed, as far as possible, by existing non-general staff agencies organized for the purpose.

In considering the whole question of reorganization and staff control, we should go to the very root of the matter. The conditions of future wars will require closer and closer unity of action between the Army and Navy, and these two arms, which are organized and maintained for our national defense, must be merged into one great organism for that purpose. The Army must not be allowed to develop at the expense of the Navy, nor should the Navy be developed and our land forces neglected. In theory the President is the co-ordinator of these two services, but in practice he has no time for such duty, and as a result each Secretary

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goes independently to Congress and secures from that body all he can for his own service. All this can be avoided by replacing the Secretary of War and the Secretary of the Navy on the Cabinet by one secretary for national defense. As assistants to this single Cabinet officer there should be a secretary for the Army, a secretary for the Navy and a secretary for Munitions. With such a plan in operation the objections to a separate Air Service would pass away, and a secretary for Air could be authorized, co-ordinate with the secretaries for the Army, Navy and Munitions.

Whatever plan is adopted should be simple, fundamentally sound and then adjusted in an orderly manner throughout the Army. No plan, however perfect, will produce satisfactory results unless excellent discipline exists throughout the Army. We expect to find good discipline throughout the line of the Army, but we do not always find it as we advance to higher staff organizations. Commanding generals should be given the greatest freedom in selecting their staffs and in removing those found unsuited for any reason. In the same way the Chief of Staff of the Army should have the power to remove any officer on duty in the War Department, and all officers there should hold their positions at his pleasure. We should not charge any officer with such a great responsibility unless we are willing to give him the maximum amount of freedom in the organization of his office as well as in the selection of his assistants.

E. S. Hartshorn
Lieutenant Colonel, General Staff, A. E. F.

The Act approved January 21, 1903, creating the general staff, is an exceedingly well-drawn enactment, and as the organic instrument or constitution of the general staff, it is susceptible to little, if any, improvement. It is difficult to state to what extent by-laws in the form of added legislation or regulations are necessary to supplement this constitution.

A proper interpretation of this Act by officers thoroughly trained in general staff procedure should result in the discharge of staff duties in a manner satisfactory to all elements of the service. To prescribe a rigid method of procedure, or as the author states a "doctrine in plain words" for the general staff, appears inadvisable, since the conditions existing in the winter of 1917-1918 may repeat themselves in the future, and in such times of stress the Chief Executive and the Secretary of War should be accorded the utmost freedom of action as to the means to be employed in solving the difficult problems confronting them. In this connection attention is called to the fact that it was necessary very shortly after the beginning of the period of mobilization to remove many restrictions placed upon the general staff in time of peace. Lieut. Col. E. Requin, of the French general staff, with reference to the influence of our general staff, states (page 23, "America's Race to Victory") " . . . but considered as a general staff it did not exist. Its Chief of Staff was, by the laws and regulations then in force, deprived of that high authority which he ought to have exercised over his own staff officers, as well as over the several departments of the Army."

Under "What does the general staff do?" the author credits the staff with two functions, *i. e.*, "Advice, or to give orders." I beg leave to add another function, "to render service," both to the commander and to the troops, since a good staff is the servant of both. The red tabs of the British general staff officer have been described for many years by the faculty of the British Staff College as a "badge of servitude," and throughout the course every effort is made to inculcate in the student personnel this doctrine with respect to staff procedure.

The relationship of the commander and his general staff section, with respect to the channels of command, requires most careful consideration, since the danger of building up what may be termed a "staff officer's command" exists at all times. It should be clearly understood that there can be but one commander and that the necessary decentralization of functions incident to the performance of general staff duties should never constitute an excuse for departing from the prescribed channels of command through responsible commanders.

The author's conception of functional control by the staff, under the supervision of the commander, is based upon sound principles. If bureaus or corps reported to any *one division* of the general staff, it would be obviously necessary for that division, or "G," to exercise within itself the functions of the entire staff and to maintain sections corresponding to those which now constitute the four coordinate primary administrative subdivisions, that is to say, administration, intelligence, operations and supply. The solution of a replacement problem, for example, by these proposed subsections, or sub-G's, would be interesting and instructive and would at once indicate the impossibility of any co-ordinated effort under this system.

Our recent association with our Allies and a critical examination of European staff procedure indicates that the organization of our general staff does not require extensive revision. On the part of the general staff there should be a sympathetic appreciation of the needs of the troops, a highly developed sense of service and a clear understanding of general staff procedure, and on the part of all a keen desire to play for the team.

LeRoy Eltinge
Colonel, Cavalry; formerly Brigadier General, Deputy Chief of Staff G. H. Q., A. E. F.

I think the author has made a good analysis, and that it should be helpful. I would, therefore, suggest the following addition, to clarify the conception of the relations between the Commanding General and his general and technical staff:

The Commanding General may in a sense to be said himself to give all the orders that emanate from the general staff; for he keeps his staff constantly and fully advised as to his policies, and the staff simply applies these general policies to all particular cases that arise. As a practical matter this is done in two ways: (*a*) By personal conference with all or part of his staff; (*b*) by the approval or amendment of proposals submitted to him by members of his staff, issued in the form of staff memoranda.

As an example of (*a*): The Commanding General says, "I desire particular attention given to the prompt completion of the road from X to Y." It is then the duty of G-1 to arrange the work of the engineers, quartermaster corps and motor transport corps toward the end desired, and to inform them what work each must postpone or abandon, in order to accomplish the desired result.

As an example of (*b*) G-2 sends a note to G-3 stating that identifications of enemy troops opposite are badly needed. G-3 adds to this that a raid on such a part of the hostile trenches appears most feasible. The Commanding General approves or amends this proposal and returns same, or calls in G-2 and G-3 and goes over the situation with them. The Commanding General having decided upon the operation to be undertaken, it is up to G-3 to give all

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the necessary detailed orders and to supervise their execution.

Geo. P. Tyner

Lieutenant Colonel, General Staff; formerly Colonel, G. S., Assistant Chief of Staff [G-4], 2nd Army, A. E. F.

The article on "Fundamentals of Staff Control" bears on a subject of great importance to the service. Fundamentals of general staff control have often been misunderstood and often incorrectly applied, this due both to absence of knowledge of correct principles and disregard of established policies by officers occupying general staff positions.

The laws governing our military establishment distribute the supply and technical staff functions of the army amongst different bureaus, departments and services. Each is responsible for its own operation and performance up to 100 per cent efficiency. But as a team they must have a "quarterback" to insure that the policies of the "captain" run smoothly and effectively. If anyone attempts to work independently, they are all "downed" and the "play" is stopped.

The author of this article exhibits an intimate knowledg of his subject and unhesitatingly hits the nail on the head. It might be clearer to the uninformed if his description of staff control were applied to the activities of other services as well as to the engineers. The point is properly emphasized that none of the services work exclusively with any particular general staff section. The action of any general staff section is the action of the Chief of Staff. The sections are merely his assistants, and the division of their duties does not coincide completely with the activities of any particular service. This applies in the War Department and applies in an infantry division as well.

Occasionally a general staff section must jump in and actually operate a service. This, however, should be confined to those rare cases where the responsible representative of the service fails, and it is known that those of his assistants who are present are equally inefficient. Such operation by the general staff should never extend beyond the time necessary to install an efficient replacement officer in charge of the service. In the meantime the local responsibility for that service rests upon the staff.

As stated in the article the question of rank between the chief of a general staff section and the representative of a service is of no importance. If the chief of the general staff section is a trained general staff officer, and if the service representative knows his work, there will be no friction which will not be promptly "nipped in the bud" by their common commander.

John S. Fair

Lieutenant Colonel, General Staff

This article is a very clear and concise exposition of the duties and functions of the general staff and will help materially in creating a better understanding of what staff control is. Ever since the creation of the general staff there has been a persistent misconception, both on the part of general staff officers and others, as to the functions of such a staff. The World War has helped to clear the situation. From the beginning of the war there was an imperative need in the War Department for an organization to control as well as "supervise and co-ordinate" war-time activities in the name and by authority of the Secretary of War.

The present organization of the War Department General Staff was not finally established until early in 1918. The final organization into four divisions, viz:

1. Operations,
2. War Plans,
3. Purchase, Storage and Traffic, and
4. Military Intelligence,

was the result of evolution.

The assignment of duties to the divisions was along functional lines except in those cases where other considerations prevailed. The utilization of a Chief of Staff presiding over a War Department general staff, and acting as the agent of the President and the Secretary of War, not only in the matter of carrying out adopted policies but also in the determination of policies, is absolutely necessary for proper administration. Without such an agency adopted, policies will not be executed, and new policies will be presented to the Secretary and secure adoption on a one-sided presentation of the case.

There is one special function that peculiarly belongs to general staff officers which is not fully emphasized in the foregoing discussion. I refer to the exercise of supervisory power in the matter of seeing that orders are carried out after they are issued. The War Department has recognized the necessity for the better instruction of officers in general staff duties by the establishment of the General Staff College. Congress has recognized the principle that only officers thoroughly trained in general staff functions should be eligible for detail to general staff duty by including in the bills for the reorganization of the Army a provision for a general staff eligible list and restricting details to the general staff to those officers whose names are borne on this list.

Jno. C. H. Lee

Major, Corps of Engineers; formerly Colonel, General Staff, Chief of Staff 89th Division, A. E. F.

I think that our general staff system, as it worked out, needs material adjustment, first, as regards its relation to the bureaus and staff department, and, secondly, as regards its relation to the line. Colonel Young has dealt very forcefully with the first problem and has presented the clearest view of the existing system I have ever read. His war experience was near the fountain head—G. H. Q. Mine was with a division. Almost he convinces me, until I remember the low-brow's saying about general staff orders: "Beaucoup are issued—but damn few obeyed."

Colonel Young says "There are only two things the general staff can do—advise or give orders." But who exacts compliance with the orders? The Commanding General? Must he go about crawling junior subordinates? Or the Inspector General? He was at one time, in fact, vested by G. H. Q. orders with responsibility for discipline. Right here is where the "theoretical single mind" with all its magnified G-lobes failed in active operations: too many orders, many conflicting orders, nobody really held responsible that orders were obeyed. Take, for example, a case: G-1 orders the division engineer to keep his entire regiment on communications and handling engineer supplies. G-2 sent out orders for the construction of O. P.'s (two-platoon jobs) and for map work requiring another platoon of men. G-3 ordered engineer supervision sent to each infantry brigade to stake out and wire the position of resistance, also wire cutting details to train with the infantry for the coming advance, and a detachment to report to the artillery brigadier for getting up his guns. Later G-3 sent orders

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for engineer detachments to report to each brigade commander to construct the successive brigade P. C.'s. And *reports*—each G demanded a report! G-1 happened to see the report with only half the regiment working on roads and bridges. He protested. The engineer remonstrated and finally went to the general with the question: "Who is my boss, anyway?" Can we blame him?

Under a system where twenty or more staff heads are considered responsible to the commander, but where there are between him and them four or more G's, each giving orders to all, any incompetent man can ride along with the excuse that the other "G" told him "differently." If the engineer can't know definitely what his job is, how can anyone else know and see that he does it?

At a stationary headquarters it may be possible to assure results by the functional control system. I am sure that it is most difficult if not impossible in a division staff. The functional theory is like higher mathematics. Highly trained minds "hive"* it, talk it, think it, and seem to get results with it. A mathematics student thinks he hives it too—as we did at the Engineer School when we heard Dr. Steinmetz talk electricity in terms of the calculus. But when we start to explain that to, and apply it with the low-browed soldier—it can't be done. To a combat soldier the functional system seems to require an ideal condition among the commander and his general staff—ideal in temperament, training, and well-nigh telepathy—if the theoretical single mind is going to function over the line and the staff. Also it requires ideal subordinates, capable and willing to obey all orders, or to report the facts when orders are not obeyed.

In war we must make our work *simple,* so that each man can know clearly what his job is, what he has to do his job with, and who is his boss to hold him up to it. I feel that this is the basis of sound staff organization, and without sound organization we can't expect results in hard campaign.

[The Discussion of Major Lee's article follows in the next column.]

Cost of Levee Construction in Louisiana

The earth utilized in building the levees of Louisiana, by the levee districts, and the state, during the past two years, has continued to be moved mostly by power-driven machinery, the latter still standing first in place of volume of work performed; that performed by scrapers drawn by mules, second, and by men with wheelbarrows, third. The percentages, according to the recently issued report of the Board of State Engineers, were as follows:

By power-driven machinery, 65 per cent; by scraper drawn by mules, 30 per cent; and by men with wheelbarrows 5 per cent.

The average cost of the levee work performed by the levee districts and by the state, by all methods, during the past two years was $0.30 per cubic yard; and by the three methods named, as follows:

By power-driven machinery, $0.215 per cubic yard; by scrapers drawn by mules, $0.46 per cubic yard, and by men with wheelbarrows, $0.31 per cubic yard—*Engr. and Cont.*

Working Speed of Tractor

It is an established fact, states the April report of the Nebraska Department of Public Works, that the working speed of horses is from 1½ to 2 miles per hour, while the working speed of a tractor is from 2½ to 3½ miles per hour.

*"Hive"—West Point slang: to discover, appreciate, or understand.

Staff Organization and the "Theoretical Single Mind"

(Continued from Page 512)

Discussion

Douglas MacArthur
Brigadier General, U. S. Army; formerly Chief of Staff and Division Commander, 42d Division, A. E. F.

The purpose of organization is one of the most important and interesting of subjects, and yet one of the least understood in the service. Too many even of our brilliant officers believe that it means merely the accumulation of personnel and releasing to that personnel the authority to write "By order of . . ." It, of course, should be the means whereby a single controlling head makes known and puts into effect his ideas and policies. Unfortunately, however, the average commander, instead of outlining definite policies to his subordinates and relying upon them to carry out the details thereof, delegates to them the authority to determine the policy itself. Having "decentralized" to this extent, the commander too frequently begins to interfere with many of the minor details which are properly the functions of the subordinate. Most of the mistakes that the American Army has made in the last thirty years, both before and during the World War, can be traced to a wrong conception and application of organization. There has been no mechanical framework which made it possible for the ideas of the commander to be translated down through all ranks, the substitute therefor being the conglomerate ideas of dozens of men speaking in his name with conceptions frequently unknown to him and generally unco-ordinated. For success, there can only be one head to any one organization.

John H. Parker
Colonel, Infantry (A. E. F.).

The theory of a composite directive mind, "a theoretical single mind," composed of a general and a selected group of staff officers, is German, is utterly discredited by the German debacle, and could never find a supporter except on the hypothesis that competent commanders will not be available.

The fundamental error is that responsibility cannot be fixed upon individuals under such a system. The very theory of titled figureheads to be carried to success by technically trained assistants was the origin of that doctrine in the German army. The results require no comment. From conception of war aims, through selection of the time to strike, and conduct of operations during the war, down to the pitiful "bluffing" of inability to maintain public order in Germany with a force that the Junkers claim was not whipped, the same thread of error runs all the way.

The value of the mark is eloquent testimony that the Germans were "whipped." To the end of the fighting their forces were not only numerically superior at all points of contact—in the Argonne my single National Army regiment met and licked and took prisoners from four different regiments of the Prussian Guards, and our experience was typical—but also better trained, better equipped, and better managed in every element of staff service than ours. The men we captured were real soldiers, "Veterans of fifty victories," as they boasted at Seicheprey. The failure of German arms did not result from any failure of the German soldier as a fighting man. At Gesnes on the 29th of Sep-

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tember, when my regiment, that got its machine guns, automatic rifles, trench mortars and hand grenades within 200 yards of the German line on the 26th of September, ten minutes before zero hour, broke the German line, the bayonets flashed into the machine gunners of two German machine gun nests within 24 paces, as I fell. The German soldier fought his guns until he was bayonetted at his post.

This rule was general.

Their failure, then, cannot be ascribed to their soldiers, and must be placed on their system of command, which was based on the vicious idea of "A theoretical single mind."

The essential weakness of structure in this theory is the utter impossibility of *fixing responsibility.* It is a system cunningly devised for the very purpose of enabling "titled figureheads" to avoid all responsibility for erroneous decisions, but enabling them to claim all credit for success, and to ruthlessly "break" and discredit any individual who threatens to become prominent enough by his success or superior intelligence to endanger the credit to be allotted to these "titled figureheads." The German system was designed for just that purpose, and it failed because it was fundamentally, inherently, viciously, fatally defective. The same defect ran through their social, political, and diplomatic structures.

The German system was fastened upon Fort Leavenworth years ago, at a time when German propaganda had convinced many American officers of the correctness of the German claims that all the military knowledge and science in the world had been absorbed and predigested by the German General Staff, and that this German prepared military pabulum was the only possible diet that could be digested by the American School for Staff Officers.

I have very often heard distinguished Leavenworth graduates expound the theory that the "titled figureheads" of the German Army would find their prototype in "Political incompetents" in the American Army in time of war.

The proponents of this idea were very much in earnest about it. They were convinced that they were right. Their motives were beyond criticism. Their desire for American success was beyond question, and they were most eager to do all in their power to promote that success—even to sacrificing themselves in the obscure performance of the ungrateful duty indicated for such staff officers in the German plan. And many of them graduated from successful performance of such duties to the command of troops, as replacements could find opportunities for such service, thereby illustrating the true American spirit which always seeks the post of danger and of opportunity, and which could not be wholly destroyed even in those who were betrayed into acceptance of a false and dangerous doctrine by German propaganda.

The Leavenworth schools are now busily engaged in preparing a purely American doctrine.

The doctrine of a "theoretical single mind" finds its best illustration in that hoary military anachronism called a "Board"; that useful device for avoiding individual responsibility under the form of collective action. When the conclusions of "Boards" are not the action of a single dominant mind they are invariably compromises, and compromise action always represents the minimum of right, the maximum of delay in reaching a conclusion. A board is a long, narrow, wooden object. Is it possible that the term "Board" came into military use by analogy?

The system of a composite directive mind, "a theoretical single mind," has all the advantages and all the drawbacks of a "Board."

In point of fact, our tactical blunders in France were usually the blunders of staff officers, actually "functioning for and in the name of" their chiefs.

I do not recall a single case within my personal knowledge where an American general officer ordered in person an operation that was a tactical blunder. I know personally of various incidents where zealous staff officers, invested by this hideous and pernicious doctrine with authority to give orders of their own motion, but in the name of chiefs ignorant both of the conditions and the orders being thus given in their names, either consummated egregious blunders at the cost of human lives or were prevented from doing so by the sounder judgment and wiser action of regimental and brigade commanders, their seniors in rank and experience, their superiors in every way as soldiers and officers, from every standpoint except the erroneous assumption that the staff officer, as a member of the "composite" "theoretical single mind," was in some way thereby made superior.

The true "operations staff" of a commander is composed of his unit commanders, and not of clerks and messenger boys.

These commanders are responsible. Any theory that makes them in any manner subordinate to any staff officer, that makes them serve two or more chiefs, that leaves in their minds the least doubt that every order received by them is in very truth and very fact an expression of the single and individual will of their immediate superior—and of no other person—any such theory is based on false premises or false deductions, and will lead to disaster in our service, as it did in the German service, if made the foundation of our organization.

When orders received do not cover a situation, and where action must be taken before the will of the commander, in person, can be known, it is *the responsible unit commander himself, and no other person, who must make a decision and on that decision must act.* No staff officer, no matter how high in rank, no matter what his position, can divest the unit commander of this *responsibility.* The only means of escaping it are death, and devolution of command; and in either case the same responsibility passes to the successor in command. It cannot, under any conceivable circumstances, devolve upon any staff officer. If the staff officer actually knows the will of the commander and conveys that will to the unit commander, then the decision is that of the superior. But if the staff officer assumes to give orders when he does not know the commander's will, then he is guilty of the most damnable crime possible—that of attempting to destroy the lawful organization of military administration in time of war, during a critical tactical situation, in the presence of the enemy. For this offense any staff officer who commits it should be summarily shot.

With these few comments interpret my attitude as a rather earnest endorsement of the views expressed by Col. Lee.

Chas. E. Kilbourne
Lieutenant Colonel, Coast Artillery
Lieutenant Colonel, Chief of Staff, 89th Division, A.E.F.

Major Lee's presentation of this important subject, is of course, entirely sound. Success depends upon each responsible officer from the division (or higher) commander down to the corporal having a definite job. And it devolves upon each responsible officer so to allot the work among his subordinates that nothing important will be overlooked. In my opinion, nothing makes more greatly for success than for each officer to anticipate, as far as is practicable every contingency and place the responsibility upon a subordinate, thus leaving the higher commander free to

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to meet, with a clear mind, the new emergencies which are certain to arise and which it is impossible to anticipate.

I do not believe there is any great difference between the doctrine of the service schools and that stated by Colonel Lee. The General Staff officers are practically part of the commander's mind, in that they relieve him of all the fatiguing study, laying before him all information in such thoroughly digested form as will permit him to come to a wise and prompt decision without having to consider an infinite number of details, and seeing that his decision is carried through to conclusion. I believe, also, that occasions will arise where the staff officer, knowing the commander's plans not only to the extent published, but also beyond the point it may be advisable to announce them, must give orders "in the name of the commanding general." All general officers I have served under have expected this of their staff officers.

Stephen O. Fuqua
Lieutenant Colonel, Infantry, A. E. F.; Chief of Staff 1st Division

The principles enunciated in this article are seemingly sound, particularly those on Organization. In fact, most of them are military axioms which have long been accepted and advocated by military men. However, the application of these principles is necessarily varied. The author, in this article, builds a staff structure at variance with the very principles enunciated as his foundation stones.

It is difficult to get the author's ideas of the function of a chief of staff. He says, "The division commander holds his tactical assistants (brigadiers) responsible for the tactical details of the work, while holding his staff assistant (chief of staff) responsible for all staff details." From this one draws the idea that the author believes that the division commander drives, metaphorically speaking, four reins—three tactical and one staff. Further on in the article we find the author appreciating the intended mission of the chief of staff, but only to a limited degree. He says, "The division commander having made his decision, the chief of staff must see to it that the G-3 officer supplies a comprehensive order expressing the commander's wish to his tactical assistants and to the chief of staff." Still further on the author states the true mission of the chief of staff. "As for the chief of staff, his duties and responsibilities demand an officer of caliber at least equal to that of the brigadiers. His responsibility, if anything, is larger, and his training should have been even more varied than that of a brigade commander, while being in all respects thorough, *he is the division commander's first advisor and should be a man in whom the commander and the brigadiers have confidence.* The italics are those of the commentator and are made use of to emphasize that this is exactly the function and qualifications of a chief of staff in capsule form, and with which the Staff Manual and the Leavenworth doctrine are in accord with the author. This principle announced by the author and given structural form would not place the chief of staff as one of the four "assistants" to the division commander, but would make him what all military students, including the author, intended him to be—the principal advisor to the division commander. The author's idea in the first pages of this article is seemingly to separate the chief of staff from operations, the division commander dealing directly with the three brigade commanders. This idea of divorcing the chief of staff from operations is very wrong and certainly antagonistic to the very best thought on staff organization. It is true that the division commander should deal directly with his brigadiers—his three tactical assistants as the author refers to them—whenever practicable; but, if possible, the chief of staff should be present at these conferences to advise his division commander whenever called upon in matters pertaining to disposition of troops, supplies, ammunition, relation of movement or plan to neighboring troops, etc. However, the normal case will be in those fleeting moments when rapid decision and quick execution are demanded—when the "tactical assistants" are not available for conferences, or when they are out "on the job," when reports from the "tactical assistants" are local in character and require proper interpretation and co-ordination—then the chief of staff functions as a gatherer of information from the sources available at his command, formulates an estimate of the situation and constantly keeps his commander confronted with that situation, being prepared at all times to present a true estimate and a sound plan. The chief of staff should be the executive officer of the division and the medium for the transmission of the will of the commander to staff or troops as well as a co-ordinating agency which insures the proper functioning of the whole machine.

I believe that in campaign there is a certain amount of detail work, especially in the G-1 section, which should be taken up directly with the corresponding G section in the next higher unit without first addressing either the commanding general of the division or the commanding general of the corps. This would apply, however, only to details of working out a plan which had been adopted by the corps and communicated to the division in which the division commander was aware. I believe that the division G-1 should not be allowed to deal with the corps G-1 on anything which would change the principle or plan which had already been adopted. It seems, however, to me not to be expected that a division G-1 having a question, for example, of additional facilities for supplying his division be taken up with the corps commander through the division commander. The question can be settled by direct communication between the division G-1 and the corps G-1 so long as the principle involved is not altered.

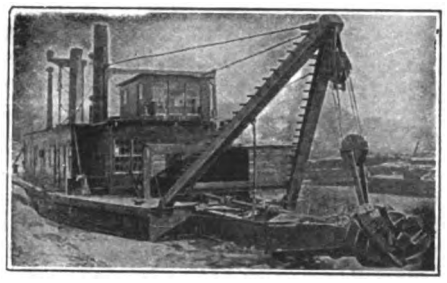
I do not agree with the author's statement to the effect that a staff officer's responsibility ceases after delivering an order to a tactical command. His next immediate duty after delivering such an order is to follow it through and see that it is executed, and if not executed, advise the division commander of what has or what has not been done.

With reference to the author's subdivision of the duties of the G-1 section, it does not seem feasible to me to have any officer actually in command of troops an assistant in the staff section, such as the author proposes in his third, fourth and fifth subdivisions of the G-1 office. The G-1 office should have in it an assistant who would coordinate the work of the engineers, commanding officer of trains and the division surgeon, but these officers themselves should not be assistants.

I believe that the subdivision of duties as indicated in the Provisional Staff Manual is an improvement on Major Lee's ideas.

With reference to the division munitions officer, I do not agree at all with the author and am firm in my conviction that the division munitions officer must be in the G-1 office and that the motor train of the division must function under the G-1 section through some immediate line officer, such as the commanding officer of trains or the M. T. O. If the Field Service Regulations are to be followed, I would say that the munitions officer must be on the staff of the

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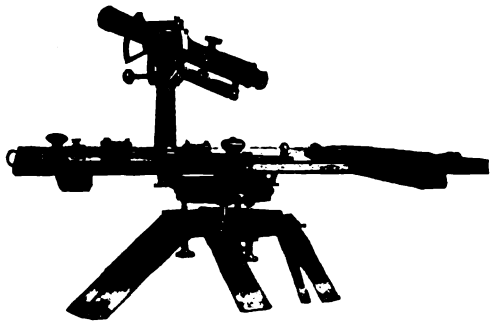
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field artillery brigade commander and not, as the author states, in the ammunition train.

The Chemical Warfare Service officer is now a chief of technical service as well as a staff officer, and should have the same relative position on the staff as the division quartermaster.

With reference to the author's remarks concerning relative rank of officers on the staff, I do not believe that the best interests of the service warrant the use of a colonel in that capacity. As a matter of fact, the way G-1 and G-3 and G-2 will function will depend, first, upon the chief of staff, and, second, upon the personality and ability of his three assistants and not on their rank. The assumption is, of course, that if a colonel is placed in G-1, it means that G-1 office will be in command of an officer who is of greater experience than would be the case if it were in charge of a lieutenant colonel. Still I believe that a lieutenant colonel has had sufficiently varied service to insure a successful G-1 section. As a matter of fact, I believe that a level-headed and capable, well-balanced major could perform the duties satisfactorily. There should not be any friction between the G-1 section and the engineers, for example, simply because the engineers are commanded by a colonel and the G-1 section by a major or lieutenant colonel. It is essential that both understand the difficulties and desire each to co-operate with the other. Sympathy, co-operation and understanding between the G-1 section and the technical services is the essential point. It is not a question of relative rank. Probably, one reason why general staff officers are said to interfere in the line of command and to handle matters in their own names, is because of their high relative rank in organizations.

In the division of intelligence duties I think that the reconnaissance section should be divided into a topographical section and an observation section. The topographical section should come entirely from the engineer regiment to division headquarters, subject to call, and its duties should concern maps only. The observation section should be in charge of air and ground reconnaissance; this would make five subsections instead of four subsections in the intelligence section. In Major Lee's fourth subsection in the intelligence section is included "mail," this duty is generally handled by the division adjutant. If any mail seems subject to censorship, it is turned over to this section for action. The routine of handling mail, however, should not fall under the intelligence section.

There is no question in my mind but what the present organization, outlined in our Staff Manual, intends that the commander should command in every sense of the word. It is certainly not contemplated that the general staff officer shall assume any command nor that he should issue any orders of great importance without either tacit consent of his organization commander or a complete understanding of his organization commander's mind that would cause him to assume the responsibility to act for his commander during his absence. I am sure that all of the principles of organization outlined by Major Lee are considered in our Staff Manual, and that our present organization, with some slight changes, admits of the carrying out of all of these principles. A great deal depends on the subdivision for assignment of duties by the division commander and the chief of staff.

W. Goff Caples
Major, Engineers; formerly Colonel, Division Engineer
1st Division, A. E. F.

Staff relations are important matters. The system of giving what amounts to a command to the G's, is indefensible and insufferable. As a rule the G's will be found younger than, and junior to, the other staff officers. This case was particularly aggravated in the recent war where many of the G's of the divisions had practically no experience at all. No man can keep his self-respect and be under the command of an officer many years junior to him both in age and rank. If the G's are to exercise command, they must be the officers next in seniority to the chief of staff, who, in turn, under such a system, would have to be next in seniority to the general. If the system, as it existed in some divisions, is to be continued, there is no choice left an officer except to get on the general staff himself, or throw away his last vestige of self-respect. A division staff officer, and particularly the division engineer, must have dealings with every one of the G's. Without early and thorough knowledge of the G-3 plan it is frequently impossible to make the best use that could be made of the engineer troops. The liaison with G-2 should be an especially active one. Under a system where the G's are co-ordinate with, and not commanders of the other staff officers, there would be no necessity for G-2-C section, which amounts generally to nothing more than a duplication of the work that should be done by the engineers. In matters relating to administration and supply, the engineer has to deal with G-1. In a properly organized system all staff officers should report direct to the chief of staff. The G's should be what they were formerly designated, assistants to the chief of staff, and not assistant chiefs of staff. There is a marked difference.

G. R. Young
Captain, Corps of Engineers; formerly Lieutenant Colonel, G. S. (G-4)
G. H. Q., A. E. F.

Major Lee's article is a valuable and entertaining contribution to our knowledge of its subject. But I believe that, mathematically speaking, he exterpolates his curves too far from a limited number of known points. What will answer for a group of 20,000 men will not do for a group of 2,000,000. On this basis I offer a few comments on his article.

Elsewhere in this issue I have given my conception of existing theories of staff control. Major Lee proposes a revision of these theories.

The essence of the proposal appears to be that we abandon the functional division of staff duties, the so-called "theoretical single mind," composed of the commanding general and his general staff, and adopt an organizational system where certain divisions of the general staff have complete control over certain organizations or elements of the army. Coupled with this is the removal of tactical fighting units from staff control.

Major Lee's article was evidently written from the point of view of the division. My own staff service was entirely with general headquarters of the A. E. F., and it is natural that I should criticise the article from that point of view rather from the divisional.

It then appears to me that while Major Lee's system may be perfectly workable for a division, which is the smallest unit having a general staff, it would present grave difficulties when applied to larger units. To illustrate briefly, consider the analogy of Major Lee's proposed system as applied to the highest command in the A. E. F., namely, the General Headquarters of the C. in C.

The C. in C.'s immediate tactical subordinates commanding fighting units, during active operations, were the commanding generals of the 1st and 2nd Armies. His supply chiefs were grouped at Tours, under the C. G. S. O. S. (an arrangement made necessary by local conditions, and which

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would probably not be repeated in a normal campaign). Major Lee's arrangement would have called for a chief of staff with five G-sections at G. H. Q. G-1 and G-4, which divided between them the functions of supply, transport, administration, equipment, shipping and overseas requisitions, would one or the other have been in direct command of The Adjutant General, Judge Advocate General, Inspector General, Chief Quartermaster, Chief Ordnance Officer, Chief Engineer, Chief Surgeon and certain minor activities. G-3 would have been in direct command of the Chief Signal Officer. This does not cover all the activities which would thus be controlled, but will serve as an illustration.

G-2 and G-3 would be responsible for the collection of information and for the translation of the C. in C.'s commands into effective tactical orders. The functions of G-5 may not be considered here.

But none of the G-sections, nor the chief of staff, would have any control over the commanding generals of the first or Second Armies, nor over any organizations or echelons of those armies. No one would be interpolated between the Commander-in-Chief and the commanders of the 1st and 2nd Armies.

The functional difficulty of this arrangement would lie in the size and complexity of the units dealt with and the extent of territory covered by them. The 1st Army at one time controlled territory covering probably two or three thousand square miles, in which were a tremendous complexity of supply functions and organizations handling supply matters. It was out of the question that a commanding general of the 1st Army should have an intimate knowledge of the details of the operation of this great machinery; and in fact Major Lee's thesis is specifically that he should not; such matters being delegated to his chief of staff and G-sections. But this supply machinery of the 1st Army tied in, over a line of scores of miles in length, crossed by many roads and railroads, with an even more complex supply organization under the control of General Pershing's chiefs of services in the S. O. S. It was equally impracticable that the C. in C. should be familiar with the details of this latter supply organization, as again is admitted in Major Lee's thesis—and equally essential that it be controlled by the appropriate G-sections at General Pershing's Headquarters.

Now, this line of demarkation between the S. O. S. and the largest fighting army was the most critical point in our entire war machinery from a supply point of view. In order to keep things moving across this line, and to keep the activities on one side co-ordinated with those on the other, it was found essential that the activities on one side be controlled by a single man, namely, the Commanding General, S. O. S., and the service chiefs under him; on the other side by a single man, namely, G-4, of the 1st Army; *and that the two together be controlled and co-ordinated by a single man, namely, G-4 of G. H. Q.*

And this arrangement at once involved the necessity of G-4, G. H. Q., issuing orders, in the name of the Commander-in-Chief, but in most cases quite without the Commander-in-Chief's personal knowledge, to the subordinates of the Commanding General of the 1st Army, issued quite without the knowledge of the Commanding General of the 1st Army. And these subordinates were frequently the very tactical fighting unit commanders, whom Major Lee insists should be removed from the chain of staff control and should receive orders only down the line of direct tactical command.

This variety of absolutely necessary staff "interference" in the chain of direct tactical command often went down several degrees, not simply as between G. H. Q. and an army, but as between G. H. Q. and a corps or division. To illustrate:

On a certain occasion (which might be multiplied a great many times) it was necessary to move a division, belonging to an army, by trucks. It takes many more trucks than are normally assigned to a division to move its personnel wholly by truck. Due to the shortage of trucks in the A. E. F., the greater part of all reserve trucks were held under the control of G. H. Q. What actually happened was that the order went out through due military channels, via army and corps, for the division to move. G-4, G. H. Q., was then notified that it must find the trucks to move it. That office directed a subordinate of the C. G., S. O. S., to have the trucks at a certain point at a certain time. It then directed G-1 of the division to arrange to have his division at that point at that time, and put them on the truck. The orders were carried out, and the division was duly moved. But what actually happened was that a sub-sub-assistant of the C. in C. issued direct orders to a sub-sub-assistant of the C. G., S. O. S., and other direct orders to a sub-sub-sub-assistant of the C. G., 1st Army; and by the latter procedure injected himself into the sacrosanct area of the fighting tactical command; and this without any reference to the Commanding General of the 1st Army, or Commanding General of the corps in question, or the Commanding General of the division in question.

Putting the thing in general terms, I believe that the clear-cut division which Major Lee draws between the fighting tactical units and all other units, as applied to the division, is not applicable at the other end of the line, where one must consider hundreds of thousands of men instead of thousands. In the control of these very large units I believe that there must be a chain of direct staff control from the subordinates of the commander of one unit to the subordinates of the commander of the smaller unit. I believe, further, that this chain must often involve the fighting tactical units, so that instructions will be issued to them, or to echelons of them, by members of the general staff, even of the supply and transport portions of the general staff. It is worth noting in this connection that the fighting tactical units to which Major Lee refers in his article are brigades; and a brigade is exclusively a fighting unit. It has no strictly non-combatant troops of any importance which are an integral part of it. But an army of a million men, though it also as a whole is a fighting unit, has hundreds of thousands of troops forming an integral part of it which are essentially non-combatant, and which must, in the nature of things, be under a dual control, the control of tactical command from the army commander, and the service or staff control from the higher supply staff.

All this, however, is not really intended as a criticism of Major Lee's thesis as applied to a division, but only to the rigid extension of that thesis indefinitely upward. I have heard criticisms and suggestions regarding our staff system, similar to this one, from many officers serving with divisions or even with corps; though I have never seen the matter presented in such a clear-cut way, nor with the essentials so clearly stated, as in Major Lee's article.

I think the conclusion to be drawn is that the strictly functional division of staff duty is proper at the upper end, with the supreme command of a very large force; and that as one proceeds downward through armies, corps and division, its outlines become more and more blurred, until in the division an arrangement is found in effect very similar to that outlined by Major Lee, implying a combination of organizational and functional control, with the former

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predominating. Organizational control is much more apt to come about automatically in a small unit, where each *chief* deals directly in such matters with the *chiefs* under him; instead of an office subordinate of one chief dealing with an office subordinate of the lower chief. In the former case the personalities are always the same and work along the same lines; and if Smith is always giving a certain kind of orders in a certain way to Jones, no theory of organization ever written will prevent Jones from considering himself as in effect the direct organizational subordinate of Smith. But where Smith has twenty juniors in his office and Jones has fifteen, and any one of one set is likely to be talking to any one of another set—as happens with the large units—the personal element largely disappears. And where personal contact and personal understanding weaken, there must be an increase in system, theories of organization, military channels, and the other necessary parts of red tape.

It is then my belief that Major Lee's thesis contains material, so far as I am qualified to judge of the matter, for an excellent staff manual for a division or possibly a corps; but that it would hardly be safe to apply it in toto to an army, or army group, and hardly justifiable to revise our staff theories for the higher commands along these lines.

Final Discussion by Major Lee

When the writer prepared his article he realized that some criticism and perhaps even some acrimonious discussion would result. He trusts he is betraying no confidence when he now recalls that such acrimonious discussion was desired by ye editor in order to draw attention, stimulate interest and perchance increase the circulation.*

The writer has only praise for the foresight and courage of the Leavenworth Schools and for the way in which Leavenworth men on the whole developed the A. E. F. organization for General Pershing. Surely, however, even "Leavenworth" learned something during the World War. Without Leavenworth, America would truly have been in a bad way, but this fact does not necessarily mean that the Leavenworth doctrine is perfect. True greatness admits of advancement and progress, admits of scrapping worn-out ideas for newer and sounder ones. Is it not possible that the time has come to consider replacing the German general staff principles by sound American organization? True, all European staffs felt the influence of and in the past have largely followed the German School, the dominant military influence of the past generation. But that is now history. The Kaiser's wish is no more the most rousing and convincing way of expressing an order. Europeans will cling longer to the influence of royalty, the wish of the king, or the command of the general. With us Americans, however, this hero worship carries relatively little weight among efficient men. We prefer to get our orders from our immediate boss himself, the man who best knows what he is talking about.

It is not easy to express oneself in a single article on such a broad subject. For example, there is no intention of divorcing the chief of staff and G-3 from operations. They are, of course, the commander's tactical advisors. And G-3 does the tactical hack work for the general and attends to details so far as the division is concerned (but not brigade or regimental details). The main point at issue is that *neither* G-3 nor the chief of staff can *control the troops*, the line troops, the troops that are commanded by the brigadiers. To see this, the reader should try to picture himself in the brigade commander's position. Both at home and in the A. E. F. the writer saw a strong tendency for the division commander and staff to assume the brigade commander's prerogatives, to give him detailed orders, to undercut him by dealing with his colonels. This wasn't done so much with the artillery, for usually the staff knew relatively little about the artillery. The old army tendency was that of the colonel meeting the company commanders at officers' call, undercutting the majors, just as the division commander began to undercut his brigadiers. A good brigadier can do a lot for the division commander in a fight, but no one can tell whether the brigadier is good or not unless he is given full responsibility and is held up to it.

The second principal point at issue is that the staff chief *commands the staff*. He doesn't have to give staff orders in the name of the commander. In all the foregoing discussion no question is raised about this. If such is accepted, the writer is very glad, for he considers it to be of importance secondary only to the aforementioned: viz, that the staff does not control the line.

The writer believes in all that General Moseley says and also admits the points made by General Conner, except it is felt that sound American staff development should be along clear-cut organization lines—not functional. General Conner's plan of four G's in every staff from battalion to G. H. Q. is very thorough. While he is eliminating The Adjutant General's Office the writer would also eliminate the Inspector General and make the true inspector, the unit commander, the Inspector General for each unit all the way down.

The writer can not agree entirely with Colonel Tyner, Colonel Fuqua and Colonel Eltinge. They express certain ideas that seem fundamentally opposed to sound organization built upon responsibility and command. The writer first wishes to say, however, that he agrees fully with Colonel Fuqua regarding the general duties of the chief of staff, his advisory duties to the commander. The writer regrets that his article is capable of such misinterpretation.

When Colonel Fuqua says that the staff officer after delivering an order must next "follow it through and see that it is executed," he is, in the writer's opinion, gravely undercutting the brigadier. The writer is glad that Colonel Fuqua thinks that all the principles of organization mentioned in the article can be admitted into our present staff system.

In Colonel Eltinge's example (*b*) he cites a typical case where, as the line sees it, the G's "frame up a show" and put it over on the brigade commander. To quote Colonel Eltinge: "It is up to G-3 to give all the necessary detailed orders and to *supervise their execution*" (!?!)

Colonel John Henry Parker speaks feelingly as a line soldier, even if he is a graduate of Leavenworth. The writer believes that many other line commanders of the A. E. F. feel the same way about it.

The writer has derived much of his staff knowledge from Colonel Kilbourne. As he says, many times will come when the staff officer will have to give orders in the name of the commander because the staff officer through his closer association knows better the commander's plan, intentions and responsibility. The staff officer is merely expressing then the commander's will as he best understands it. If in doubt he should discuss it with the brigadier, who will know more about the immediate situation in front. As loyal subordinates to the commander they will try to arrive at the decision he would make, and then carry it out.

*Major Lee betrays no secrets. To "increase the circulation" is, or should be, the aim in life of every editor. Differences of opinion, especially if tinged with good-natured sarcasm, not carried too far, *appear* to produce the desired result.—*Ed.*

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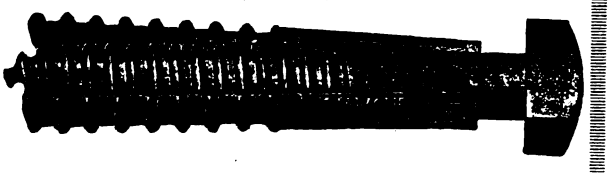
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But always it is the commander, his will, that controls the troops.

The writer has already commented on Capt. Young's excellent article. He makes no claims to knowledge of higher units, but sees no reason why the G-4 of G. H. Q., who should command the S. O. S., should not be able to deliver to the Army G-4 at the distributing points (advance depots or rail heads) just as dependably as a divisional G-1 delivers his supplies to the regimental supply officers at their distributing points. The principles are the same, and the writer would think that the higher the echelon and therefore the more complex the plan, all the greater need for clarified organization, responsibility and control. As to army truck moves, the writer saw the other, the "bitter," end of them. They were far from smooth, usually confusing and often chaotic.

As General MacArthur says, "The purpose of organization is one of the most important and interesting subjects, and yet one of the least understood in the service." Our army generally has failed to develop and maintain real interior organization. Our regulations talk of squad control, but on the very next step (the sergeant's command) the system breaks. True, in garrison, there seems to be no need for it. We become victims of expediency. We get immobilized and drift into stationary habits of peace time. It is feasible for one company supply sergeant to hold the clothing and equipment memo-receipts for all the company. One officer in the troop can be responsible for all the animals; one for all the guns and materiel of the battery. Platoons are recognized only at drill, and then are changeable. It is "easier" and therefore excused as "more efficient." Post headquarters deals with a dozen or more subordinates directly—or through the loose paper reins of the adjutant. Within the limits of the reservation and the Regulations, the quartermaster, the range officer and a dozen other staff officers can't go far wrong, and it is "easier" for the post commander to handle them directly. Similarly it is "easier" for the regimental commander and staff to deal directly with the company, troop or battery commanders. But witness the confusion when the garrison takes the field. There is no flexibility to meet the constantly changing condition of campaign. There is no sound organization.

Thus did war find the Regular Army. For the large part we had to forget the way we were accustomed to, realize that we had been blind to the demands of war, and start over again. Instead of the crisis finding us with strongly organized military character, based on years of sound habit, so that in full stride we could lead forward the men who joined us to learn—we had to stop, reconstruct and then stumble forward, trying to teach that which we were really learning ourselves for the first time. And the result was that the great new American Army had most of the faults of the old Regular Army—and the greatest of these was disorganization. Young company and battalion commanders wore themselves out, broke down and even committed suicide, because they were doing the N. C. O.'s work. They didn't know and didn't use their interior organization.

There has been much talk about handling men—and about West Point methods. Here is a definite fact. The cadet in the past has lived through four character-forming years with no true example of sound interior organization ever shown him. There has been no squad organization in the Corps of Cadets. In ranks, squads were formed for appearance at parade, and for as trivial reasons broken up. The squads never lived together, going on guard as squads, the corporals having no responsibility, nor the sergeants, nor the lieutenants, as such! The "tac"* really did it all. For four years, the cadet wasted a splendid opportunity to learn as second nature the true value of interior organization. The first principle of efficiency in handling men is to give the man a job he can handle and then know how he does it, and let him know that you know how he does it. It is little wonder that cadets never learned this. They should learn it by four years of habit so that it becomes as lasting a characteristic as honor and industry. If this were done, if true interior organization were recognized throughout the service to be worth the price of effort, if not, indeed, as essential to training and character making, we would take a long step forward and earn the compliment we used to feel we deserved—"good organizers" and "able to handle men."

Simple Plant Makes Good Record in Dam Construction

With a force of approximately 21 workmen, aggregates have been excavated, hauled, crushed and screened and concrete has been mixed and placed at the rate of 300 cubic yards in an 8-hour shift at the Devil's Gate Dam, one of the structures being built by the Los Angeles County Flood Control District.

About 17,000,000 cubic yards of gravel, sand and rock had to be removed in preparing the foundations for the dam proper and in excavating the spillway. About 9,000 cubic yards in the dam foundations were handled by a guy-derrick having an 85-foot boom and operating 1 cubic-yard skips loaded by hand. One foreman and 12 to 16 men loaded about 100 skips in an 8-hour shift. The spoil was piled just above the upstream face of the dam and will be leveled off to form a fill against the masonry. A high promontory, against which one end of the dam abutted, was selected for the site of the crushing plant, material bins and concrete mixer.

Suitable materials for concrete were found in the bed of the arroyo about 1,500 feet above the site of the dam. The sand and gravel, and boulders up to 16 inches in diameter, are loaded by steam shovel, having a ¾-cubic-yard dipper, directly into dump trucks to be hauled to the mixing plant. A gyratory crusher that will handle rock up to about 16 inches in diameter is located beneath the truck dumping platform and all materials from the trucks go through this crusher. From the crusher the materials are taken by a 70-foot elevator to screens on top of the bunkers. These screens separate as sand all material up to ¼ inch in diameter. That which falls through the screen, with 3-inch perforations, is classified as rock, and larger material passes on to another gyratory crusher which reduces it to 1-inch size for use in the tunnel, or elsewhere where reinforcing is used. The supply of over-sized rock from the big plant is quite uniform and well within the capacity of the small crusher, and after passing through this crusher the rock is taken to bunkers by a conveyor.

From the screens the sand and rock drops into bins located above the hopper of a 45-cubic foot mixer which, in turn, delivers to a spouting system running out over the dam. Three cables span the gorge directly over the dam. Concrete chutes are suspended from the cables by block-and-tackle, so that they can be adjusted to the desired height or swung to position over any portion of the dam. About 75 per cent of the total concrete yardage can be poured directly from the mixer into the dam.—*Eng. News-Rec.*

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*"Tac"—West Point slang for the army officer assigned to supervise the instruction of a company of cadets—a "tactical officer."

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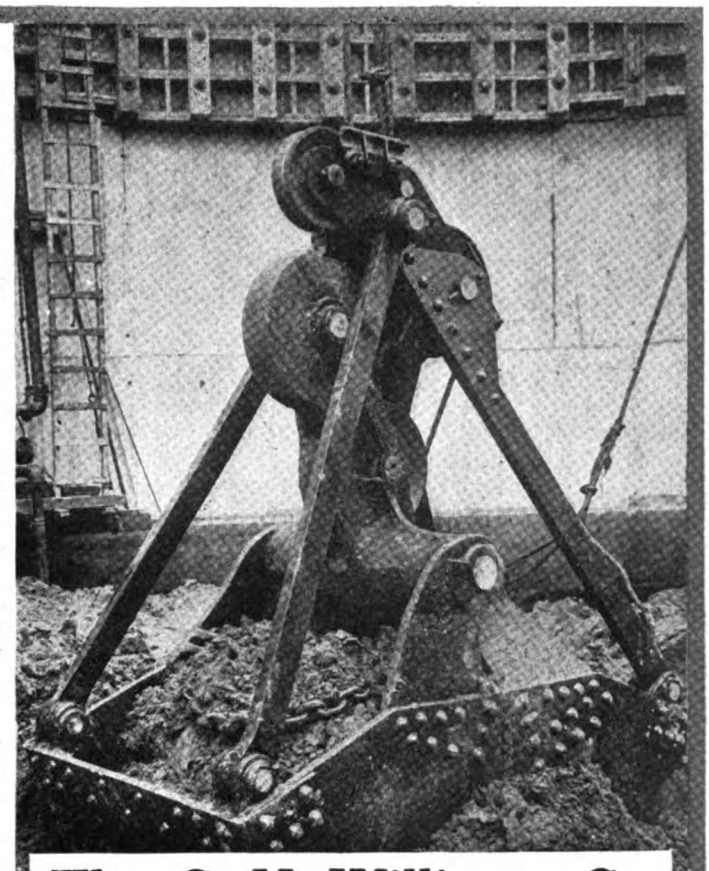
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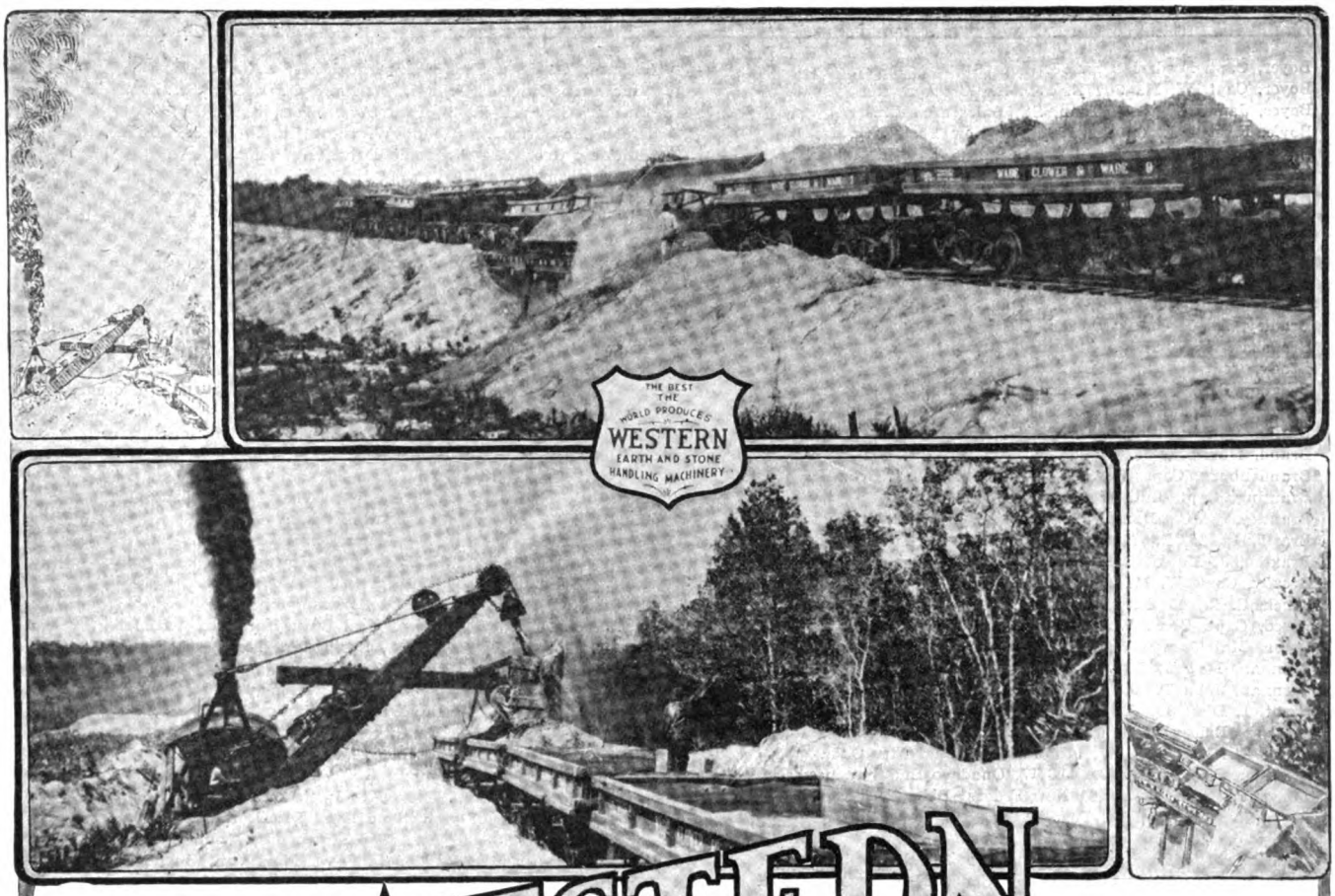
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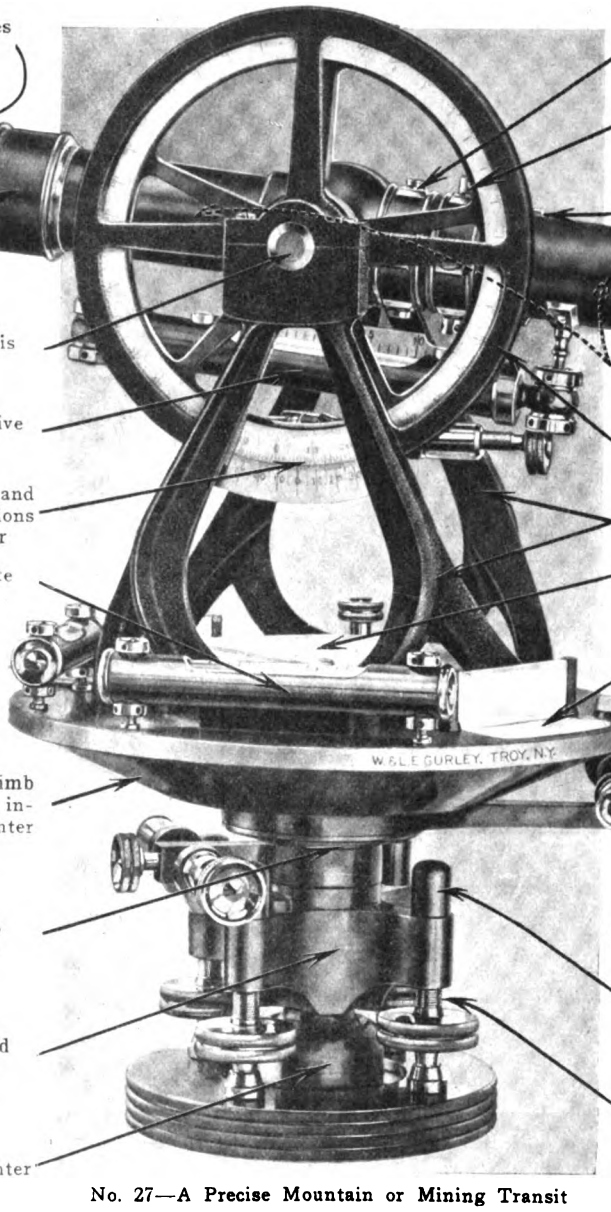
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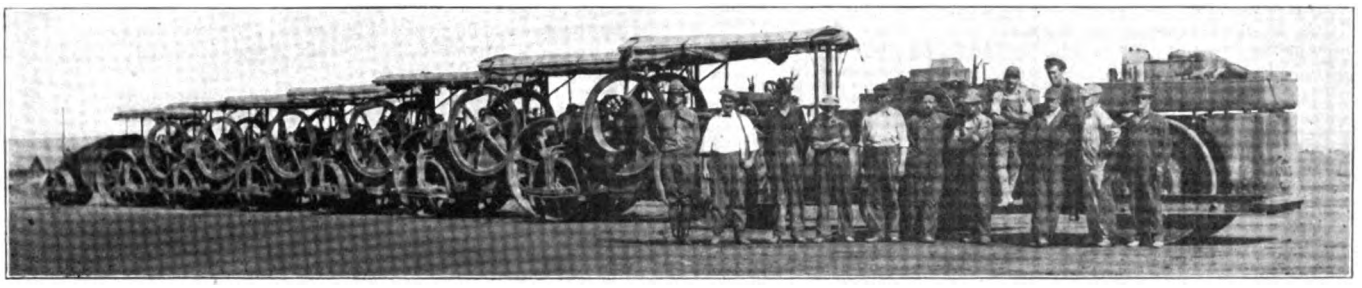
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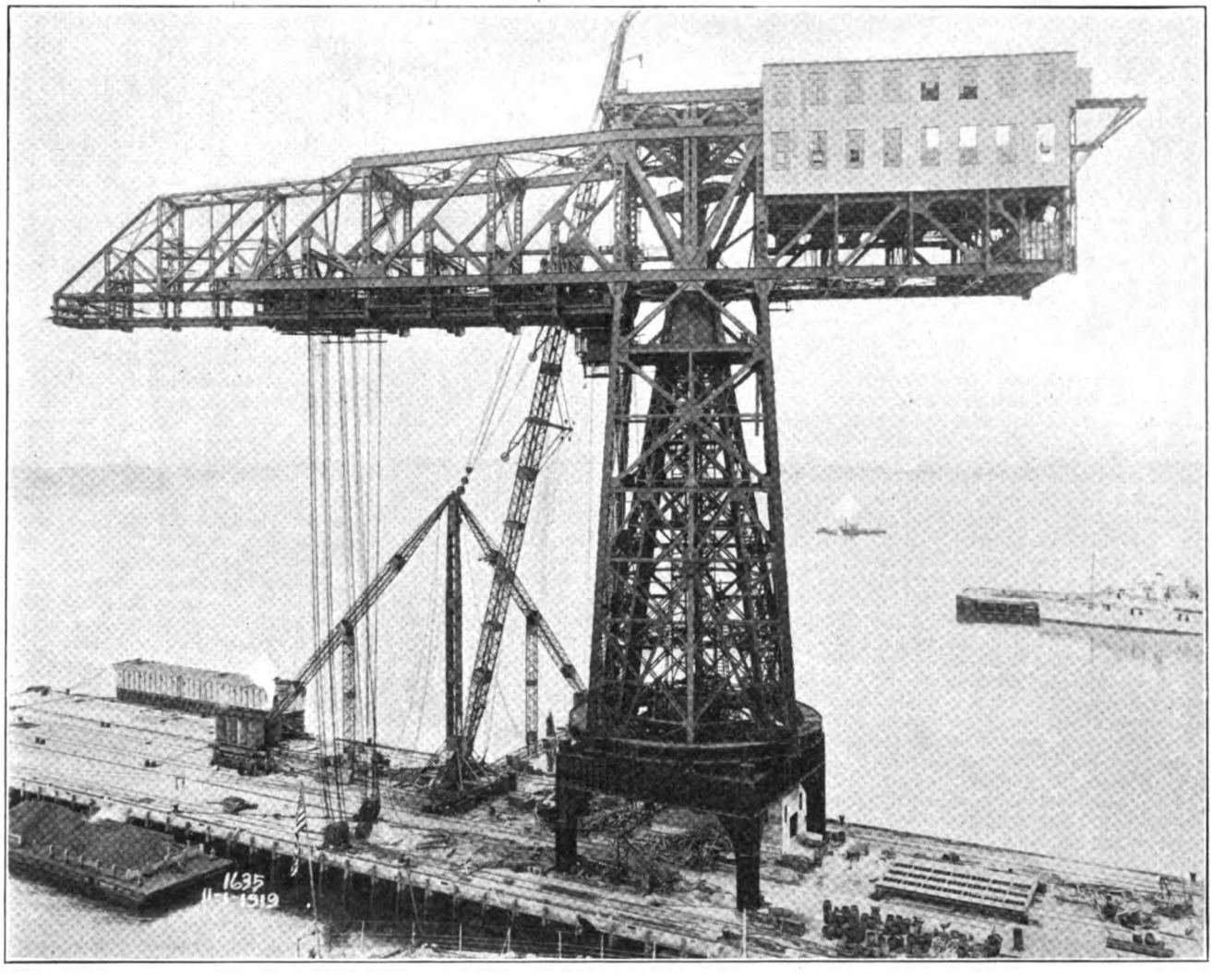
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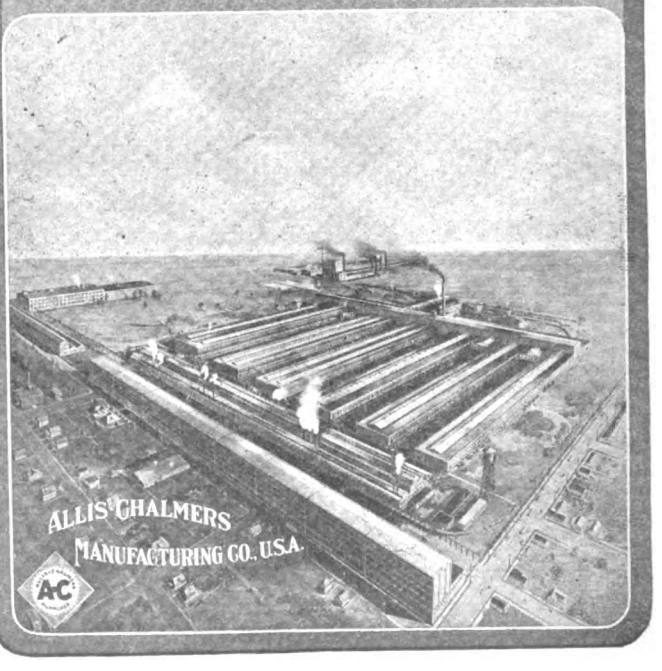
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November 1, 1920.

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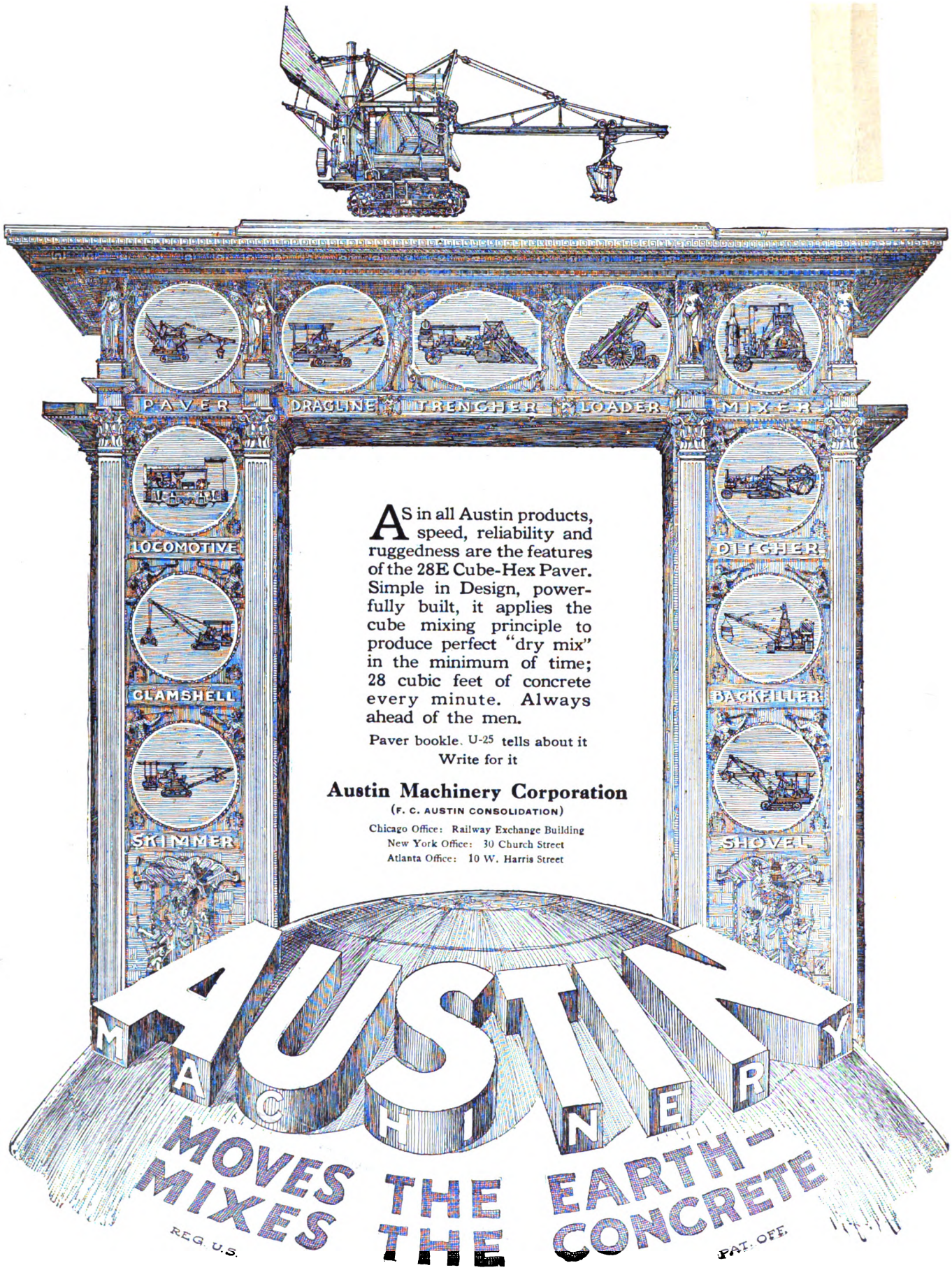
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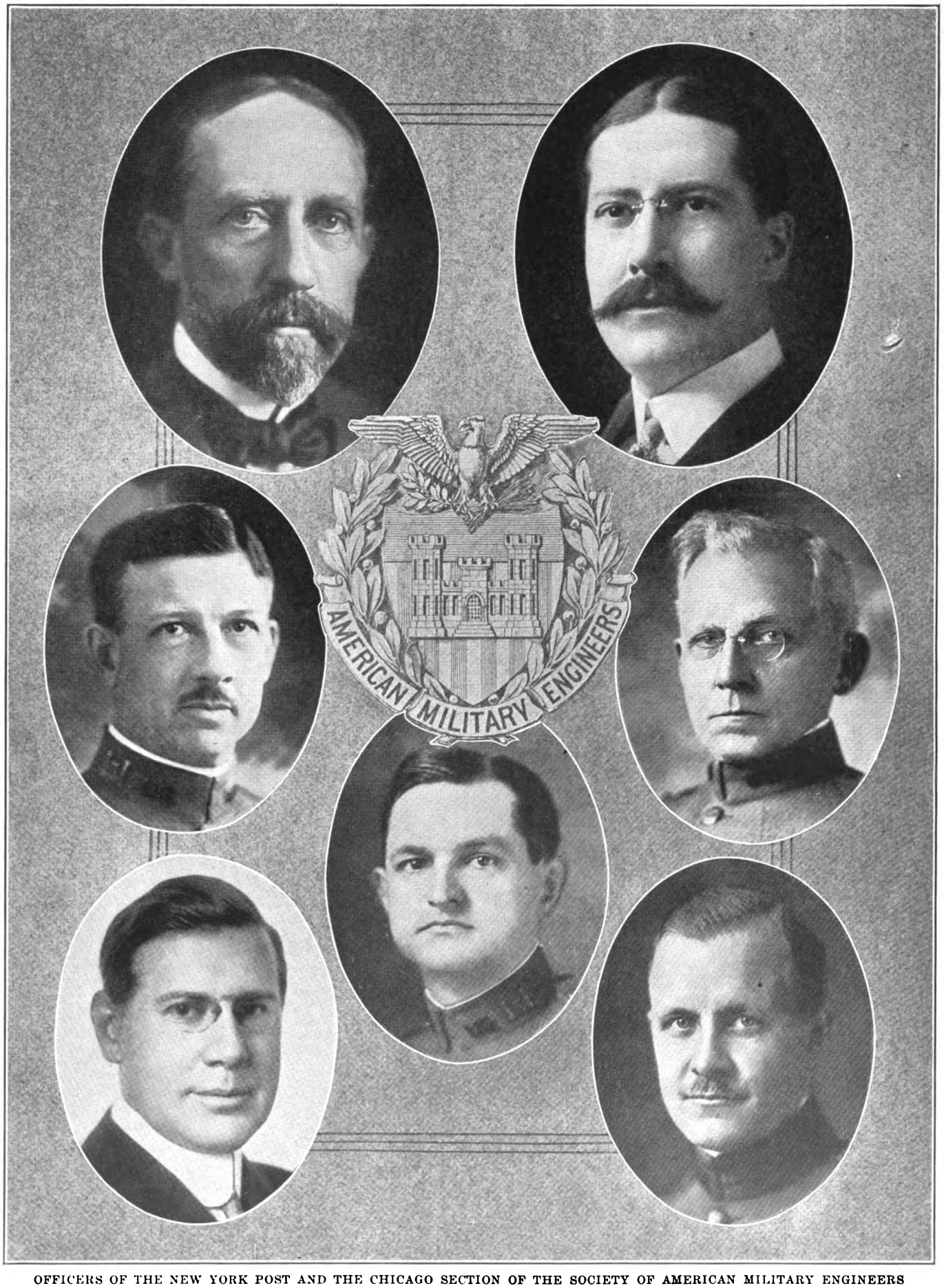
The Great Lakes-St. Lawrence Waterway
Capture of Hill 269 by the First Engineers
The Roads of Alaska

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The Roads of Alaska

Work of the Alaska Road Commission

By

James Gordon Steese

A. M.; F. R. G. S.; Major, Corps of Engineers
President of the Commission

[NOTE—In this entertaining article Major Steese, President of the Alaska Road Commission, gives a vivid picture of the road construction in our far off territory, the difficulties under which the work has been done, and its great influence over the development of a new country where, as always, transportation is the most urgent need.

To the military man the article will be of special interest, for it will be observed that the roads of Alaska are built on strictly military principles—built to meet a situation, which has been well met.

The striking characteristics of the roads of Alaska, as brought out in this article are: first, the adaptation of road building methods to actual conditions; second, the *intensive use* of roads, the few crude roads of Alaska mean more to her economic life than those of any other state; and third, the astonishing economic results from a very small expenditure, an example and inspiration to all builders of roads, not as roads alone, but as vital routes of transport.

In a later issue it is hoped to present another article on Alaska's roads, describing the methods of construction and some of the difficulties that have been met and overcome.—ED.]

THE development of Alaska, as of any other pioneer country, is dependent primarily upon facilities for land transportation. Without trails, roads, and eventually railroads, there can be no progressive economic development. Unlike large areas in the western United States, where wagon, or even automobile travel can pass almost without hindrance, in Alaska wheeled transportation is, in almost every locality, quite impossible until roads have been constructed. That lack of transportation, more than any other agency, is retarding the development of Alaska, is conceded by all who are familiar with Northern affairs. In the interior, the great cost of moving freight by teaming or packing, together with the difficulty and uncertainty of moving it at all, constitutes the main obstacle to the growth and development of the district.

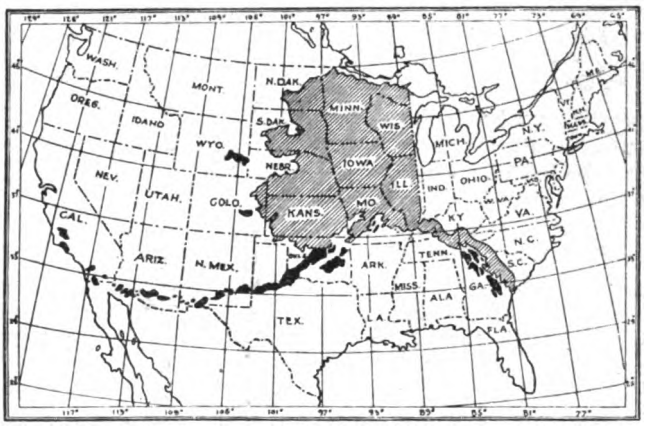


Fig. 1. Alaska super-posed on the United States

The bulk of the road and trail work in Alaska is concentrated under the control of the Alaska Road Commission. In addition to its own funds, it expends the major portion of the appropriations of the Territorial Legislature for roads, bridges, and trails. Considerable money appropriated for the Department of Agriculture, and limited in its application to the Chugach and Tongass Forest Reserves, has been expended by the Alaska Road Commission. By close co-operation between it and the above two agencies, having limited funds for road work, the entire road and trail program is co-ordinated, and all money is spent upon a consistent system without duplication of effort and only slight increase in overhead expense.

Board of Road Commissioners for Alaska

Gen. Wilds P. Richardson, U. S. Army, was the first President of the Alaska Road Commission, and remained at its head from the time of its first organization, in 1905, until December, 1917, when he was called to overseas service in the Great War. As reorganized since the close of the War, the Commission is now composed of three officers of the Corps of Engineers of the United States Army; Maj. James G. Steese, President; Maj. John C. Gotwals, Engineer; Capt. C. S. Ward, Secretary and Disbursing Officer. The Commission reports to the Secretary of War through the Chief of Engineers, U. S. A., under whose direction River and Harbor improvements and other public works are constructed and maintained.

Location and Description

The principal office of the Commission is at Juneau, Alaska. District offices are maintained at Valdez, Seward, Fairbanks and Nome. The work committed to it by law is the location, construction, and maintenance of wagon roads and pack trails from any point on the navigable waters of the Territory of Alaska to and between towns, camps, and settlements therein.

Alaska has an area of 590,880 square miles, which is more than twelve times the size of New York State, or practically one-fifth the size of the entire United States. At its southern point it is 700 miles from the northwest point of the State of Washington by the usually traveled route. Thence the southeastern Alaska Archipelago and a strip of mainland lying west of the Canadian boundary extend northwesterly for about 520 miles to the major portion of the Territory which lies west of the one hundred and forty-first meridian, and has a dimension of approximately 900 miles north and south and 700 miles east and west, with the Alaska Peninsula and Aleutian Islands reaching out from the southwestern portion nearly 2,500 miles toward Siberia. The comparative areas of Alaska and the United States are strikingly shown in Fig. 1 above.

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Though Alaska is often loosely referred to as an Arctic province, nearly three-quarters of its area is within the north temperate zone. The climate of the coastal section is comparable with that of Scotland, but somewhat warmer. That of the inland region is not unlike the climate of Alberta and Manitoba in Canada. The northerly section, bordering the Polar Sea, is the only one in which Arctic conditions prevail. In Fairbanks (latitude 65 degrees, same as northern Norway), in the summer time, the same clothing is worn as in New York City.

There is little level area in Alaska, except the moss-covered tundra of the far north and northwest. The coastal region as far west as Cook Inlet is wet, extremely rugged, and covered with a dense growth of medium-sized timber, especially on the seaward slopes. The valleys of the interior or central portion are fairly well timbered near the streams; elsewhere they are covered with a thick growth of underbrush, and the ground is overlaid with a blanket of moss, beneath which the soil is usually frozen to a great depth. In summer these valleys are transformed by the melting snow and by the surface thawing into morasses and swamps, through which travel on foot or on horseback is a slow and laborious process. As one leaves the stream valleys the timber becomes lighter, and on the hill slopes fairly good ground may be found. In a few places considerable areas of dry gravel bench exist, but nowhere is it possible to use wheeled vehicles over any considerable distance except on the roads.

Resources

The agricultural resources of Alaska are just beginning to be developed. Local markets are now supplied with potatoes and other root crops, garden truck, hay, berries and limited amounts of cereals. Two grist mills have been taken into the interior. When more attention is paid to agriculture, particularly to the selection of suitable varieties, the Tanana, Susitna and Matanuska Valleys and several smaller districts can be made to supply the markets for a greatly increased population. The backward state of agriculture is partly due to the fact that the present population is made up of miners rather than of farmers. The agricultural output will probably never exceed the local demand.

The timber resources of Alaska are very extensive and important, especially in spruce and hemlock in the southeastern section. Extensive stands of birch suitable for furniture are found in the interior. In spite of the inferior quality of Alaska timber, it not only answers for local use but is being exported in increasing quantities; 50,000,000 feet were cut in 1919. About an equal amount ($1,600,000 worth) of lumber, principally Douglas fir, was imported from the United States. Recent water-power legislation favorable to the wood pulp industry has already resulted in several projects. It is estimated that Alaska can furnish indefinitely one-third of the pulp paper used in the United States.

Moose, caribou, reindeer, mountain sheep, goats, ducks, grouse, etc., furnish considerable food supply to the present population in the interior, but there is little revenue from the exportation of game. The reindeer herds have increased sufficiently, however, to justify the expectation of the exportation of an increasing amount of frozen meat. Attention is now being given to the possibility of handling musk-oxen in substantially the same way. Marten, mink, bear, muskrat, lynx, ermine, fox, etc., are exported in gradually decreasing amount but in increasing total value. Seal has produced large amounts, but it has been, until recently, completely protected. Beaver is still protected. Furs produced about $4,175,000 in 1919.

Salmon is the principal product of the fisheries, but large quantities of halibut, cod, herring and whales also are secured. The fisheries have been the principal support of the south and southeast coast population to date. The output was $52,000,000 in 1919.

The following minerals are developed and producing in order of value: Gold, copper, silver, coal, lead, tin, platinum, palladium, marble, gypsum and petroleum. The following have been discovered but are undeveloped owing to the high cost of transportation or to government restriction: Zinc, antimony, quicksilver, peat, asbestos, graphite, as well as low grade deposits of all of the preceding list. Output for 1919 in gold, $9,000,000; in other metals, $10,000,000.

Total Production

	To 1919	1919	Total
Total mineral production	$418,000,000	$19,250,000	$437,250,000
All products, to include 1920	----------	----------	$1,000,000,000
Total commerce for 1919	----------	----------	$120,000,000

Original condition. Prior to the organization of the Alaska Road Commission, there were, in the whole of the Territory, less than a dozen miles of what might be called wagon road, with a few hundred miles of pioneer trail, mostly constructed by expeditions under the War Department. Travel was largely confined to the open waterways in summer and to their frozen courses in winter. When mining machinery and other supplies were to be transported from the coast or river landing, they were in most cases hauled over the snow during the winter, with some preliminary clearing of the route when necessary. Travel across country in summer, generally speaking, was possible only on foot or with pack-horses. It was difficult always, and frequently dangerous on account of the numerous swift and deep streams, fed by the ice-cold waters of mountain glaciers.

Previous projects. In the summers of 1898 and 1899 War Department expeditions under Captains Abercrombie and Glenn and Lieutenant Herron made explorations which collected much valuable data regarding the country and the best natural routes of travel. For the fiscal year, 1901, Congress appropriated $100,000 for roads and trails in Alaska, to be expended under the War Department. Practically all of this was spent on the route leading from Valdez to Eagle, but was sufficient only for the construction of a crude pack trail through sections otherwise impassable and the building of some of the most necessary bridges along the route. In the summer of 1904 an appropriation was made for a survey and estimate for a wagon road along this route. The survey was made under the direction of the Chief of Engineers.

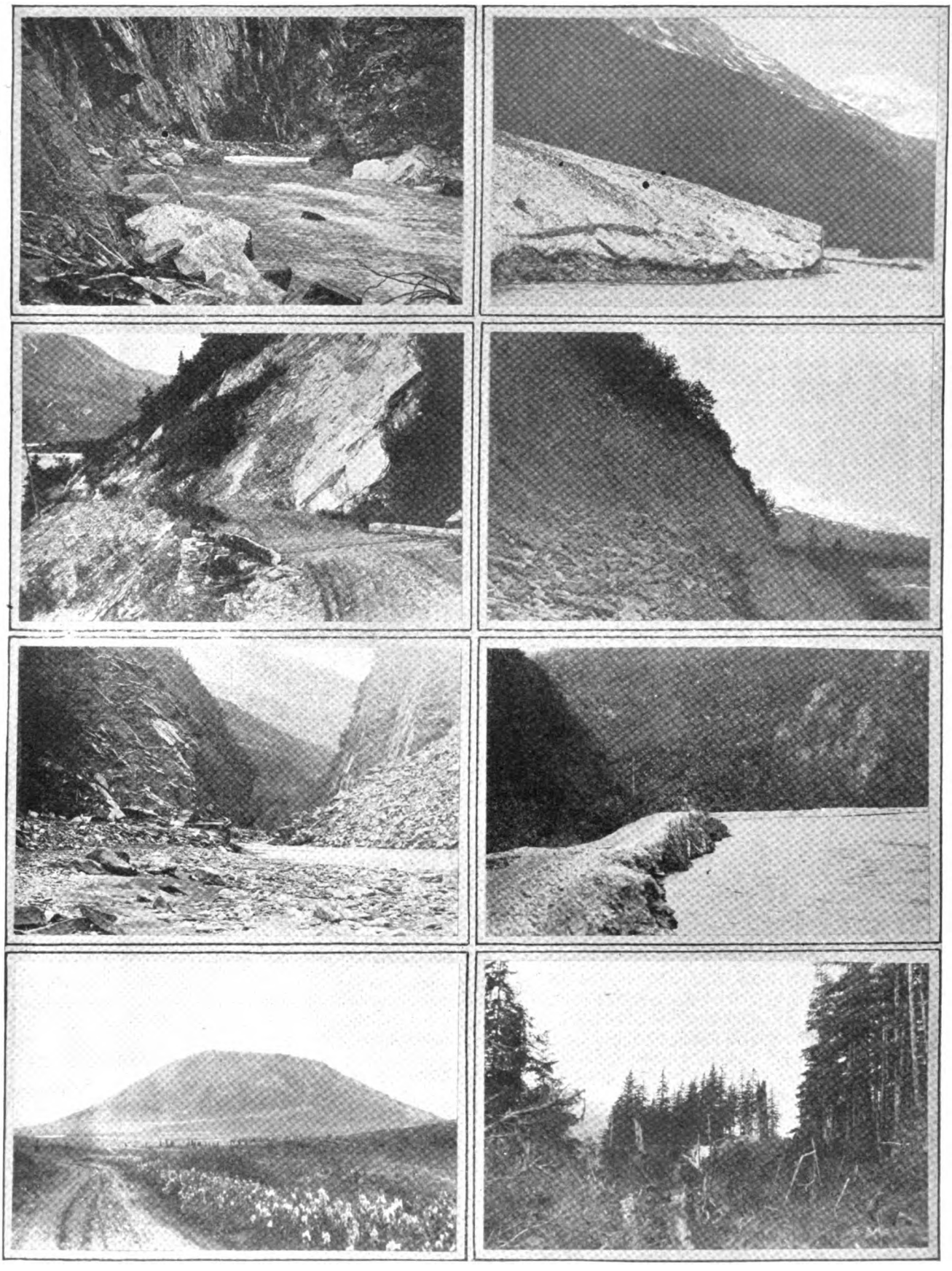
Existing project. The existing project began with an act of Congress approved January 27, 1905. It requires primarily the maintenance and improvement of the present system of roads and trails, aggregating about 4,890 miles in length, and such new construction as funds will permit.

Inland travel and transportation. Inland travel and transportation are by means of:

(*a*) Wagon in summer and bob-sleds in winter where road conditions will permit, usually only on "wagon roads" or "sled roads" constructed by the Commission.

(*b*) Pack trains in summer and double-enders in winter where road conditions will permit, but where other traffic cannot be accommodated. A large number of trails for these classes of traffic have been constructed over short distances to individual mines, usually as tributaries to the Commission roads or trails, or to natural watercourses.

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TYPICAL SCENES ON ALASKAN ROADS

Effect of a flood on a roadbed in Keystone Canyon. New line under construction

Teikhell River Gorge

Roadbed in Keystone Canyon after flood in Lowe River

Pillsbury Dome on the Valdez-Fairbanks Road. Wild flowers grow luxuriantly in summer time

Road buried under snow-slide

Side-hill bench through terminal moraine, Lowe River Effect of summer thaw

Entrance to Keystone Canyon

Heavy clearing near Ketchikan

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(*c*) Summer packing on men's backs or dog teams in winter are used where little or no work has been done, or where extremely unfavorable snow conditions are encountered. The former is employed only in isolated localities in summer. Except where river surfaces are used, some work is always necessary to permit the use of dog teams.

In the classification of the Alaska Road Commission, *wagon roads* are any roads cleared, grubbed, ditched and graded and drained sufficiently to accommodate wagon traffic. *Sled roads* are cleared and graded like wagon roads, but not grubbed. They are drained only sufficiently to prevent their destruction by the summer rains. Their wearing surface is of snow. *Trails* include any construction less than the above suitable for summer or winter pack traffic.

Railroads, completed and projected. Several railroads have been projected and operated for short distances. Exclusive of the Government railroad, the total mileage constructed is 466 miles. The only lines operated in 1920 were the White Pass & Yukon, 110 miles (only 20.5 miles in Alaska, the balance in Yukon Territory), and the Copper River and Northwestern, 195 miles. This does not include private tram lines connected with some mining developments.

The Government railroad. During the investigations which led to the construction of the Government railroad there were three problems to be considered: 1st, to open up the Alaska coal fields; 2d, to develop Alaska by providing a trunk line from the coast to the interior (Yukon River); and, 3d, strategic questions with reference to military control of the Pacific. The Alaska Railroad Commission made a preliminary examination in 1912 and submitted its report to Congress in February, 1913. The Alaska Engineering Commission was authorized in March, 1914, and started operations that same summer. The final route was selected by the President early in 1915 and active construction began that year.

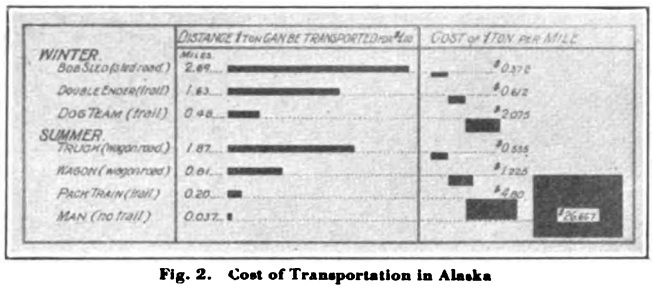


Fig. 2. Cost of Transportation in Alaska

The Government railroad, as at present projected, contemplates a main line of 471 miles from Seward, an open all-the-year port on the south coast, to Fairbanks in the Tanana Valley, the center of distribution for the interior. In December, 1920, this was completed except for about 90 miles, between miles 265 and 358 over the Broad Pass section. In addition the following bridges for the completed section have not been built: Susitna River, mile 264; Nenana River, mile 370; and Tanana River, mile 411. These are all important structures costing in the neighborhood of a million dollars each. It is expected that this 90-mile gap, upon which considerable clearing and grading have already been done, will be completed by December, 1921. The total cost will be between 50 and 60 million dollars.

In addition to the main or trunk line, branches are in operation from Matanuska Junction, mile 151, to Chickaloon in the coal fields, 38 miles, and from Fairbanks to Chatanika in the mining district, 39 miles. Of the total of about 550 miles, all is new construction except 115 miles which were purchased and rehabilitated at considerable expense; 71 miles from Seward to Kern Creek from the old Alaska Northern Railroad Co., and 44 miles around Fairbanks from the Tanana Valley Railroad Co. (narrow gauge).

Last summer passenger trains were operating three times weekly between Seward and Anchorage, mile 114, and twice weekly between Anchorage and Talkeetna, mile 227; also three times weekly between North Nenana, mile 412, and Fairbanks, with a gas car on alternate days. An irregular service as required was maintained in other completed sections and branches, and passengers were also carried on freight trains. The passenger fare was about 6½ cents per mile with an additional 1½ cents per mile for chair car when available.

Tourist routes. Scenic Alaska has already become a tourists' paradise for those travelers who are willing to leave the beaten track of Pullman cars and resort hotels. There are comfortable ocean and river steamers, good hotels in all important towns, and no real hardships or even serious inconveniences need be feared. But Alaska is still a pioneer country, its greatest charm to a great number of travelers, and one must expect to experience delays while waiting for boat connections, to get out of an automobile sometimes to walk around a bad spot in the road, and be satisfied with modest accommodations at the roadhouses in the interior.

From among the great variety of trips that may be made, the following typical ones have been selected. In all cases, the time and cost are figured from Seattle, the usual port of departure.

(*a*) To ports of southeastern Alaska as far as Skagway, circular tour of about 10 days, 2,300 miles, cost $87 to $97. (*b*) Same, extended to Southwestern Alaska as far as Seward and Anchorage, including Government Railroad, one way between Seward and Anchorage, and side trip from Cordova to Childs Glacier on Copper River Railroad, total tour about 21 days, 4,600 miles, cost about $175. Fairbanks from Tanana Valley R. R. Co. (narrow gauge). Seattle direct, tour 60 days, 7,500 miles, cost about $750.

(*c*) Additional three to five days will permit continuing on Copper River Railroad from Cordova to Chitina and then by automobile over Government road to Valdez, catching next boat to westward, or original boat on return trip eastward, 250 miles, $60.

(*d*) Trip (*a*) extended to Lake Atlin and Whitehorse, total tour about 21 days, 2,600 miles, cost $140 to $150.

(*e*) Midnight Sun Special Excursion—to Fort Yukon, inside the Arctic Circle, via Southeastern Alaska, Whitehorse, Dawson and return by same route, about 24 days, 4,200 miles, cost about $295.

(*f*) Trip (*e*) continued down the Yukon and up the Tanana Rivers to Fairbanks, automobile over Government Road up Tanana and Big Delta Rivers, across Alaskan Range, down Gulkana River Valley to Willow Creek, and then to Chitina and Copper River Railroad to Cordova, or on up the Teikhell and Tsaina River Gorges, over the Chugach Range and down the Keystone Canyon to Valdez, in either case then west and return as in (*b*) or (*c*), total tour about 40 days, 5,000 miles, cost about $500.

(*g*) *The complete Alaska tour.* To Southeastern Alaska, Lake Atlin, Dawson, Fairbanks, Valdez, Seward, as in (*f*), and then overland again via Government Railroad and road to Nenana and Fairbanks, down the Tanana and Yukon Rivers to St. Michael and Nome, and ocean steamer to Seattle direct, total tour about 60 days, 7,500 miles, cost about $750.

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Costs of transportation. Fig. 2 indicates graphically the costs of transportation by the usual modes of transport in Alaska. Railroad transportation cannot yet be regarded as a usual form for Alaska, and steamship rates are entirely arbitrary, depending upon competition. They, like the existing railroad rates, have been fixed by two factors only: 1st, the cost of hauling on some competing wagon road, sled road, or trail, where such competition exists (or, in the case of steamships, sometimes by competing steamer line); and, 2d, by the highest rate the freight can stand and be shipped at all.

The diagram shows the actual costs at the rates for teams, labor, food, forage, etc., prevailing in the great interior regions of Alaska. They are based also on the costs of hauling large quantities. On the south coast the comparative values are the same, but actual values are about ⅓ less because of lower costs of above controlling elements.

During the opening of new diggings in the Chisana region a few years ago, beans, coffee, sugar, hay, candles, bacon, grain etc., was sold $1.50 per pound. The freight charges were almost a dollar a pound, so that the original cost of the article was of relatively little importance. And even at that, the supply could not keep pace with the demand. Last summer, the freight charges for transporting supplies from Dawson in the Klondike to some mines about one hundred miles away in the American 40-Mile District were greater than the original cost of the supplies plus the freight from U. S. to the Klondike. (Dawson is 1,700 miles from Seattle.)

The following table shows the expenditures under the Alaska Road Commission and the mileage of roads and trails constructed by it up to June 30, 1920:

Fiscal year	Funds appro. U. S. Treas	Alaska Fund	Total	Road Wagon	Road Sled	Trail
1905-6	$ ----------	$ 170,379.47	$ 170,379.47	----	---	133
1907	150,000.00	196,745.70	346,745.70	76	132	----
1908	250,000.00	111,972.32	361,972.32	90	252	119
1909	250,000.00	113,617.65	363,617.65	286	12	13
1910	350,000.00	10,396.79	360,396.79	268	25	206
1911	100,000.00	166,777.95	266,777.95	39	86	201
1912	150,000.00	167,303.72	317,303.72	56	74	710
1913	125,000.00	228,118.29	353,118.29	47	36	794†
1914	155,000.00	168,862.31	323,862.31	5	---	34
1915	125,000.00	159,755.12	284,755.12	35	---	40
1916	165,000.00	135,720.62	300,720.62	18	6	323
1917	500,000.00	76,747.90	576,747.90	60	---	81
1918	500,000.00§	97,020.18	597,020.18	26	13	155
1919	100,000.00	199,024.26	299,024.26	25	---	147
1920	100,000.00	157,416.69	257,416.69	----	---	267
Total	$3,020,000.00	$2,159,858.97	$5,179,858.97	1031	636	3223
1921‡	350,000.00	160,000.00	590,000.00*	---	---	----

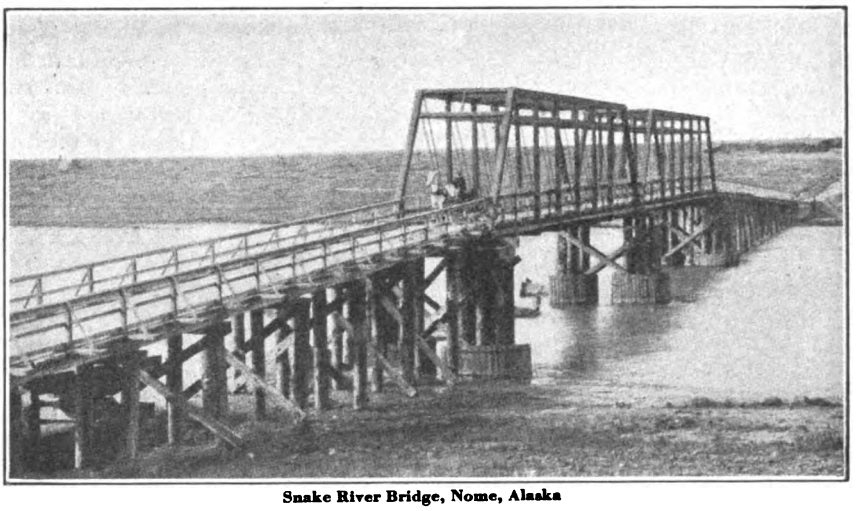
§ Available for two years.

† This figure includes 257 miles heretofore staked temporarily, but not classified as trails. The actual new construction for the year would be 541 miles.

‡ Appropriated for fiscal year ending June 30, 1921.

* Includes $80,000.00 from the Territory.

In addition to its own funds ($5,179,858.97 in above table), the Commission had supervised up to June 30, 1920, the expenditure of the following co-operative funds: (*a*) from the Department of Agriculture, to be expended only in the Chugach and Tongass Forest Reserves, $249,500.00; and (*b*) from the Territory of Alaska, $101,000.00. Grand total, $5,530,358.97. Expenditures have been distributed as follows, including maintenance:



Snake River Bridge, Nome, Alaska

For wagon roads	$4,433,300.00
For sled roads	286,200.00
For trails	402,875.00
For examinations, reconnaissance, etc., not followed by construction	57,483.97

The annual cost of maintenance of routes in Alaska varies considerably with the locality, the range of climate being greater than that of the United States and the cost of labor also varying greatly. The experience of the Road Commission indicates that for all Alaska proper, average construction and maintenance costs, including bridges, are about as indicated in the following table:

Classification	Cost of Construction Per Mile	Annual Maintenance	Total Cost Per Mile 1905-1920
Wagon roads	$2500*	$250*	$4300
Sled roads	300	25	450
Trails	100	10	125

*Note. For earth roads only. Higher classes of construction cost more but have proportionately much less maintenance charges. As the mileage increases, the total maintenance charges increase, so that smaller proportionate amounts are available each year for new construction.

During the sixteen years of the Commission's existence slightly over one thousand miles of road (besides much greater lengths of sled roads and trails) have been constructed and maintained at a cost of about five and one-half million dollars. Two policies of the Commission, through all this period, have shown the highest wisdom; first, that of building successively trail, sled road and wagon road, as the traffic along a communication line justified; second, building largely with local labor. These two policies assured sound development, resulting in roads carrying traffic as soon as completed. To import labor to construct roads would make possible the building of roads away from centers of present or even prospective population and serving, when completed, only as monuments to the builders. The soundness of the Commission's policy is further emphasized by a survey of roads now in use. Under no possible conception would the abandonment of any part of the present road and trail system be justified.

A careful traffic census was begun by the Commission in 1911. Comparing the expenditures for freight on each route at the present rate with the cost of transporting the same amount of freight at the rates prevailing before the road was constructed, a figure is obtained which represents the economic saving to the community served by the construction of the particular route in point.

Combining the saving for all the routes built by the Com-

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mission, the following table for 1911, 1912 and 1913, has been compiled:

Year	Expenditures for the year	Total expenditures for roads to end of year	Economic saving to shippers
1911	$266,777.95	$1,908,460.70	$1,981,677.00
1912	317,303.72	2,225,764.42	2,141,688.00
1913	353,118.29	2,578,882.71	2,144,667.00
1911-1913	937,199.96	2,578,882.71	6,268,032.00

From this table it is seen that the saving in these three years alone was almost three times the total expenditure for roads to the end of 1913. For 1920, the saving will be even more notable.

Operation and results during fiscal year 1920. The work of the last fiscal year has been largely maintenance of the existing mileage of wagon roads, sled roads and trails. Substantial progress was made in this respect, with the result that two-thirds of the length of the Fairbanks-Chitina road has been given a gravel surface. During the early summer of 1920 an automobile drove over this 320-mile road in twenty-two hours actual running time. In August, 1920, an automobile made the trip over the Fairbanks-Valdez road in 25 hours actual running time for the first 352 miles. The remaining 18 miles were made in two hours, including three miles on foot around the relocation through Keystone Canyon.

The winter of 1919-1920 was followed by a very late spring, and although a mantle of heavy snow fell in February and March and was late in disappearing, the spring break-up occurred with but little damage. The Commission took advantage of this favorable condition to work upon several new projects. Labor conditions have been slightly improved although the scale of wages is still rising.

Condition at end of year. The total mileage of roads and trails constructed by the Commission is 4,890 miles, consisting of 1,031 miles of wagon road, 636 miles of sled road, and 3,223 miles of trails. The main element in the road system, the Valdez-Fairbanks Road, has been kept open from Chitina, on the Copper River Railroad, to Fairbanks. Extreme high water from Lowe River damaged the Valdez end of this road between mile 8 and mile 17 to such an extent during July, 1919, that the funds available would not permit the reopening of this road. However, this work was taken up vigorously during the present season and there is every prospect of rehabilitating this road in time for use next season.

The progressive improvement of the remainder of the Fairbanks Road has continued through the fiscal year. The remaining mileage of roads and trails was carried through the year with ordinary repairs. A small mileage of new construction was carried out partly under co-operative agreements. 4,600 miles of the route form a connected system reaching from the open coast ports to the Arctic Circle and to the Kotzebue Sound country above Behring Straits, affording communication by road or trail with practically every settlement in Alaska, except those in the southeastern part and isolated coast towns.

Local co-operation. The funds disbursed are obtained from an appropriation "Construction and maintenance of military and post roads, bridges and trails, Alaska," and from receipts from the "Alaska Fund" by act of Congress approved January 17, 1905, and amended by act approved May 14, 1906. More than 40 per cent of the total cost of the road and trail system has been paid from the Alaska fund. Beside the above sources of funds, co-operation was had with both the Department of Agriculture and the Alaska Territorial Road Board wherever possible.

The most extensive co-operative work was that performed on roads in southeastern Alaska by agreements with the Territorial Road Board and the Department of Agriculture. The methods of the Commission, worked out through long years of successful experience and applied to as great extent as was possible under the agreements drawn up, greatly aided the Department of Agriculture and the Territorial Road Board in the rapid prosecution of this work.

Effect of Improvement. The roads and trails constructed by the Commission have not only opened up to development nearly all sections of the Territory, but have effected large savings in freight charges. Data collected by the Commission in 1913 indicated that the direct saving in cost of transportation of freight in that year, due to the construction of roads by the Commission, was $2,144,667. It is doubtful, however, if anything like that amount of freight would have been transported without the roads, and the indirect loss which would be occasioned by the restriction on output and development if the roads did not exist, can not easily be estimated, but is certainly very great.

Mail was handled by automobile on 160 miles of the Richardson Road between Chitina and Fairbanks during the entire winter. The use of automobiles has not been encouraged by the Commission, but their number is increasing rapidly. Approximately 90 per cent of the traffic on the main wagon roads is handled by motor, which has greatly increased the cost of road maintenance.

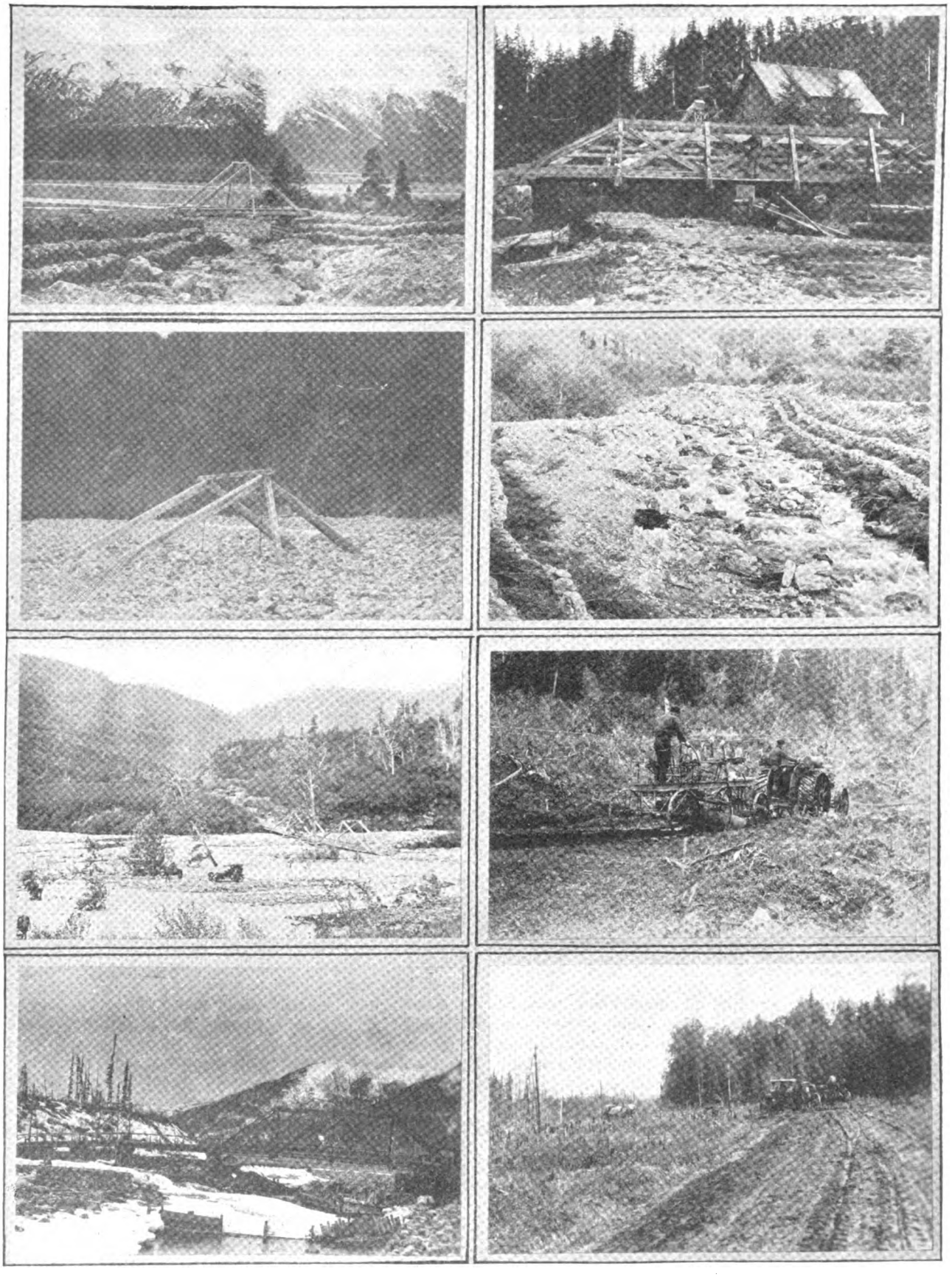
Alaska's future. The close of the fiscal year, June 30, 1920, marked the end of the war period in the work of the Alaska Road Commission. The road system has been kept open during the period of the war and some slight improvements made. The economic situation now met in Alaska and the plan of the Commission for future road construction will now be reviewed.

Alaska has suffered economically from three main causes by reason of war conditions: First, increased prices and wages made the mining of gold, the chief industry, unprofitable except from the richest claims; second, high wages in the United States attracted many prospectors and settlers from Alaska; third, and most important, a greater percent than from any state, of the young men of Alaska, variously estimated at from three to five thousand men, entered the service of the United States. Taken together, the result has created a shortage of the vigorous, virile miner and prospector upon whom finally the prosperity of Alaska rests. Already signs are seen that the tide is turning and that a few years will see the return to Alaska not only of these men but also of many ex-service men to whom the development of Alaska offers a promising field for endeavor.

Alaska's commercial development and its future embrace both hard facts and fascinating dreams. The former must be held to, and the sound common sense of the point of view presented in the report of the Alaska Road Commission for 1917 is worthy of reiteration.

As stated in a former report, "The truth about Alaska is good enough." Any information disseminated on the subject, by exploitation through newspaper articles and other publicity agencies, which tends to give a wrong impression of the true conditions can only result in injury to the Territory in the end. Alaska is for the present, aside from the fisheries, essentially a mining country, and with encouragement and support to the miner and prospector and to capital as well, which is sorely needed to open up its resources, and with reasonable aid in the construction of wagon roads and trails, the Territory will develop and grow in population and in home building along normal lines; but slowly and with much labor. The truth must be faced in the end, in spite of enthusiastic reports and glowing predictions and books of romance written on the subject. These latter are frequently interesting and doubtless well intentioned, but serve rather to entertain the tourist and sightseer than to aid the investor and home seeker. The natural resources as they are developed can

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ALASKAN ROADS ARE BUILT ON MILITARY PRINCIPLES TO MEET IMMEDIATE AND URGENT NEEDS

A typical bridge over a typical glacial stream. Big Delta River in background

When a glacial stream changed its course. The stream later moved back under the bridge. Bear Creek

Bear Creek Bridge still in service. Originally about 13 feet above the water

McCarthy Creek Bridge built of materials salvaged from Nizina River Bridge

A sturdy type of short span combination highway bridge. Juneau-Eagle River road

Controlling the bed of a small glacial stream---brush weighted down by stone in wire-net bags

Grading with tractor

Moving camp, Tanana Valley

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be levied upon to assist in bearing the expense of road building and eventually to carry it altogether.

Alaska's present important industries are mining, fisheries and fur. High hopes exist for paper, oil and coal production. All may materialize. Important reserves of pulpwood exist, and with the rise in price of print paper in the United States, developments are possible. Oil, under the new leasing law, is being sought both on the Alaskan Peninsula and in the Controller Bay District. The oil is of an unusually high quality but no large producing wells have been found thus far. As to coal, while both the Matanuska and Behring River coals are of high quality, until such time as a shortage of native coal exists in our Pacific Coast states no export market for this coal can be found. The presence of this local coal, however, greatly aids local Alaskan consumers. Important advances are being made in agriculture, and again the production of limited quantities of garden truck, root crops and grain, for local consumption, is the evident future of agricultural effort.

Altogether, the present and future industries of Alaska offer opportunity for a livelihood for a substantial population. It must be remembered that about one billion dollars in wealth have been extracted from this country and little more than one-tenth of this value left in Alaska is in the form of federal or private improvement. To provide for this future, to facilitate the ready exchange of goods between Alaska and the United States, to provide channels through which goods may be exchanged within Alaska, reduces in the end to a problem of securing adequate transportation facilities.

Commercial statistics

Total commerce of Alaska for the fiscal year ended June 30, 1919.	
Shipments of:	
Domestic merchandise from the United States to Alaska	$ 35,544,034
Domestic merchandise from Alaska to the United States	71,594,966
Foreign merchandise from Alaska to the United States	473,193
Domestic gold and silver from the United States to Alaska	98,523
Domestic gold and silver from Alaska to the United States	9,224,759
Foreign gold and silver from Alaska to the United States	83,360
Total	$117,018,835
Shipments of:	
Merchandise from foreign ports to Alaska	$ 1,334,403
Merchandise from Alaska to foreign ports	1,074,367
Total	$ 2,408,770
Grand total	$119,427,605
Total mineral production up to include 1919	437,250,000
All products to include 1920	1,000,000,000

The number of men entering the armed forces from this territory almost eliminated the possibility of new commercial development. The rise in general prices also has greatly handicapped the gold mining industry. However, there is every evidence of rapid recovery in all commercial lines, and Alaska, with great potential possibilities, faces the future with confidence.

Work upon the government railroad from Seward to Fairbanks is gradually opening up a new area of interior Alaska. Numerous requests have been made from this area for road construction contiguous to the railroad. Careful consideration has been given to these requests and work will be done wherever funds are available and the project warrants.

Transportation system. First in importance in Alaska's transportation facilities are the splendid existing coastal and interior waterways. Essentially an overseas country from the United States, the open waters of the Gulf of Alaska and southeastern Alaska are virtually Alaska's richest possession. After these come the easily navigable (although open but five months of the year) rivers of the Yukon, Tanana, Kuskokwim, Kantishna, Iditarod and Koyukuk. The water-borne commerce upon these rivers and ocean waters are, and always will be, the chief life giving element in Alaska's commerce.

Next to the water-borne commerce in importance comes the land transportation connecting up base ports and waterways. Two means exist, of course, railroads and wagon roads. As to railroads, with the completion of the Government Railroad from Seward to Fairbanks, about $100,000,000 will have been invested from public and private funds in railroads. For both railroads and wagon roads the function must be, in the present state of Alaska's development, to cross divides and connect up lines of water communication. For railroad development, the expenditures already committed are such as to take care of the development of Alaska for a long time.

As to wagon roads, the nature of the commerce existing and expected in Alaska is such as to make them especially necessary. The Government Railroad, now nearing completion, will be of little value until the commerce of the country passed through is brought to the railroad upon tributary highways. But in providing such roads, the immediate construction of numerous feeder roads constructed to fit only the topographical features of the Territory, even if the fabulous cost could be met, would give but meager return. These feeder roads must be built with a careful consideration of both the topography of the country passed through and the economic return to be expected. Finally, before the tonnage which the Government Railroad can carry materializes, it will be found that an amount equal to that spent upon its construction must be invested in tributary wagon roads. To enable a substantial development of this generous federal project to take place, to aid in the balanced development of all parts of Alaska, a modest but thoroughly considered program of wagon road construction has been presented.

Terminal and harbor facilities. All ports in southeastern and southwestern Alaska, as far west as Cooks Inlet, are open to shipping all the year round. All Alaskan ports, except Nome and St. Michael, are well equipped with docks at which ships may lie in almost all weather. Anchorage is frozen up for about five months in the year, and Nome and the Yukon and other river ports for about seven months. All cargo must be handled by ship's tackle. Skagway, Cordova, Seward, Anchorage, Nenana and Fairbanks have rail connections from the docks to the interior.

Alaska compared with other states. From the best statistics available it would appear that Arizona, the poorest State in the United States in wagon roads, has about 35 times as many miles of road in proportion to its area, as has Alaska. Connecticut, the State with the best showing, has about 1,800 times the proportionate mileage of Alaska, and the entire United States has over 500 times as great a proportion. Of eighteen foreign countries, Australia, the poorest, has 50 times as much, and England and Wales, the greatest, have 185 times as much.

In a sparsely settled country, since individuals must travel relatively greater distances in the processes of commercial communication, the necessary mileage per capita must be very great. On this basis, taking the States west of the Mississippi River, Alaska has less roads per capita than any. Nevada, the State whose conditions of topography, population, age and industries are most similar to Alaska, has seven times the mileage of roads per capita.

In the matter of expenditures, Nevada is the only State

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spending as small an amount per square mile for roads as Alaska, while New Mexico, with the next smallest expenditure, spends nearly six times as much, or allows for about nine times as much road work per square mile, if we consider the cost of labor, etc. It should also be noted, that over large areas of Nevada, New Mexico, etc., wagon or even automobile travel can pass almost without hindrance, while in Alaska wheeled transportation is in almost every locality quite impossible until roads have been constructed.

Future road development. The Alaska Road Commission has, up to the present time, undertaken work on fifty different routes. About 4,600 miles of its 4,890 miles of roads and trails form a connected system reaching from the open navigation of the south coast to all inhabited sections of the Territory. The maintenance of these routes requires an annual expenditure of about $200,000.

In 1913 the Commission drew up a comprehensive program of road construction and development to cover the succeeding ten years. This project was based upon (*a*) the maintenance and improvement of the existing projects, (*b*) the completion of projects already undertaken, (*c*) the completion of projects already approved but not then undertaken, and (*d*) the completion of projects likely to arise with the development during the ten-year period. This program called for a total expenditure during the ten years, 1914-23, of $7,250,000 and would have resulted in providing Alaska with a complete road system such as its immediate needs seemed to justify, and probably sufficient to meet all reasonable demands until the Territory became sufficiently developed to take over all internal public works as a part of its own government.

This program was also based upon the assumption that governmental restrictions and red tape would be removed and the Territory allowed to develop normally as in the case of our other great western territories. The enormous expenditures contemplated that same year for a Government railroad seemed to augur a more liberal attitude on the part of the Government. Seven years of that period have now passed by and three factors have arisen to derange those calculations: First, the Great War; second, the lack, until this year, of any indication of a change of attitude on the part of the Government looking to a rational policy of Alaskan development; and, third, an average expenditure per year of only $375,000, instead of $725,000 for the past seven years for road and trail work. For the two years of the war the total appropriations were only $370,000, or $185,000 per year, only one-fourth the average required.

As to the importance of road and trail work, the following is quoted from the report of the Alaska Railroad Commission:

With one or two notable exceptions, these roads are not comparable with the best highway construction in the States, but for the money expended in their creation and maintenance they have shown a remarkable return, and have assisted greatly in development. The

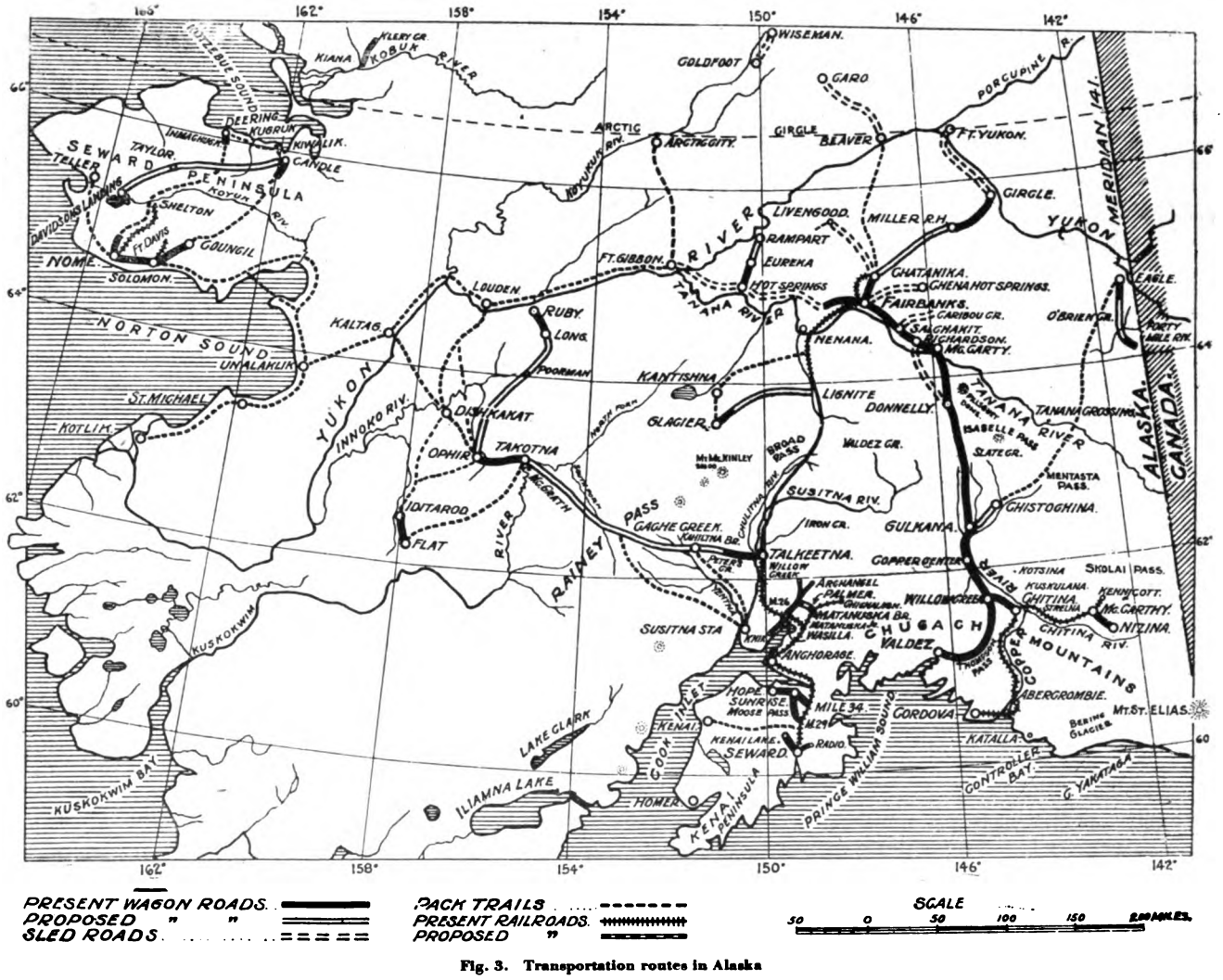


Fig. 3. Transportation routes in Alaska

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immediate commercial value of the expenditures of the Board can be shown in the reduction in summer and winter freight costs wherever they have been built. The Alaska Railroad Commission desires to record itself as greatly impressed with the work accomplished by the Board of Road Commissioners, and to express its belief that, *in guiding lines of future railroad construction* in Alaska, work along the lines developed by that Board should be continued and enlarged upon.

The new Commission, feeling that the War is sufficiently past to permit of the United States taking up again its work of interior development, has drawn up a new program involving an expenditure of a million dollars a year for a period of ten years. This program is based upon the same general considerations as the 1913 program, but takes into account also the following new factors: 1st, the damages and deterioration of the existing project during the lean war years; 2d, the increased cost of labor, materials and supplies; 3d, the provision of a system of feeders for the Government Railroad; and, 4th, the necessity of providing a more substantial type of construction to withstand motor traffic.

With the knowledge based on sixteen years' experience in Alaskan road construction, this Commission, with the proud record of achievement through all its existence as a guarantee for the future, sets forth a ten-year program of road construction that will carry forward substantially the reviving industries of this Territory and will provide the Government Railroad with a generous contribution of traffic.

Initial considerations. To prepare any program of road construction, both the topography of the region traversed and the economic return expected must be studied. In topography alone, the glaciers, glacial streams, swamps, elevated snow covered mountain ridges, frozen soil and dense vegetation offer obstacles of remarkable obstinacy. As to economic returns, the traffic existing and prospective must be estimated. The building of roads through known mineralized, but undeveloped areas, to reach developed areas is sought.

To be considered at the same time is the location of projected roads in relation to other lines of traffic; that is, waterways and railroads. In the present state of Alaska's development, it is unwarranted to parallel such lines of traffic with wagon roads. It is especially aimed to build as feeders and in a few cases cross divides and link together existing lines of traffic. Roads planned upon such a conception will give the greatest return with the minimum of cost.

Of almost equal importance to the above considerations is the adjustment of the program to the funds that are requested. This modest program can be constructed within the estimated cost and time. It would require only a draftsman's service to cover the map of Alaska with a network of roads that could not be constructed with any reasonable appropriation within less than fifty years. This estimate is, therefore, made with a view to being a practicable program with the funds and time that may be reasonably expected. This program of road development covers that desired during the next ten years, 1921 to 1930, inclusive. The new road mileage which is projected totals seven hundred miles. These roads are termed 1921 roads. This will call for a rate of construction of seventy miles per year. The cost of these roads, to construct and maintain through this period, will average ten thousand dollars per mile. This cost is an average for all districts. The roads selected for construction during this period are along well defined lines of travel which have received previous development as trails and sled roads and whose worth is unquestioned.

In the work proposed for the next ten years, three classes of road building operations will be carried on. First, the new construction planned as arterial or feeder highways and totalling seven hundred miles for the period, will be carried out. These roads will, in the main, follow old lines of development. These are described in detail below. Second, roads, termed development roads, the value or location of which is not yet fixed, will be constructed from time to time with a limited apportionment of funds. A number of roads of this type are described hereafter. Construction of roads of this type provide the necessary flexibility to meet new conditions. At a later time these development roads may become arterial roads. Third, the present road and trail system must be kept up. This requires an expenditure for maintenance which is estimated, from past expenditures of the Commission, to be $200,000 per year.

Physical features of Alaska. In presenting the program in detail, it is necessary to outline briefly the physical features of Alaska and the lines of communication already established. The portion of the territory now under development naturally divides into the following districts:

1. *Southeastern Alaska*, embracing the islands and coastal mainland east of the 141st meridian. This district is served almost entirely by water-borne commerce and no new construction is planned under this program. The necessary short tributary roads to settlements not already constructed can be built as development roads.
2. *Copper River Valley*, embracing Cordova, Valdez and Kennecott and served by the Copper River Railroad, extending to the summit of the Fairbanks Road.
3. *Susitna Valley*, embracing the country traversed by the Government Railroad in the Susitna Valley, including Seward, Anchorage and Matanuska. The Alaskan Peninsula and Kodiak Island are closely related in development to this district, and are included therein.
4. *The Kuskokwim*, embracing the lower Yukon Valley and the valley of the Kuskowkim west of the Alaska Range. This district is very meagerly provided with transportation facilities and the most important project of this program aims at its relief.
5. *Yukon District*, including Fairbanks and the Yukon and Tanana Valleys. This region is of high importance for development as here must originate the most important tonnage for the Government Railroad.
6. *Nome District*, Seward Peninsula and Kotzebue Sound Country.

Program proposed. The "1921 Roads" included in the proposed program and a number of possible "Development Roads" will now be described in detail.

1921 Roads

Project "A." Susitna and Kuskokwim Districts. Talkeetna, Takotna, Ophir and Ruby Roads. Total mileage, 280.

These roads reach from Ruby, on the Yukon, through the most promising mining district of the Kuskokwim, through Mt. McKinley Park, to Talkeetna on the Government Railroad. Sixty miles of this route are already under construction. The most promising mineralized region of the Upper Yentna Valley is reached.

Project "B." Nome District. Davidsons Landing, Kugarok and Candle Roads. Total mileage, 135.

This road runs from tidewater through the Kugarok mining district to Kotzebue Sound at Candle. It is of the highest importance for the further development of the Seward Peninsula.

Project "C." Yukon District. Roosevelt, Glacier and Lignite Roads. Total mileage, 75.

These roads connect the important Kantishna Mining District with the head of navigation on the Kantishna River and with the Government Railroad near Lignite.

Project "D." Yukon District. Eagle and 40-mile Boundary Roads. Total mileage, 50.

This is an extension of an existing road and improvement of a sled road to the 40-Mile mining district from Eagle. Connection will be made at the Alaska-Yukon Territory boundary with the Mile Creek Road to Dawson.

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Project "E." Yukon District. Chatanika and Miller House Roads. Total mileage, 80.

These roads connect two old Road Commission projects, enabling traffic to pass from Circle on the Yukon to the Fairbanks District and serving as a very important feeder to the Government Railroad.

Project "F." Yukon District. Rampart and Hot Springs Roads. Total mileage, 21.

These roads connect two old projects, connecting Rampart, on the Yukon, with Hot Springs, on the Tanana.

Project "G." Copper River District. Gulkana and Chistochna Roads. Total mileage, 40.

These roads are important tributaries to the Fairbanks Trail, and are a part of a future main artery road from the Copper River Valley to the Yukon at Eagle, making accessible the promising Slate Creek mining district.

Development roads

Under Development Roads the most important possible projects are noted below:

Alaskan Peninsula—

Wide Bay—Oil Fields; 25 miles.

Reaches from tidewater at Wide Bay to the old fields now being prospected near Cold Bay.

Iliamna Lake—Lake Clark; 20 miles.

Serves as a portage from Iliamna Lake to Lake Clark.

Kenai Peninsula—

Kenai—Homer; 70 miles.

This road, with the completion of the Kenai Mile 29, will give a system of roads to the Kenai Peninsula reaching every district and making connection with the Government Railroad at Mile 29.

Susitna Valley—

Talkeetna—Iron Creek; 45 miles.

This road will connect an important mining district in the Susitna Valley with the Government Railroad.

Government Railroad—Valdez Creek; 50 miles.

This road makes accessible to the railroad the important Valdez Creek Mining District. This district is now reached only by a seventy-mile trail from Meiers on the Richardson Road.

Copper River Valley—

Abercrombie (Copper River R. R.)—Katalla; 45 miles.

Makes accessible the Katalla oil field to the Port of Cordova, and especially necessary in case a railroad extension is not made.

Katalla—Cape Yakataga; 80 miles.

Reaches a new oil field now being prospected and otherwise inaccessible for development.

Nizina River to Nizina; 10 miles.

This will include the Nizina River Bridge and make accessible the upper Chitina Valley to the Copper River Railroad.

Strelna to Kuskulana River; 16 miles.

This comprehends the improvement of existing roads built by mining operators and makes accessible an important mining district in the upper Kuskulana Valley.

Chistochina—Chisana; 45 miles.

This makes accessible the upper Chistochina Valley workings to the road projected on this year's program from Gulkana to Chistochina.

Yukon Valley—

McCarty to 40-Mile; 135 miles.

This road would complete a through road from Dawson and Eagle to Fairbanks and would pass through a very promising and undeveloped agricultural region in the upper Tanana Valley.

Circle to Fort Yukon; 80 miles.

Makes accessible both winter and summer the important trading post of Fort Yukon. This settlement of fifty whites and five hundred natives is now reached by water in summer and with difficulty over the ice on the Yukon in winter.

40-Mile to Tanana Crossing; 60 miles.

An extension of the Eagle—40-Mile Road passing through an important mining district and reaching the valley of the Tanana.

Chatanika—Livengood; 56 miles.

This road makes accessible the important mineral developments around Livengood.

Beaver—Caro; 75 miles.

Provides a line of traffic between the Chandalar mining district and the Yukon.

Fort Gibbon—Arctic City; 100 miles.

Connects the valley of the Koyukuk with the Yukon Valley.

Eagle—Seventy Mile; 40 miles.

Connects the Seventy Mile mining district with Eagle.

Nome District—

Nome—Kugarok; 60 miles.

Connects the Nome District with the Kugarok mining district and with the Davidsons Landing—Candle Road projected under this year's program.

Southeastern Alaska—

Skagway—White Pass; 13.5 miles.

This is an important international road and by co-operative effort on the part of the Canadian Government would make travel by road from Skagway to White Horse possible.

Taku Landing—Boundary; 22 miles.

This road, if prolonged by the Canadian Government into the Lake Atlin region, would permit travel from Juneau to Lake Atlin.

The map (Fig. 3) indicates the program proposed by the Commission, exclusive of isolated projects in southeastern Alaska and in the Alaska Peninsula. It will result in giving Alaska, in addition to short spurs and development connections between the producing communities and water or rail transportation, the following through routes by road or trail:

Result of proposed 10-year program

Season	*Vehicle*	*Roadway*	*Mileage*		*Through Routes*
Summer	Automobile or Wagon	Wagon Road	573	"a"	Valdez or Chitina to Fairbanks, Chatanika and Circle.
do	do	do	469	"b"	Government Railroad to Cache Creek, Tacotna (Kuskokwim District), Ophir, Long, Ruby (Yukon District).
do	do	do	97	"c"	Eagle to Forty Mile and International Boundary (connects with Canadian Road to Dawson).
do	do	do	159	"d"	Davidsons Landing to Kugarok and Candle.
do	Pack Train	Wagon Road,	2887	"e"	Route "a" connected
do		Sled Road, or Trail.			to Routes "b," "c" and "d."
do	do	do	3802	"f"	Route "e" extended to Ft. Yukon, Caro, Livengood, Rampart, Arctic City, Iditarod, Kotlik, St. Michael and Nome.
Winter	Bob-sled	Wagon or Sled Road	1353	"g"	Same as Routes "a," "b," "c" and "d."
do	do	do	988	"h"	Route "a" extended to Fort Yukon, Livengood, Rampart and Ft. Gibbon.
do	Double-ender or Dog Team	Wagon Road, Sled Road, or Trail	3802	"i"	Same as Route "f"

Mileage, Entire project	*Wagon road*	*Sled road*	*Trail*	*Total*
Through routes above	1298	470	2034	3802
Miscellaneous routes	567	630	1266	2463
Total	1865	1100	3300	6265
Existing system	1031	636	3223	4890
New construction	834	464	77	1375

The Government Railroad, as planned at present, will be completed in December, 1921, at a total cost of between $50,000,000.00 and $60,000,000.00. An Alaska Advisory Committee (federal) reported on June 11, 1920, that:

The construction of wagon roads and trails is one of the most important and urgent needs of Alaska. Without the construction of a large mileage of wagon roads and trails the resources of the Territory cannot be made available. Nothing will contribute more to development of tonnage for the Government Railroad than a system of tributary wagon roads. The Committee recommends that Congress be asked to make an annual appropriation of not less than a million dollars for the construction and maintenance of wagon roads and trails in Alaska.

Conclusion

Alaska has been slowly developing for twenty-two years.

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Sixteen years ago the first steps in road construction were taken. The first steps in railroad building were made even earlier, but so far all have been unsuccessful, chiefly because the railroads could land freight only at their freight platforms and had no road feeders to distribute their tonnage. No railroad can be successful without roads as branches or feeders, any more than a tree can grow by its trunk alone without branches and leaves.

A railroad must have large tonnage, and trunk-line railroads, such as proposed for Alaska, cannot hope to succeed except as they become arteries of trade supplying large areas. Such areas must extend some distance from the railroad line and terminals, and they can be made tributary thereto only by means of branches. In a highly developed country the larger of these branches may be small railroads or even small systems, but the last connecting line between the railroad and its customers, the mine, the farm, and the factory, is wagon or truck.

Great natural riches can make a country productive even without the assistance of roads, as Alaska proved before 1906. Since that time, however, the evidence of the value of the few existing roads has been demonstrated, and the necessity of completing the road systems has been made manifest.

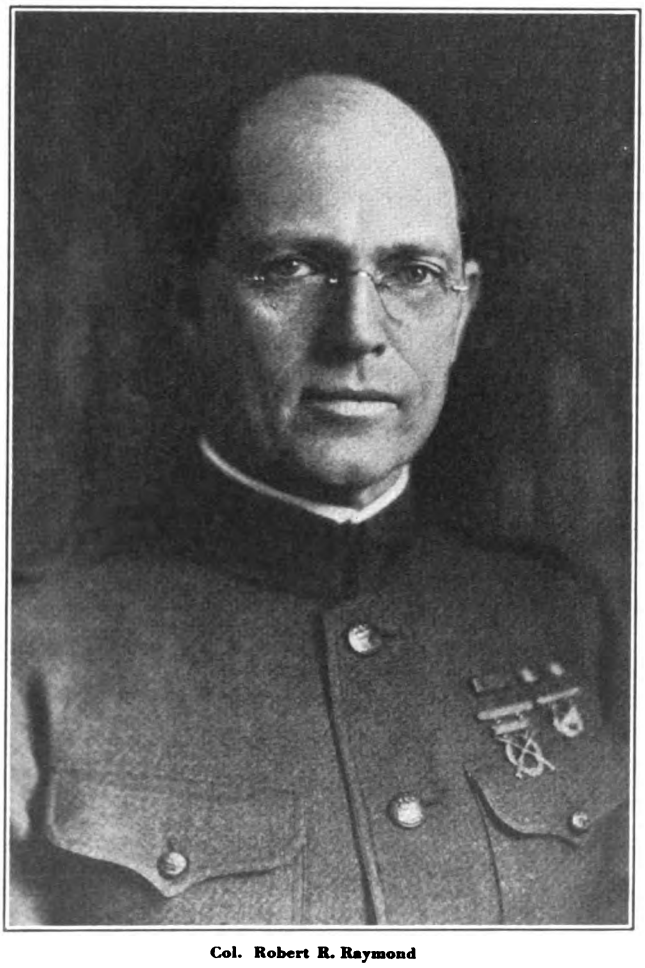
If left to itself Alaska will continue its slow rate of development, and by building its own roads and creating industries sufficient to warrant private enterprise, it will, in half a century, become an empire in spite of all hindrance. No rapid or general development has or will follow the construction of the Government trunk line railroad to the interior unless preceded or accompanied by the construction of numerous wagon roads and trails as feeders. By the construction of highways as the development of the country demands them, this period may be shortened to one-half. The railroads and highways should shorten it to one-quarter. The experience of Alaskan railroads already constructed is a strong indication that without road systems no Alaskan railroad need be expected either greatly to stimulate the development so much to be desired, or to be anything but a financial failure itself.

Retirement of Engineer Officers

Col. ROBERT R. RAYMOND, a well-known and popular officer of the Corps of Engineers, on December 21, 1920, was retired from active duty, at his own request after more than 30 years' service.

Colonel Raymond was born March 5, 1871, in New York, the son of Gen. Charles W. Raymond, a distinguished officer of the Corps of Engineers. He graduated from West Point in 1893, and his entire service has been with the Corps of Engineers, in which he reached the grade of Colonel in 1920.

Colonel Raymond's principal service to the government was in connection with the development of our seacoast defenses to which, being of great inventive ability, he contributed many notable improvements, including the ammunition hoist for seacoast batteries. His aptitude for invention and for the improvement of construction methods found application in many situations both within and even without the scope of his own duties. He was directly responsible for some of the most important features of the novel and successful plan for uncovering the wreck of the *Maine* in Havana harbor. Amongst many other activities Colonel Raymond was the first editor and creator of PROFESSIONAL MEMOIRS, the predecessor of this journal.



Col. Robert R. Raymond

During the late war he organized and trained the 313th Engineers, 88th Division. His last assignment on active duty was as District Engineer of the Cleveland District.

Col. FREDERICK W. ALTSTAETTER, an officer widely and favorably known in the Corps of Engineers and the Army generally, was retired from active duty on August 21, 1920, on account of physical disability.

Colonel Altstaetter was born December 11, 1875, in Ohio, and graduated from West Point in 1897. He reached the grade of Colonel in the Corps of Engineers in 1920.

His service included a wide range of activities, both civil and military. He served many tours of duty with engineer troops, including the Philippine Insurrection; and was in charge of a number of important river and harbor improvements, including the districts of Wheeling (W. Va.), Grand Rapids (Mich.), Savannah (Ga.).

During the Philippine Insurrection, Colonel Altstaetter, then a Lieutenant, was taken prisoner by the insurrectos and remained in their hands for several months, which resulted in injury to his health from which he never entirely recovered.

The government is fortunate in being able to retain his services as District Engineer of the Savannah District.

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Prize Map Problem

Duties of Divisional Engineers in an Advance

[The solution of practical problems, such as that which follows, is conceded as the best method available in time of peace for the instruction of officers in the duties that will fall to their lot in time of war.
This problem is based on a situation in "open warfare"—which makes the greatest demand upon combatant engineer troops.
Officers of all ranks should be familiar with the general duties of the engineers in campaign, and it is recommended that all who are interested solve this problem.
For solutions submitted in competition THE MILITARY ENGINEER offers the following prizes:
In case 30 solutions are received, 3 years' subscription to THE MILITARY ENGINEER (or 3 years free membership including the journal, to members) for each of the 3 best solutions received.
In case less than 30 solutions are received a similar prize will be awarded to the 2 best received.
The competition is *not* limited to members of the Society of American Military Engineers.
All solutions should be submitted to the Editor of THE MILITARY ENGINEER, 423 G Street, N. W., Washington, D. C., not later than March 1, 1921. A letter of transmittal should accompany each solution, but the name of the competitor should not appear on the solution itself. Manuscripts should be typewritten if practicable. Sketches may be submitted if desired.
The solutions will be passed upon by a board of three engineer officers, who will determine the winners. These will be announced in a later issue, at which time also, if practicable, the winning solutions and a solution by the author of the problem, will be published.—ED.]

THIS PROBLEM is intended to exemplify the use of Engineer troops in open warfare, and the issuance of orders based on small scale maps. The physical data is based on a very general knowledge of the region, but will be assumed as correct in the solution of the problem. (See map, page 15.)

General Situation

War has broken out between the United States and the Red Nation, and the latter has attained sea supremacy. On September 25 a Red force has landed at SAN DIEGO, Cal. No other landings are as yet effected. The 8th and 10th U. S. Divisions, which have been mobilized at LOS ANGELES, about 125 miles north of SAN DIEGO, are advancing southward to contain or drive out the Red force. Each has 1 regiment of cavalry and 10 heavy tanks attached. The 8th Division is moving down the Coast Highway, which passes through OCEANSIDE-ENCINITAS-DEL-MAR-LA JOLLA. On September 28 its cavalry gained contact with Red forces along AGUA HEDIONDA CREEK, about 5 miles south of OCEANSIDE. The 10th Division is moving down the interior highway which passes through ESCONDIDO, POWAY and MERTON. Both divisions are at full strength (1918 organization), and completely equipped. While the Red navy has occasionally shelled the single-track railroad and highway, the fire was not effective, and these are open to OCEANSIDE.

The composition of the 8th Division is:

Division Headquarters.
16th Brigade (32d and 33d Regts. Inf. and 24th M. G. Bn.).
17th Brigade (34th and 35th Regts. Inf. and 25th M. G. Bn.).
8th Artillery Brigade [24th and 25th F. A. (75s, horse-drawn); 26th F. A. (155-mm. howitzer, tractor-drawn)].
18th M. G. Bn.;
8th Regt. Engineers;
8th Engineer Train;
Signal Corps troops, trains, field hospitals, etc., complete.

Attached:

6th Regt. Cavalry;
101st Tank Co.

The Engineer Regiment consists of:

Regimental headquarters,
Colonel, lieutenant colonel, 4 captains, 1 lieutenant,
18 master engineers,
45 other grades, mounted,
101 other grades, dismounted, including band of 19 men.
2 Battalions, each of
Battalion headquarters—major and captain,
3 companies, each of 5 officers, 250 enlisted.

Regimental headquarters has 1 motor car, 4 motorcycles and 6 tool wagons, containing map reproduction, surveying, drafting and miscellaneous equipment.

Each company has 4 tool wagons in addition to field wagons.

The Engineer train (2 officers, 85 enlisted), has 23 technical wagons, 13 loaded with picks, shovels, axes, saws, etc.; 6 with small arms ammunition and 4 with sand bags, barbed wire, pickets, etc., and 12 motor trucks similarly loaded; all in addition to the necessary field wagons.

A water tank train of 12 water tank trucks, each of 500 gallons capacity, has also been furnished the Division Engineer for the operations.

Physical Features

The country is generally treeless, except that some timber is found in the river bottoms, and there are occasional plantations of eucalyptus. Much of the land is uncultivated, and such is generally covered with a dense growth of brush. It is toward the end of the dry season, and water is found only in the largest streams. There are a few scattered wells in the river bottoms. The streams lie in narrow, deep cut valleys or canyons, and at the mouth of each is a wide marsh, intersected by small meandering channels. The coast highway is a concrete road. It crosses the stream outlets on embankment, with bridges from 50 to 300 feet in total length, of various construction. The other roads, which are quite numerous, are generally dirt, and the location of many have changed since the date of the map.

Special Situation

On September 29 the advance guard of the 8th Division, consisting of the 32d Infantry, 1 Bn. of the 24th F. A., and Company E, Engineers, reached the north side of AGUA HEDIONDA Creek late in the afternoon at the end of a long day's march. The division has halted for the night along the highway, and extends as far north as OCEANSIDE. The trains are just north of OCEANSIDE. The tanks are held up by an unsafe bridge about 40 miles to the north, and the 1st Battalion of the Engineers is strengthening bridges from that point on to OCEANSIDE. Division Headquarters is in the hotel at OCEANSIDE.

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At 5:00 P. M. Colonel A, the Division Engineer, is summoned by the Chief of Staff to a conference, at which he finds the three assistant chiefs of staff, and the division artillery commander, signal officer and machine gun officer. The following instructions are given: "The Air Service report small forces of the enemy moving south toward SAN DIEGO this afternoon. The few prisoners taken by our cavalry are all from the 149th Red regiment, belonging to the 40th Red division. The force in front of us is probably small and already withdrawing. A civilian just arrived from San Diego states that 15 Red transports have so far arrived. We estimate that not more than two Red divisions have landed. The 32d Infantry is in contact with enemy outposts along AGUA HEDIONDA Creek, and the cavalry are patrolling up the north side of the Creek as far as the branch railroad. The advance cavalry of the 10th Division has gained contact with the enemy in the hills just south of ESCONDIDO, and the advance guard of the 10th Division had reached MOOSA at 4:00 P. M.

"We advance at 5:30 A. M. tomorrow; the 16th Brigade leading, the 17th in reserve. DELMAR is the day's objective. The cavalry will operate on the left flank and will endeavor to cut off retreating Red detachments. The division will be ready at all times to take up a defensive position if superior enemy forces are encountered. Division Headquarters moves to ENCINITAS as soon as this is cleared by the 16th Brigade."

Colonel A informs G-3, in charge of operations, that he will submit his proposed disposition of engineer troops to the latter within an hour, and informs G-1, in charge of administration and supply, that he will submit the proposed arrangements for water supply by 7:00 P. M. G-1 grants Colonel A's request that the Engineer Train, heretofore under the orders of the Commander of Trains, be placed under Colonel A's orders. G-2, in charge of information, strongly urges that the correction of the maps as to roads, etc., in the zone of the division operations be continued by the engineers.

As he leaves the conference, Colonel A receives the following messages:

From Captain Z, Company E, Engineers, dated 3:30 P. M., by runner: that the bridge across HEDIONDA Creek is intact and that E Company P. C. is in a ravine about 2 miles east of CARLSBAD.

From Major Y, 1st Battalion Engineers, dated 3:00 P. M., by motorcyclist, that the 1st Battalion has been relieved and is proceeding in trucks to OCEANSIDE, where it will arrive about 6:30 P. M. Wagon transport of the battalion will follow by road tomorrow.

From the Corps Engineer, at LOS ANGELES, by wire; that the corps troops have taken over all work as far as OCEANSIDE; that Colonel A is to report fully on the condition of the railroad south of OCEANSIDE as uncovered by our advance; and that a division of heavy ponton equipage, horse-drawn, is leaving LOS ANGELES the following morning to report to Colonel A.

Further Information

There is a small lumber yard at OCEANSIDE, well stocked with ordinary building material, such as can be expected in a town of a few thousand inhabitants, and there is a small supply of railroad bridge timber and ties in the railroad yard. There is ample water supply in the town, with fire hydrants in the streets. Any kind of material can be had at LOS ANGELES. The only information available on water supply to the south is that there is water in the SAN DIEGUITO River five miles from the mouth, and that DELMAR is supplied through a long pipe line from the river. Headquarters of the Engineer Regiment is stationed at OCEANSIDE. With headquarters there are small detachments from the companies engaged on correcting the road maps. Six automobiles have been secured for their use. A detachment of 10 mounted men is with the cavalry for the same purpose. The 2d Battalion, less Company E, is at CARLSBAD. The Engineer train is 3 miles north of OCEANSIDE. The water tank train is in OCEANSIDE.

Required

(*a*) A brief preliminary statement of the manner in which Colonel A is assumed to have organized his headquarters to perform its various duties; and of the standing instructions designed to insure the transmission of orders and information within the regiment.

(*b*) The assumed results of any conferences with the appropriate officers necessary to the proper co-operation of the Engineer troops with other arms and services.

(*c*) The orders and messages issued by Colonel A and by his lieutenant colonel to carry out the mission of the regiment the next day, giving the distribution of each and method of transmission.

(*d*) A brief general outline of any action, not covered by the orders and messages issued, that Colonel A proposes to take the following day, if there is no change in the situation.

NOTE: The regiment has been mobilized but a short time, many of the officers have had no combat experience, and all instructions must be explicit as to what is to be done. The officers of the regiment may be expected to know how to do their tasks, after the various missions have been very clearly stated.

The requirements given are sufficient to clearly indicate the contestant's estimate of the situation. The committee will, however, give due consideration to any memoranda accompanying the solution which a contestant desires to submit in explanation of reasons for the action taken.

Portable Car Unloader

A remarkable machine for unloading bulk materials from railroad cars into vessels or storage bins has recently made its appearance. It is the result of a development extending over many years. In these times, when the rapid loading and unloading of cars is so vital a problem, such a machine fills "a long felt want."

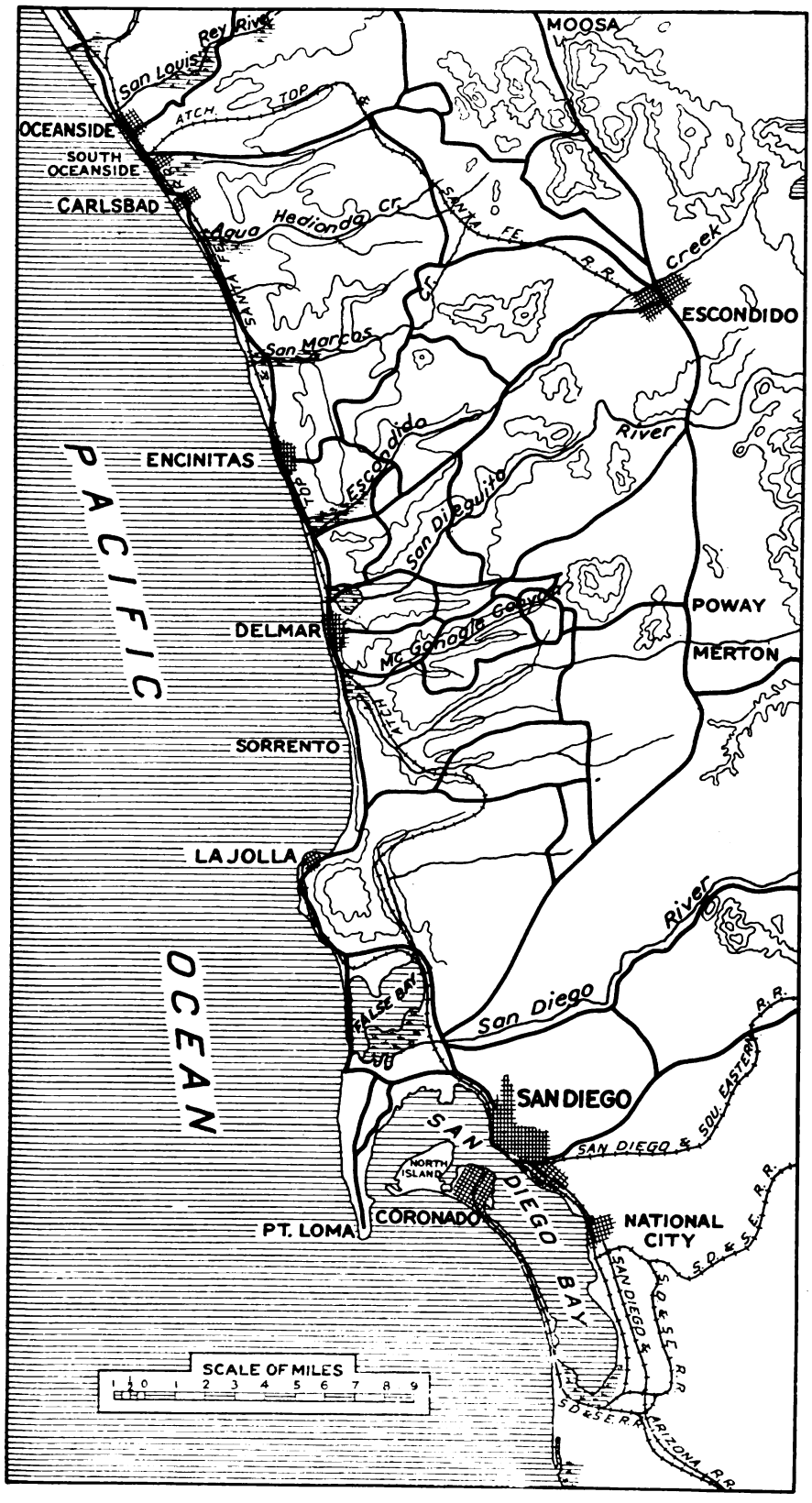
The material is elevated by a bucket belt conveyor on a steel frame covered with sheet metal, all suspended from an overhead track or from a swinging boom of a derrick, or attached to a building. The length of the elevator is about 40 feet and its cross section 2 feet 6 inches by 3 feet 6 inches. It is driven by a 10-horsepower electric motor operating through a gear reduction, resulting in a speed of 2½ r. p. m. at the head sprocket of the conveyor.

Each bucket of the conveyor as it inverts in passing over the head sprocket discharges into a chute or spout, which in turn discharges into the vessel to be loaded.

This machine has a capacity of 125 tons per hour. Smaller sizes have capacities ranging from 50 to 75 tons per hour.

The operation is very simple, requiring only one attendant. The machines may be employed in "batteries."—*Ry. Age.*

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(See Pages 13 and 14.)

Moisture in Concrete Vaults

[NOTE.—We print herewith two interesting letters on the subject of moisture from condensation in concrete vaults. Mr. Dingman's letter was referred for comment to Colonel Winslow, an authority of wide experience on this important subject.

To cure a disease it is first necessary to accurately diagnose it, and this Colonel Winslow does in most clear and convincing manner, after which he proposes the only practicable remedy.—ED.]

Sir: The letter in the *Engineering News-Record*, September 9, p. 521, in reference to the sweating of a concrete vault, is very interesting to us for the reason that we have had somewhat similar experiences in the past.

We do not know all of the conditions surrounding the construction of the vault, but we are inclined to believe that a large part of the trouble is due to the fact that it has never been dried out, and we feel that the sweating would be materially reduced if the vault had once been dried out by the application of heat.

We have also conferred with an architect who has had a very extensive experience in the construction of banks and he advises us that he has never succeeded in constructing a vault below grade which did not sweat. This architect states that he has constructed a great many vaults which were waterproofed, but on account of the difference in temperature between the walls and the interiors of the buildings the vaults continued to sweat. His practice, where a dry vault is needed, is to install a small electrical heater and an expeller fan; then every few days the heater is turned on to raise the temperature and the fan is started and the vault dried out. As soon as any noticeable amount of moisture collects again the process is repeated.

CHARLES F. DINGMAN,
Engineer, Flynt Building Construction Co.
Palmer, Mass.

Comment by Col. Winslow

The letter from Mr. Dingman and the article appearing on page 521 of the *Engineering News-Record* of September 9th, 1920, and referring to the sweating of a concrete vault, are exceedingly interesting to the fortification engineer, as an illustration of a difficulty which occurs frequently and makes it hard to keep dry the rooms and magazines of concrete fortifications.

The cause of the dampness in the vault is evidently not leakage or seepage or the reappearance of the water used in making the concrete, but simply the condensation of moisture carried into the vault as watery vapor in the atmosphere.

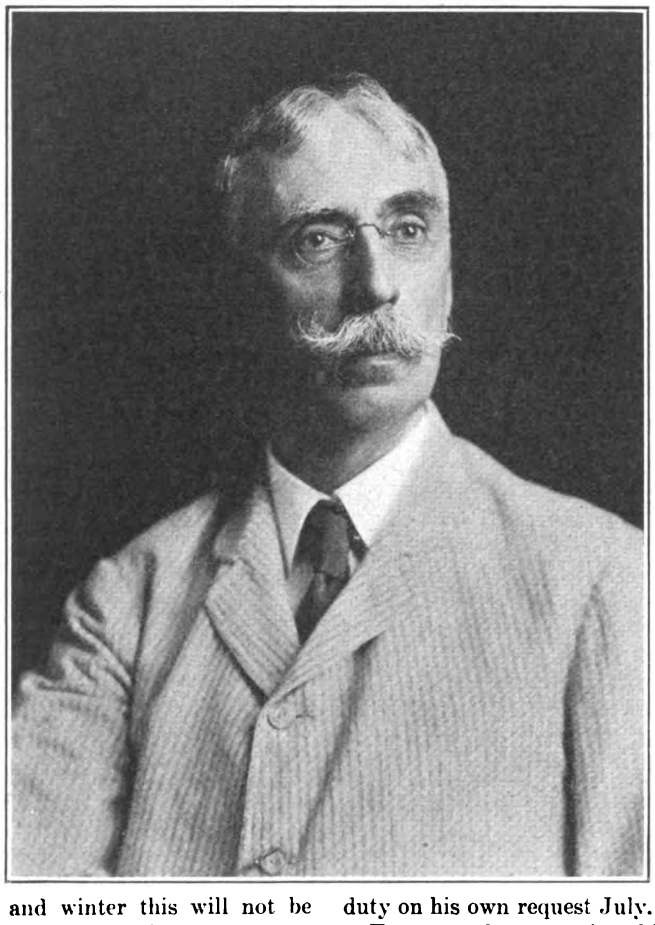
The locality is in Wisconsin where the ground becomes exceedingly cold in winter and warms up in summer slowly, lagging in this respect behind the temperature changes of the atmosphere; consequently, in the middle of the summer the atmospheric temperature is normally above the temperature of the ground. Due to their contact with the earth the temperature of the concrete walls of the vault has a tendency to approximate the temperature of the ground, and this is ordinarily below, not only the actual temperature of the air, but even the dew point of the air. The inevitable result is that when this air comes in contact with the cooler walls of the vault, condensation begins to take

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place and continues until there has occurred the condensation of all of the moisture in the air, which the air at its new and lower temperature is unable to hold in suspension.

That this is true is shown by the fact that the floor, which has naturally the coldest surface, is reported as always damp, while the comparatively thin ceiling, whose upper surface is in contact with the atmosphere, is reported as comparatively dry; and further, since on rainy days when the atmosphere is nearly or quite saturated, or in other words when the temperature of the dew point of the atmosphere approximates to that of the air itself, the condensation is reported to have been greater.

The rule for reducing the amount of condensation is very simple, and is based upon the idea that anything that serves to warm up the surface of the walls, or to prevent the surface of the walls from cooling off, will serve to reduce condensation. The surfaces of the walls are cooled off by the heat conducted from the walls to the ground. Consequently, if the walls had been made so that they were poor heat conductors, the loss of heat by conduction would have been less and the amount of condensation would have been reduced. This might have been done either by making the interior surface of porous tiles or by leaving air spaces within the walls themselves.



The vault being already constructed, with solid walls in actual contact with the ground, the only alternative is to heat up the walls artificially. This can be done by the application of artificial heat at intervals during the spring and summer. During the autumn and winter this will not be necessary, for as soon as the atmospheric temperature falls below that of the ground it will be found that the condensation will cease, because if the atmospheric temperature be below that of the vault walls the dew point of the atmosphere will be even more so. Consequently any air coming in contact with the walls of the vault will, by this contact, be heated rather than cooled, and will be made a better holder of watery vapor.

Incidentally it will probably be found that the troubles due to dampness will be reduced if, instead of providing only a few small ventilating openings, the arrangements for ventilation be much improved so that a large quantity of air can pass into and then out of the vault. The reasons for this are, that as each little volume of air comes in contact with the walls and is reduced to the approximate temperature of the walls, it gives off to the walls not only some temperature heat, but also as the watery vapor condenses the much greater quantity of the latent heat of vaporization of this watery vapor. This tends to raise the temperature of the walls, and if the ventilation be sufficiently good so that a sufficient quantity of air passes along the surfaces of the walls, they will be warmed by the heat from the air more rapidly than they are cooled off by the conduction of heat to the ground. If this process continues long enough the temperature of the wall surfaces will soon be raised up to the dew point of the air and condensation will cease. If then the supply of air still continues the wall temperature will be raised, but more slowly, by the transfer to the walls of the temperature heat of the air until the temperature of the wall surface is well above the dew point.

Apparently in the vault with its present system of ventilation, the conditions are such as to be most favorable for condensation. That is, the amount of air that gets in is such as to transmit to the walls its temperature and latent heat just about as rapidly as this heat is conducted away by the earth. Under these conditions condensation may continue almost indefinitely.

E. E. WINSLOW,
Colonel, Corps of Engineers.

Death of Col. Thomas W. Symons

With the death at Washington, D. C., on November 24, 1920, of Col. Thos. W. Symons, Corps of Engineers, U. S. A., was ended a noteworthy career in the annals of inland waterway development in this country.

Colonel Symons was born in New York State in 1850, and graduated from West Point at the head of his class in 1874. His entire army service was in the Corps of Engineers, in which he reached the grade of Colonel in May, 1908. He was retired from active duty on his own request July, 1908, after 37 years of service.

For several years after his graduation Colonel Symons was engaged on the government surveys in the west, under Captain Wheeler. His first experience with inland waterways was on the Mississippi River in 1882. Subsequently, as assistant to Major Lydecker, he took part in the construction of the Washington aqueduct, following which he served several years as assistant to the Engineer Commissioner of the District of Columbia. For six years he was in charge of harbor improvements in the Portland (Ore.) District, including the mouth of the Columbia River.

From 1895 to 1903 Col. Symons was in charge of the Buffalo District. Here he made a close study of the inland waterway problems of that region; reported on a project for a ship canal from the Great Lakes to the sea, and as a member of the New York state commission he took part in the planning of the Barge Canal. So great was his influence on this project that he was called the "father of the New York State Barge Canal."

On his relief from Buffalo, Colonel Symons served a year as Superintendent of Public Buildings and Grounds

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in the District of Columbia, and as military aide to President Roosevelt.

When work on the Barge Canal was started New York State requested the services of Symons as Chairman of the Advisory Board of Engineers to supervise the construction. To take up this work he was granted leave of absence by special Act of Congress, and served on the Board from 1904 until the virtual completion of the waterway.

Since his retirement Colonel Symons' principal activity has been the investigation and preparation of plans for a canal from Pittsburg to Lake Erie, near Conneaut, Ohio, for the movement of coal and ore.

Colonel Symons is survived by a widow, two sons and a daughter.

New Organization of the Engineer Service for Military Operations

Under Act of June 4, 1920

By

F. B. Wilby

Major, Corps of Engineers

In accordance with authority granted in the Act of June 4th, 1920, a general project for the organization of the Army of the United States has been approved by the Secretary of War, and it is believed that an abstract from that project—showing the Engineer units proposed, with a brief discussion of the duties and functions of those units—will be of interest to many Engineer officers, both active and reserve.

Engineer Troops Proposed (War Strength).

For each Infantry Division—	Officers	Warrant officers	Men
1 Combat Engineer Regiment	38	1	806
For each *Cavalry Division*—			
1 Combat Engineer Battalion, Mtd	15	--	330
For each *Army Corps*—			
1 Corps Engineer Service, of			
1 Corps Engineer Hdqrs	4	--	11
1 Corps Engineer Regiment	38	1	1150
3 Auxiliary Engineer Battalions (each 15 officers, 1008 men)	45	--	3024
Total Corps Engineer Service	87	1	4185
For each *Army*—			
1 Army Engineer Service, of			
1 Army Engineer Hdqrs	28	--	105
3 Army Engineer Regiments (each 38 officers, 1 W O, 1150 men)	114	3	3450
1 Topographical Engineer Battalion	18	--	560
1 Camouflage Engineer Company	4	--	160
5 Heavy Bridge Trains (each 4 officers, 160 men)	20	--	800
2 Light Bridge Trains (each 4 officers, 160 men)	8	--	320
1 Water Tank Train	15	--	475
6 Auxiliary Engineer Battalions (each 15 officers, 1008 men)	90	--	6048
Total Army Engineer Service	297	3	11,918
For *G. H. Q. Reserve (for 1 Army)*			
1 G. H. Q. Engineer Hdqrs	32	--	130
1 Topographical Engineer Battalion	18	--	560
1 Camouflage Engineer Battalion	18	--	560
*2 Heavy Bridge Trains (each 4 officers, 160 men)	8	--	320
†1 Water Tank Train	15	--	475
†1 Road Engineer Regiment	38	1	1150
*4 Railway Engineer Battalions (each 18 officers, 560 men)	72	--	2240
1 Construction Engineer Regiment	38	1	1150
‡8 Auxiliary Engineer Battalions (each 15 officers, 1008 men)	120	--	8064
Total G. H. Q. Reserve (1 Army)	359	2	14,649

† Add one more for each additional Army.
* Add two more for each additional Army.
‡ Add four more for each additional Army.

For the *Communications Zone* (15 per cent of all troops assigned to Armies).

Allotment of Communications Zone Engineer Troops.

"Engineer Corps"	20. per cent of Cn.Z.—For one Army	9066
50 per cent of "Army Service"	9.87 per cent of Cn.Z.—For one Army	4474
** 40 per cent of "Transp. Corps"	4.8 per cent of Cn.Z.—For one Army	2176
Total Engineers	34.67 per cent of Cn.Z.—For one Army	15,716

(** Railway Operating troops to be organized by Corps of Engineers.)

Normal Assignment of Communications Zone Engineer Allotment.

	Officers	Warrant officers	Men
1 Cn. Z. Engineer Hdqrs. (about)	100	--	250
1 Section Engineer Hdqrs. (for each Base, Intermediate or Advance Section)	10	--	27
For each Army—			
1 Depot Engineer Battalion	18	--	560
1 Lumbering Engineer Battalion	18	--	560
2 Construction Engineer Regiments (each 38 officers, 1 W. O., 1150 men)	76	2	2300
4 Railway Engineer Battalions (each 18 officers, 560 men)	72	--	2240
9 Auxiliary Engineer Battalions (each 15 officers, 1008 men)	135	--	9072
Total Cn. Z. Engineers (for one Army)	429	2	15,009

The above allotment will provide, for an expedition of one army (total strength 382,532), an Engineer contingent of 63,819 men or 16.7 per cent; and for an expedition of six armies (total strength 2,310,695), an Engineer contingent of 342,167 men, or 14.8 per cent. In each case a little more than 50 per cent of the Engineer troops are provided in auxiliary Engineer battalions.

The troops proposed for the Engineer Service in time of war may be divided into two classes—General Engineer troops, and Special Engineer troops; the first class being ready to perform all kinds of engineering work, and the latter being recruited and trained for special work only.

General Engineer troops include:

Combat Engineers with Infantry and Cavalry Divisions,
Corps and Army Engineer Regiments,
Auxiliary Engineer Battalions.

Special Engineer troops include:

Topographical troops,
Road troops,
Railway troops,
Depot troops,
Water Tank Trains.
Camouflage troops,
Construction troops,
Lumbering troops,
Bridge trains,

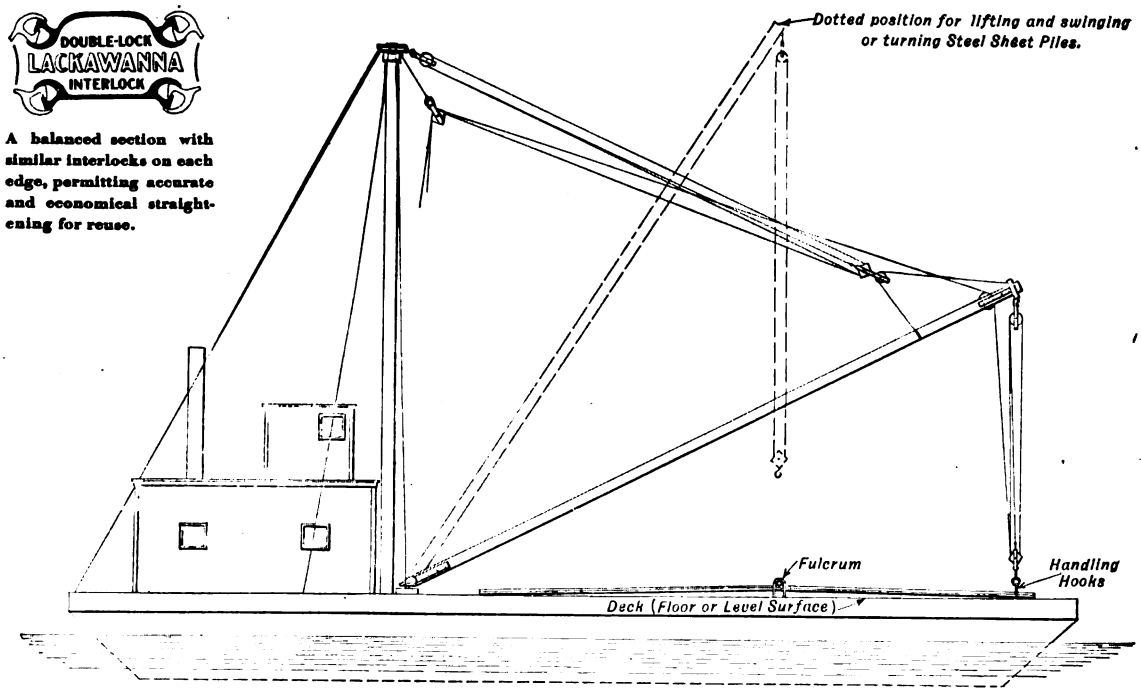
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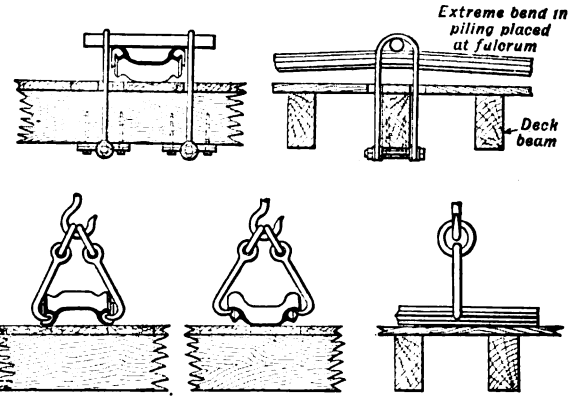
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The following Special Engineer troops, organized during the War, have been omitted as unnecessary, and their duties assigned to other Engineer troops:

Water Supply troops,
Electrical and Mechanical troops,
Shop troops,
Light Railway and various kinds of railway troops,
Mining troops, Quarry troops.

The following special troops, which were Engineer troops in the A. E. F., have been omitted, as their duties have been assigned to other arms or services:

Searchlight troops to the Coast Artillery Corps,
Sound Ranging troops to the Coast Artillery Corps,
Flash Ranging troops to the Field Artillery,
Gas troops to the Chemical Warfare Service.

As far as possible only General Engineer troops have been assigned to tactical units in forward areas, and the minimum number of Engineer troops required under all circumstances has been assigned to each army and to the Communications Zone, with a small pool of Engineer troops in the G. H. Q. Reserve available for assignment in emergency where most needed, either to a particular army preparing for offensive operations, or to the Communications Zone during the earlier stages of its development.

As far as possible, a standard company, battalion and regimental organization has been used throughout the Engineer Service.

A brief description of each kind of Engineer troops—together with a few remarks as to equipment contemplated and duties proposed for each—will give a general idea of the operation of the Engineer Service under the approved project:

Combat Engineer Regiment, 800 Enlisted

This is a two battalion regiment of six 106-man companies, and one 170-man Headquarters and Service company, for assignment to Infantry divisions only. The old Engineer Train is included in the Headquarters and Service Company. The Engineers form only 4.35 per cent of the division, instead of 6.5 per cent, as used in the A. E. F. The combat Engineer regiment will be equipped with automatic rifles, a small amount of pack transportation, and a small mounted platoon in the headquarters and service company, in addition to the usual Engineer equipment. It should be trained to execute all military engineering required by the Infantry division, as well as to fight as Infantry, when called upon in an emergency.

Combat Engineer Battalion, mounted

This is a three company battalion with a small Headquarters and Service platoon. The Engineer train, Cavalry division, has been eliminated—4 wagons carrying intrenching tools for the Cavalry regiments being retained with the headquarters and service platoon of the mounted battalion, and the light bridge train being assigned to the army. The training of this battalion should be in general similar to that required for the combat regiment with the Infantry division, as described above.

Corps and Army Engineer Regiments

These regiments will be equipped the same as combat Engineer regiments with Infantry divisions, with the omission of automatic rifles, pack train, mounted platoon, and extra wagons of Infantry intrenching tools, and the addition of complete steam operated pile driving outfit. They will have to be prepared to carry on the following work for the corps and army:

General construction,
Construction and maintenance of roads and bridges,
Construction of railroads, both narrow and standard gauge,
Water supply installation and operation,
Electrical and mechanical installation and operation,
Defensive works, Engineer supply,
Military mining.

Auxiliary Engineer Battalions

These will be four company battalions (250-man companies), organized the same as the Engineer service battalion used during the recent war, and will provide additional man-power in the army areas for the work performed by the corps and army regiments, as outlined above, and in the Communications Zone for work with Construction, Road, Depot or Lumbering troops. The allotment of three Auxiliary Engineer Battalions to each Army Corps has been made with a view to the assignment of such troops as needed to the divisions in the Corps, in order to supplement the smaller engineer regiment now assigned to the Division.

Topographical Troops

One battalion to each army, and one battalion at G. H. Q., for handling the production and reproduction of maps. Present plans for equipment for these troops contemplate a base printing plant at G. H. Q., and a mobile power driven printing plant for the army. Corps and divisions will be furnished only hand presses for map reproduction work, to be operated by General Engineer troops.

Camouflage Troops

One battalion at G. H. Q., for operating camouflage factory and general supply of camouflage material, as well as furnishing details for camouflage instruction at training centers. One camouflage company per army for supply of camouflage material and supervision of such special camouflage work as may be directed. Ordinarily, the work required for the camouflage of troops or materiel will be performed by the troops concerned, whether Infantry, Artillery or other arm. Each corps and division, however, will have on the staff of the Commanding General, an Engineer Officer, to be known as the Corps or Division Camouflage Officer, with duties of inspection and supervision, similar to the duties of the Corps or Division Gas Officer.

Road Troops

One regiment per army, to be assigned to G. H. Q. Reserve, for use where most needed, on general supervision, quarry operation, or specially important and difficult road work. The principal dependence for road work in the communications zone, as well as in the forward areas, will fall upon Auxiliary Engineer Battalions, supervised by a small technical personnel, furnished from corps and army regiments, construction regiments, or road regiments. The road regiment will be equipped with tractors, dump wagons, dump trucks, graders, and small portable crushers. Other special road machinery and equipment, such as large crushing plants, air compressors, or road rollers, will be held in depot, and issued where required.

Construction Troops

These are for duty primarily in the communications zone, although one regiment is allotted to G. H. Q. Reserve for assignment where necessary. Construction regiments will be recruited and trained, so as to perform all kinds of general construction work, including among others, the following:

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ADDRESS----------

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TABLE 1. COMBAT ENGINEER REGIMENT (War Strength)

Road Space and Tonnage:
Animal drawn, 945 yards; 45 3/4 tons.
Motor, 420 yards; 29 1/4 tons.
Total Road Space, 1980 yards.

1	Units	2	3	4	5	6	7	8	9	10	11	12	13
				Battalion			Regiment						
		Specialist Rating (Class)	One Company	Headquarters	Three Companies	Total	Headquarters	Headquarters and Service Company	Two Battalions	Total	Medical Department	Chaplain	Aggregate
2	Colonel						1			1			1
3	Lieutenant Colonel						1			1			1
4	Majors			1		1			2	2	1		3
5	Captains		1	1	3	4	2	1	6	12	3	1	33
6	First Lieutenants		2		6	6	1	2	12	15			
7	Second Lieutenants		1		3	3		1	6	7			7
8	Total Commissioned		4	2	12	14	4	4	26	36	4	1	44
9	Warrant Officer							1		1			1
10	Master Sergeants							6		6			6
11	Technical Sergeants							8		8			8
12	First Sergeants		1		3	3		1	6	7			7
13	Staff Sergeants		3		9	9		7	18	25	1		26
14	Sergeants		9		27	27		14	54	68	3		71
15	Corporals		12		36	36		18	72	90			90
16	Pvts. 1st Cl. & Pvts. (Pvts. 1st Cl.		27		81	81		40	162	202	16		618.
17	Pvts. 1st Cl. & Pvts. (Privates		54		162	162		76	324	400			
18	Specialist Ratings " "	1c						(1)		(1)			
19	" "	2c						(5)		(5)			
20	" "	3c	(2)		(6)	(6)		(7)	(12)	(19)			
21	" "	4c	(3)		(9)	(9)		(9)	(18)	(27)			
22	" "	5c	(3)		(9)	(9)		(38)	(18)	(56)	(2)		
23	" "	6c	(7)		(21)	(21)		(24)	(48)	(67)	(5)		
24	Total Ratings		(15)		(46)	(46)		(84)	(90)	(174)	(7)		
25	Total Enlisted		104		318	318		170	486	806	30		836
26	Aggregate		110	2	330	332	6	178	664	848	26	1	878
27	Horses, riding		5	2	15	17	6	28	24	78	12	1	91
28	Mules, riding							10		10			10
29	Mules, draft		18		54	54		74	108	182			182
30	Mules, pack							16		16			16
31	Total Animals		23	2	69	71	6	128	142	286	12	1	299
32	(Mules, draft, spare)							(14)		(14)			(14)
33	Wagons, tool, 4-mule		2		4	4		12	12	24			24
34	Wagons, F. & B., 4-mule		1		3	3		5	6	11			11
35	Kitchen, rolling, 4-mule		1		3	3		1	6	7			7
36	Carts, water, 2-mule		1		3	3		1	6	7			7
37	Trucks, 1 1/2-ton, Cargo (A)							18		18			18
38	Trucks, 3/4-ton, Cargo (AA)							3		3	3		6
39	Cars, motor, (D.S. or D.R.)							2		2			2
40	Motorcycles, with side car		2		6	6		4	12	16	1		17
41	Bicycles		2		6	6		3	12	15			15
42	Pistols		21	2	63	65	6	78	130	214			214
43	Rifles		99		267	267		97	534	631			631
44	Automatic Rifles		4		12	12			24	24			24

[NOTE: The above tables have not been approved by the War Department.]

TABLE 2. COMPANY, COMBAT ENGINEER REGIMENT (War Strength)

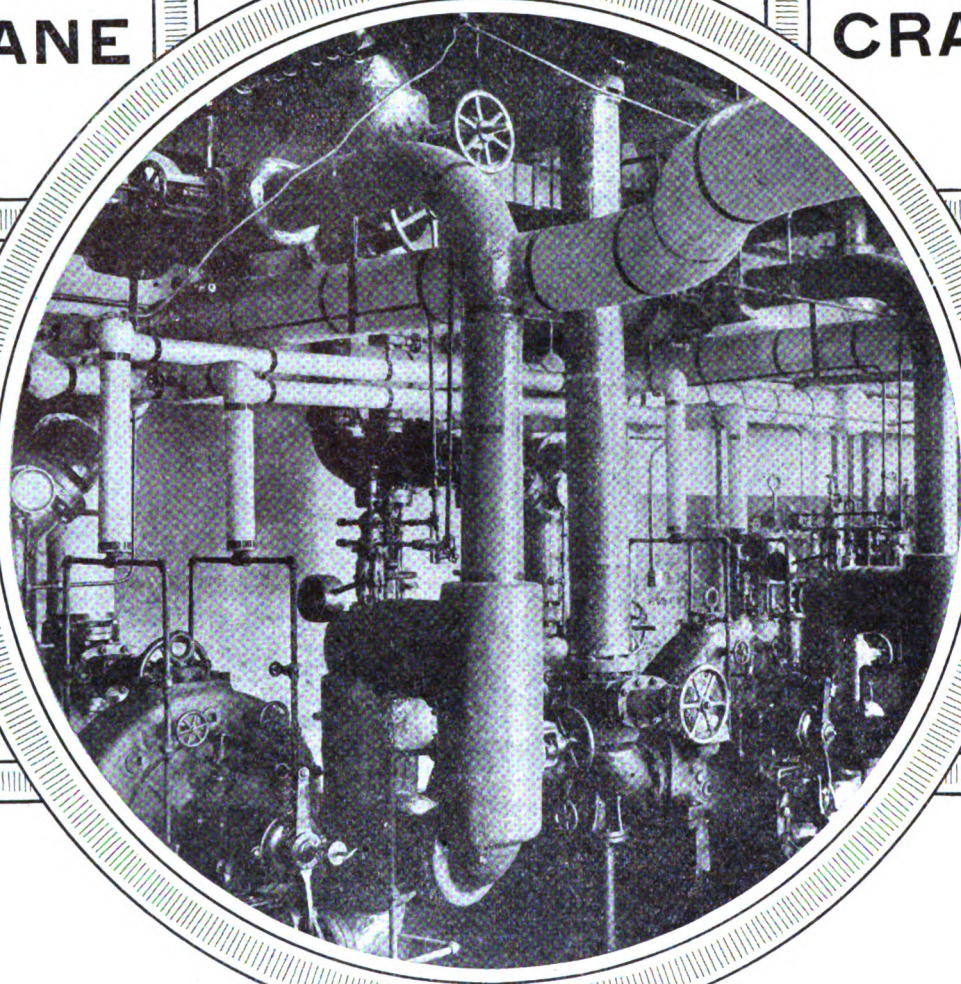
Road Space, 145 yards.
Tonnage:
Animal drawn, 3 3/4 tons.
Motor, tons.

1	Units	2	3	4	5	6	7	8
		Specialist Rating (Class)	Symbol Number	One Platoon	Headquarters Section	Two Platoons	Total	Remarks
1	Captain				1h		1	(h) Mounted on horse.
2	First Lieutenants			1h		2	2	
3	Second Lieutenants			1h			1	
4	Total Commissioned			1	2	2	4	
6	First Sergeant				1		1	
7	Staff Sergeants			1	1	2	3	
8	Sergeants, incl.,			2	2	4	9	
9	Mess				(1)			
10	Stable				(1h)			
11	Supply				(1)			
12	Miscellaneous			(2)	(2)			
13	Corporals, incl.,			5	2	10	18	
14	Clerk				(1)			
15	Miscellaneous			(5)	(1)			
16	Prvts. 1st Cl. & Prvts., incl.,			35	11	70	(a) 81	(a) Includes:
17	Blacksmith (t)	3c		(1)		(1)	(1)	27 Prvts. 1st class
18	Buglers	-		(1)		(2)	(2)	54 Privates
19	Carpenters, bridge (t)	4c		(1)		(2)	(2)	Summary of Specialist Ratings:
20	Carpenters, general (t)	3c		(1)		(1)	(1)	3c class -- 2
21	Carpenters, mine (t)	3c		(1)		(1)	(1)	4c class -- 3
22	Cooks, asst.	5c			(1)		(1)	5c class -- 5
23	Cooks, first	4c			(1)		(1)	6c class -- 7
24	Demolition man (t)	3c		(1)		(1)	(1)	Total -- 15
25	Demolition man (t)	6c		(1)		(1)	(1)	
26	Draftsman (t)	6c		(1)		(1)	(1)	(t) 8 technical specialists per company allotted by C.O. to meet local requirements, normally 4 to each platoon, with duties as indicated.
27	Horseshoer	5c			(1)		(1)	
28	Mail orderly	-			(1)		(1)	
29	Motorcycle drivers	6c			(2)		(2)	
30	Wagoners	5c		(1)		(2)	(2)	
31	Wagoners	-		(5)			(5)	
32	Miscellaneous	-		(29)	(2)	(59)	(90)	
33	Total Enlisted			43	20	94	164	
34	Aggregate			44	22	88	110	
35	Horses, riding			1	3	2	5	
36	Mules, draft			4	10	8	18	
37	Total Animals			5	13	10	23	
38	Wagons, tool 4-mule			1		2	2	
39	Wagons, F. & B. 4-mule				1		1	
40	Kitchen, rolling, 4-mule				1		1	
41	Cart, water, 2-mule				1		1	
42	Motorcycles, with side car				2		2	
43	Bicycles			1		2	2	
44	Pistols			6	11	10	21	
45	Rifles			29	11	78	89	
46	Automatic Rifles			2		4	4	

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Railway construction, Dock construction,
Bridge construction, Highway construction,

or, in other words, the construction regiments are to be the "General Engineer Troops" for the communications zone.

Railway Troops

All railway construction is done by general Engineer troops in the forward area, or by construction troops in the communications zone. Railway troops will, therefore, be provided only for operation and maintenance of railroads, either broad or narrow gauge, and will be organized into standard railway operating battalions—each battalion to include the personnel necessary for operation, maintenance of way, and maintenance of equipment for one railway operating division. The railway operating battalions will be assigned to the communications zone and G. H. Q. Reserve, the latter being available for pushing forward into the Army areas taking over the operation of new lines, ultimately to be absorbed in the communications zone.

Lumbering Troops

It is believed that the need for Engineer troops for the production of lumber in future operations will be much less than was required in the A. E. F. For any operations in the United States production will be mainly from commercial sources, although production in the theatre of operations should be developed to a maximum in order to relieve congestion on transportation lines from the Zone of the Interior. Such lumbering battalions, as are necessary in any given operation, will be organized and assigned to the communications zone.

Depot Troops

Depot battalions will be organized and assigned only to the communications zone—one company out of each battalion being recruited as a shop company. Engineer supply work in the combat zone will be handled by general Engineer troops, as explained above.

Bridge Trains

Bridge trains, heavy and light, have been provided to care for and transport ponton bridge equipment. The heavy train, when furnished with the new equipment now being developed, will have three divisions (178 feet of bridge per division), and one supply division, or a total for the train of 534 linear feet of bridge, capable of carrying all corps and army loads. The personnel for these bridge trains will care for and issue fixed bridge material provided in depots, including timber trestle material, as well as such portable steel bridges as may be developed. The bridge train, formerly assigned to the corps, has been withdrawn to the army, making five heavy bridge trains with the army, and none with the corps; the idea being to assign bridge trains to corps and divisions from the army pool, in accordance with the prospective needs of the military operations in each case. No light bridge trains are assigned to Cavalry divisions, but two are allotted to the Army for assignment in Cavalry operations, to meet local requirements. The light bridge train will be the same as that previously known as the advanced guard ponton train, consisting of three divisions of canvas ponton boats (185 feet of bridge per division).

Water Tank Trains

Each train will consist of five truck companies of 27 tank trucks each, and one truck company of 20 purification trucks; one train to be assigned to each Army, and one held in G. H. Q. Reserve, to be used for distributing and purifying water to troops in the forward areas.

The *general policy* in regard to the *maintenance and operation of communications* is for the troops working on communications in the communications zone to push forward and take over the operation and maintenance of communications as rapidly and as far to the front as possible. For this reason, all special Engineer troops required for work on communications such as road and railway troops, have been omitted from the army Engineer service. In case these troops, under certain circumstances, are urgently needed in the army areas, they will be temporarily assigned to the army from the G. H. Q. Reserve, with a view to their transfer to the communications zone as soon as the newly acquired lines of communication can be absorbed in the existing system of communications, and their operation and maintenance taken over by the communications zone.

Detailed Tables of Organization and Equipment for all Engineer units included in the approved project are now being prepared in the Office of the Chief of Engineers. The tables for the Combat Engineer Regiment at war strength—as approved by the Chief of Engineers, and submitted for approval of War Department—shown herewith.

The strength of this regiment was fixed by the War Department at about 800 enlisted, after the Special Committee —convened for drawing up the general organization project —had recommended as the Engineer component of the Infantry division, only one three-company battalion, with a total enlisted strength of 650. The following extract from the Committee's report is of interest:

> That the engineer unit which forms part of the division should be reduced to the minimum number always required; the additional engineer and labor troops required for special situations should be furnished divisions from corps troops. The strength of the engineer component in the A. E. F. division frequently resulted in its employment as infantry, where the emergency did not justify such use of special troops. The smaller Engineer component recommended in Appendix 2 aids mobility of the division and should tend to regulate the proper employment of Engineers as Infantry.

The Chief of Engineers, as well as a number of officers of other arms, advocated strongly a regimental organization for the Engineer component of the Infantry division, no matter what size was finally adopted, as well as a minimum strength for that component of 6½ per cent of the total strength of the division (the A. E. F. percentage). The 1150-man regiment, accepted for all other Engineer regiments, was definitely proposed and recommended for the Infantry division, but—in view of the very pronounced recommendations of the Special Committee for a drastic cut in the Engineer component of the division—the War Department modified the committee project in this respect only so as to increase the strength from 650 to 800, and to authorize the change from battalion to regimental organization.

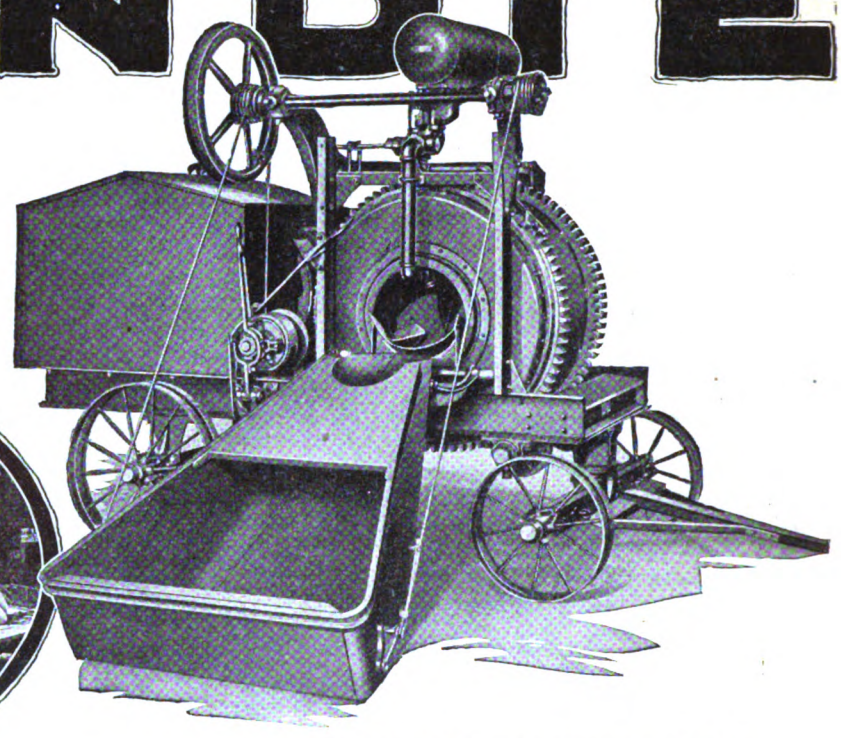
It is believed that the general organization of the Engineer Service, as outlined above, and as approved by the War Department, will provide a practicable plan for mobilizing our Engineer resources, so as to function efficiently in any future war, especially in a war on this continent. It is not modeled exactly on the organization developed during the recent war; many Engineer officers may believe that too many specialist troops have been retained, and others that important specialists have been eliminated, or that other details of organization do not represent the best practice as shown by our experience in the recent war. However, it is believed that the basic principles on which the organization was worked up are sound, that the essential lessons of the war have been incorporated, and that changes in details can well be left for future experience to dictate.

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TABLE 3. HEADQUARTERS, and HEADQUARTERS and SERVICE COMPANY
COMBAT ENGINEER REGIMENT
(War Strength)

Road Space and Tonnage:
Animal drawn, 375 yards, 22 1/4 tons.
Motor, 420 yards, 29 1/4 tons.
Total Road Space, 905 yards.

1	1	2	3	4	5	6	7	8	9	10	11	12	13
						Headquarters & Service Company							
1	Units	Specialist Rating (Class)	Symbol Number	Battalion Headquarters	Regimental Headquarters	Headquarters Section	Mounted Platoon	Transport Platoon	Band Section	Total	Medical Department	Chaplain	Remarks
2	Colonel				1h								
3	Lieutenant Colonel				1h						1h		
4	Majors			1h									(a) Battalion Adjutant
5	Captains			(a) 1h	(b) 3h	(c) 1h				1	(j) 5h	1h	
6	First Lieutenants				(d) 1h		1h	(f) 1h		2			(b) 1 Plans and Training Officer. 1 Typographical and Inteligence Officer. 1 Adjutant.
7	Second Lieutenants					(g) 1h				1			
8	Total Commissioned			2	6	2	1	1		4	6	1	
9	Warrant Officer								1	1			(c) Supply Officer.
10	Master Sergeants, incl.,					6				6			(d) Division Camouflage Officer.
11	Chief Lithographer					(1)							
12	Chief Topographer					(1)							(f) Train Commander.
13	Construction Foreman					(1)							(g) Assistant Supply.
14	Personnel					(1)							
15	Sergeant Major					(1h)							(j) Includes: 1 Dental Officer and 1 Veterinary (1° or 2° Lieut.)
16	Supply					(1h)							
17	Technical Sergeants, incl.,					8				8			(h) Mounted on horse.
18	Chief Draftsman					(1)							
19	Construction Foremen					(3)							(m) Mounted on mule.
20	Elect. & Mech. Engr.					(1)							
21	Photographer					(1)							
22	Surveyors and Topographers					(2)							
23	First Sergeants					1				1			
24	Staff Sergeants, incl.,					4	1	1	1	7	1		
25	Band								(1)				
26	Color					(2)							
27	Sergeant Majors, Bn.					(2h)							
28	Miscellaneous						(1h)	(1m)			(1h)		
29	Sergeants, incl.,					4	2	5	3	14	3		
30	Band								(2)				
31	Bugler								(1)				
32	Lithographer					(1)							
33	Master Mechanic							(1)					
34	Mess					(1)							
35	Personnel					(2)							
36	Stable						(1h)	(1m)					
37	Supply							(1)					
38	Topographer						(1h)						
39	Truck Master							(1)					
40	Veterinary										(1h)		
41	Wagon Master							(1m)					
42	Miscellaneous										(2)		
43	Corporals, incl.,					2	4	8	4	18			
44	Asst. Wagon Masters							(2m)					
45	Band								(4)				
46	Chief Packer						(1m)						
47	Clerk					(1)							
48	Mail					(1)							
49	Miscellaneous						(3h)	(6)					
50	Pvts. 1st Cl., & Pvts., incl.,					5	28	56	27	(k) 116	16 3h 3v 1h		(v) Veterinary.
51	Asst. to Chaplain	-					(1h)			(1)			(k) Includes: 40 Pvts. 1st Class 76 Privates
52	Buglers	-					(2h)			(2)			
53	Carpenter, general (t)	4°				(1)				(1)			Summary of Specialist Ratings:
54	Chauffeurs	5°						(16)		(16)	(2)		1° Class -- 1
55	Chauffeurs	6°						(7)		(7)	(1)		2° Class -- 6
56	Clerks	4°				(1)				(1)			3° Class -- 7
57	Clerks	5°						(1)		(1)			4° Class -- 9
58	Cobbler	5°						(1)		(1)			5° Class -- 38
59	Cooks, Asst.	5°					(1h)	(1)		(2)			6° Class -- 25
60	Cooks, first	4°				(1)		(1)		(2)			Total -- 86
61	Demolition man (t)	6°					(1h)			(1)			
62	Draftsman, general (t)	2°				(1)				(1)			(t) 8 technical specialists per H. & S. Company allotted by C.O. to meet local requirements, normally distributed and with duties as indicated.
63	Draftsman, Topographical (t)	1°					(1h)			(1)			
64	Electrician (t)	3°				(1)				(1)			
65	Horseshoers	4°					(1h)	(1)		(2)			
66	Mechanic (t)	6°						(1)		(1)			
67	Medical Technicians	6°								-	(3)		
68	Musicians	2°							(4)	(4)			
69	Musicians	3°							(6)	(6)			
70	Musicians	4°							(2)	(2)			
71	Musicians	5°							(15)	(15)			
72	Motorcycle Drivers	6°						(4)		(4)	(1)		
73	Packers	-					(4m)			(4)			
74	Painters, sign (t)	4°						(1)		(1)			
75	Saddlers	5°						(n) (3)		(3)			(m) 1 per Bn., 1 for H. & S. Company.
76	Topographer (t)	2°					(1h)			(1)			
77	Wagoners	5°						(12)		(12)			
78	Wagoners	-						(7)		(7)			
79	Miscellaneous	-					(16h)			(16)	(9)		
80	Total Enlisted					30	35	70	35	170	20		
81	Aggregate			2	6	32	36	71	36	175	26	1	
82	Horses, riding			2	6	6	31	1		38	12	1	
83	Mules, riding						5	5		10			
84	Mules, draft							74		74			
85	Mules, pack						16			16			
86	Total Animals					6	52	80		138			
87	(Mules, draft, spare)							(p) (14)		(14)			(p) Issued only in emergency, or when specially authorized.
88	Wagons, tool, 4-mule							12		12			
89	Wagons, F. & B., 4-mule							5		5			
90	Kitchen, rolling, 4-mule							1		1			
91	Cart, water, 2-mule							1		1			
92	Trucks, 1 1/2-ton, cargo (a)							(q) 16		16			(q) Includes 1 truck per lettered company.
93	Trucks, 3/4-ton, cargo (AA)							3		3	3		
94	Cars, motor, (D.S. or D.T.)							2		2			
95	Motorcycles, with side car							4		4	1		
96	Bicycles							3		3			
97	Pistols			2	6	26	7	9	36	78			
98	Rifles					6	29	62		97			

[NOTE: The above tables have not been approved by the War Department.]

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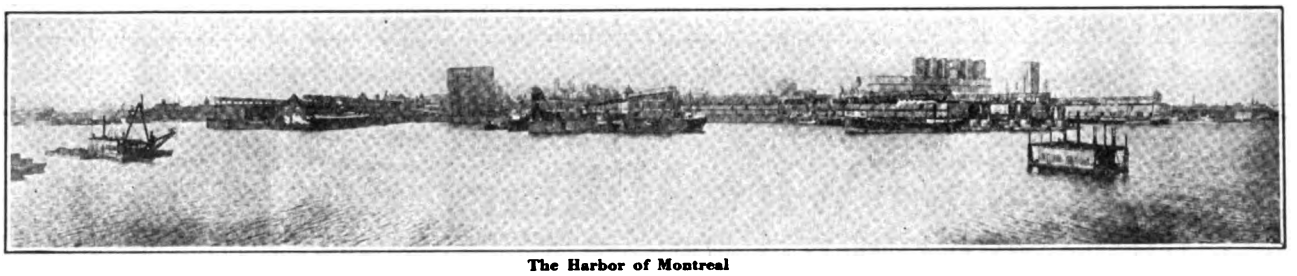
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The Harbor of Montreal

The Great Lakes-St. Lawrence Route to the Sea

By

Jno. C. H. Lee

Major, Corps of Engineers

A NAVIGABLE WATERWAY connecting the Great Lakes with the sea has been in the minds of progressive and farseeing Americans for many generations. The early explorers dreamed of it. The founders of our nation discussed it. The Erie Canal, built early in the last century from Buffalo to the upper Hudson, was an expression of it, and the prosperity thus brought to New York State and the Lake region was justification of the idea. Nor has Canada failed to act on it. By means of ship canals and improved river channels she has had 14-foot navigation from Lake Ontario to Montreal for many years. Like the Hudson below the Erie Canal, the St. Lawrence below Montreal has always been navigable for the vessels that could reach it from above.

Both countries have worked at the barriers between the several lakes, and the four upper ones are now interconnected for approximately 20-foot navigation. The rapid increase of commerce, however, has overtaken and passed beyond the capacities of the water routes below Lake Erie. Within the last decade the enlarged Erie Canal now known as the New York Barge Canal, affording 12-foot navigation, has been opened. This unfortunately offers even less navigable depth than the existing Canadian routes which parallel the St. Lawrence and which moreover the Canadians have apparently considered inadequate for some time past.

The bulk of lake-borne freight is now discharged from vessels in Lake Erie ports and transferred to the railroads. For export goods, a second transfer from railroad to ocean-going ships is, of course, necessary at the seaboard.

The strain which the war put upon all transportation in America has given further stimulus toward considering an adequate water route to connect the open sea with the great navigable lakes which border on some of the most productive sections of the United States and Canada.

The strongest expression of opinion today in favor of such a route is The Great Lakes-St. Lawrence Tidewater Association, which recently held its convention in Detroit. Their organizations in 14 states and representatives in many more are vigorously pushing the plan.

On the other hand some strong opposition has developed within this country and in Canada. The opposition is not as well organized apparently and may, therefore, not seem as strong as it may develop to be later.

Mr. Horace C. Gardiner, President of the Tidewater Association, recently said in a paper advocating the project that the territory included in black lines of Fig. 2 is economically nearer to Lake and St. Lawrence ports than any seaport east, south or west, either in actual miles or in considering mountain ranges to be crossed; that the territory is rightly called "The heart of the Country," because it comprises more than one-third of the continental area, more than one-third of the population, more than one-third of the wealth, and probably more than one-half of the productive capacity of the United States.

The latest available figures, according to Mr. Gardiner, show that within this area are produced the following percentages of the nation's total output:

	Per cent		*Per cent*
Corn	65	Cheese	57
Wheat	74	Apples	21
Flax, practically	100	Beet sugar	58
Cattle, over	50	Coal mined	36
Hogs	57	Coal reserves	72
Horses	60	Copper	39
Butter	54	Lead	46
Eggs	54	Zinc	74
		Iron ore	85

Production Centers

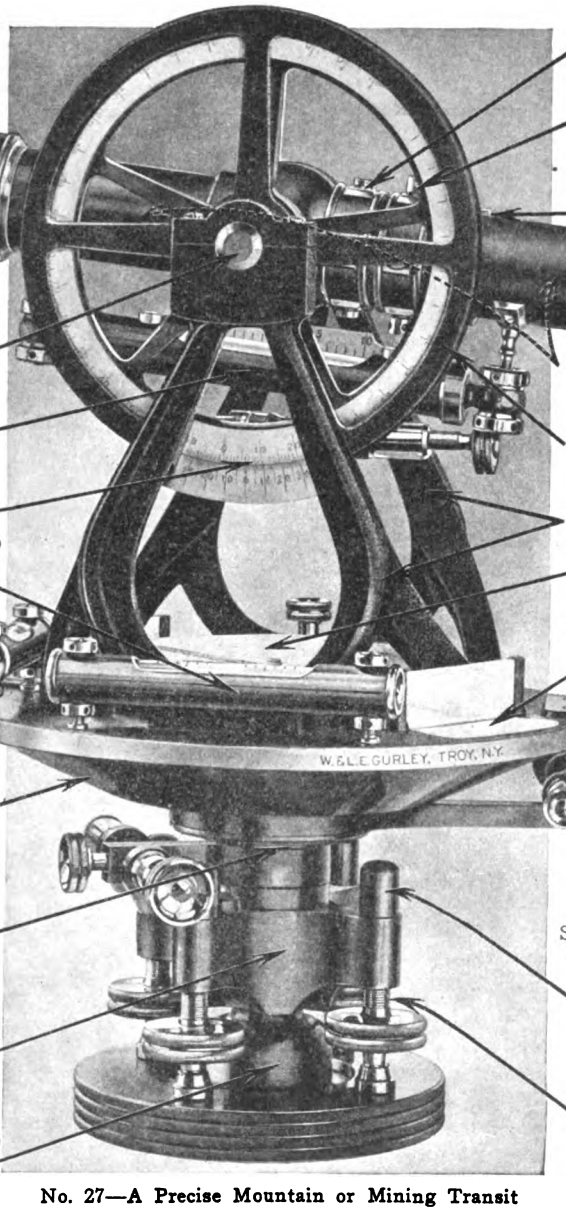
The encircled figure (Fig. 2) shows centers of population, production and value. They are based on data of 1910-1914, but, as Mr. Gardiner points out, such centers do not shift rapidly.

1. Center of population;
2. Farm acreage;
3. Farm values;
4. Wheat;
5. Corn;
6. Oats;
7. Potatoes;
8. Wool;
9. Tobacco;
11. Beet sugar;
12. Horses;
13. Sheep;
14. Milch cows;
15. Other cattle;
16. Butter;
17. Swine;
18. Iron ore;
19. Pig-iron production;
20. Bituminous coal reserves;
21. Bituminous coal production;
23. Manufacture—primary horsepower used;
24. Persons engaged in manufacture;
25. Manufacture — value added by—
26. Cheese;
28. Shoes;
29. Eggs;
30. Men's clothing;
31. Slaughtering and meat packing;
32. Automobiles;
33. Rubber goods.

Advocates of the plan point out that local charges on freight in the eastern seaboard ports are often in excess

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of the freight charges to those ports and often many times over. Moreover, they say that the congested condition does not improve, that the neck of the transportaton bottle is near New York, causing delay to freight and freighters, increasing costs and damage to export and import trade.

Illustrating the cost of handling freight locally in New York, Mr. William H. Adams, of the Detroit Board of Commerce, refers to the statement of the New York Society for Improving the Condition of the Poor that:

"Out of every dollar paid by dwellers on Manhattan Island for foodstuffs sixty cents goes for transportation *inside the industrial limits of the city.*"

Opponents to the St. Lawrence Route contend that equal or even greater difficulty and delay would be caused by the fog and ice of the river. The advocates come back with the answer that the new route will take the peakload of traffic—the late spring, summer and fall seasons—then releasing the lake-to-sea carriers for coastwise trade farther South. Moreover, freight cars on the shorter haul to Lake ports could be returned more expeditiously over their own lines, at least doubling their freight capacity.

The opposition claims that the lake carriers cannot navigate the more hazardous open sea and that the sea freighters will not find sufficient depth in the lake channels, locks and ports. To this contention the boosters reply that no one intends that the long lake freighters should ply the open sea, they have all they can do and more in the lakes; that strictly lake traffic will not lessen; and, as regards the ocean freighters, the majority of ocean freight today is carried in bottoms that can navigate the 21 to 25-foot depths of the lakes. In other words, the great ocean freighters would remain characteristic of salt-water navigation even as the long whale-back and freighter will remain of the lakes, but the bulk of the lake-sea traffic will be carried, as is always the case, by the average type well under 10,000 tons burden.

The geographical advantages of this route are pointed out by Mr. Gardiner. Fig. 4 shows a projection of the North American Atlantic and European-Atlantic ports, with meridians as straight lines and parallels as concentric circles. The following comparisons, however, measured in actual great circle distances, are quoted as of interest:

Rochester is nearer Liverpool than is New York; Buffalo is a few miles farther; Toledo is nearer Glasgow than is New York; also nearer Belfast and all Scandinavian and Baltic ports; Detroit is but a few miles farther.

From Erie and Ontario ports it is 250 miles farther via New York to northern French ports and all North Sea ports than via the St. Lawrence.

To Glasgow, Belfast, Scandinavian and Baltic ports the differential is 500 miles. To Mediterranean ports New York's advantage is small.

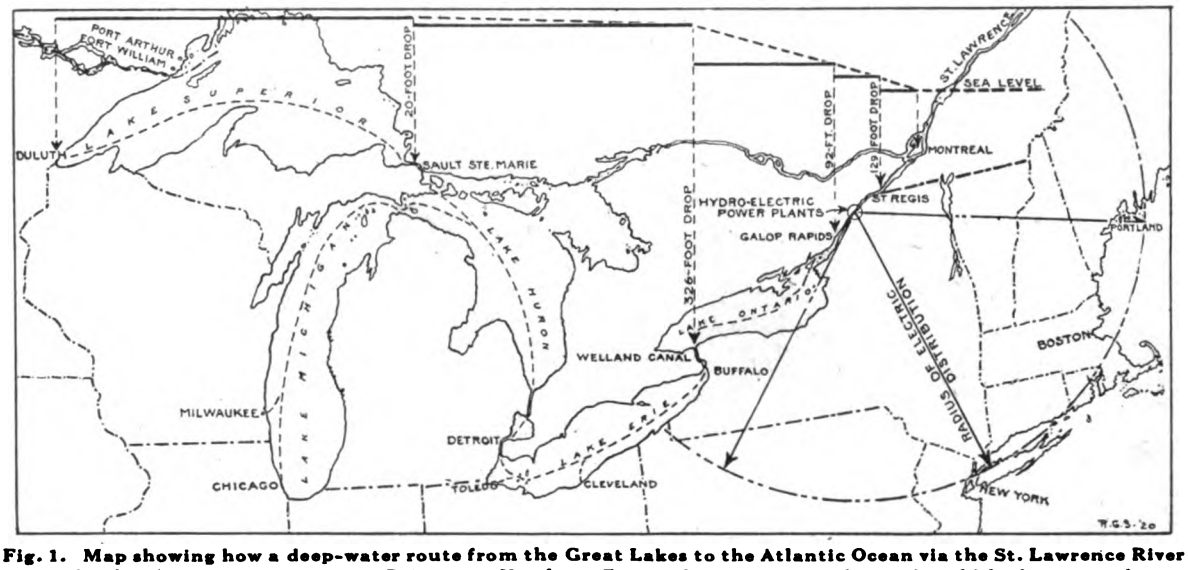


Fig. 1. Map showing how a deep-water route from the Great Lakes to the Atlantic Ocean via the St. Lawrence River would shorten a voyage to Great Britain or Northern Europe by quite 500 miles and yield hydro-power for distribution over a wide radius from the dams*

The advocates also express a belief that immigration from northern Europe to our Northwest will be stimulated and that the present lack of manpower in farming America and Canada will be relieved by these agricultural people being able to sail almost directly to the farming centers where many of their kinsmen are now developing the soil.

It is claimed also that something in the neighborhood of four million hydroelectric horse-power can be developed simultaneously with the river navigation improvements which must overcome the St. Lawrence rapids, that this power will be a boon to manufacture, will help solve the national fuel problem, and best of all, will actually pay for the cost of the entire project. The opponents deny this and say that the power is not needed. The pros and cons were generally summarized before the National Rivers and Harbors Congress during December, 1919, as follows:

For—

Bringing the Atlantic to the heart of the continent; making the Great Lakes an American Mediterranean; solving the national transportation problem; development of some 4,000,000 hydroelectric horse-power, thus remedying the national fuel crisis; enhancing the industrial powers of the seaboard; a national undertaking for national and international commerce; great saving in grain shipping costs; putting the profits into the pockets of the farmer; a lasting bond between the United States and Canada.

Against—

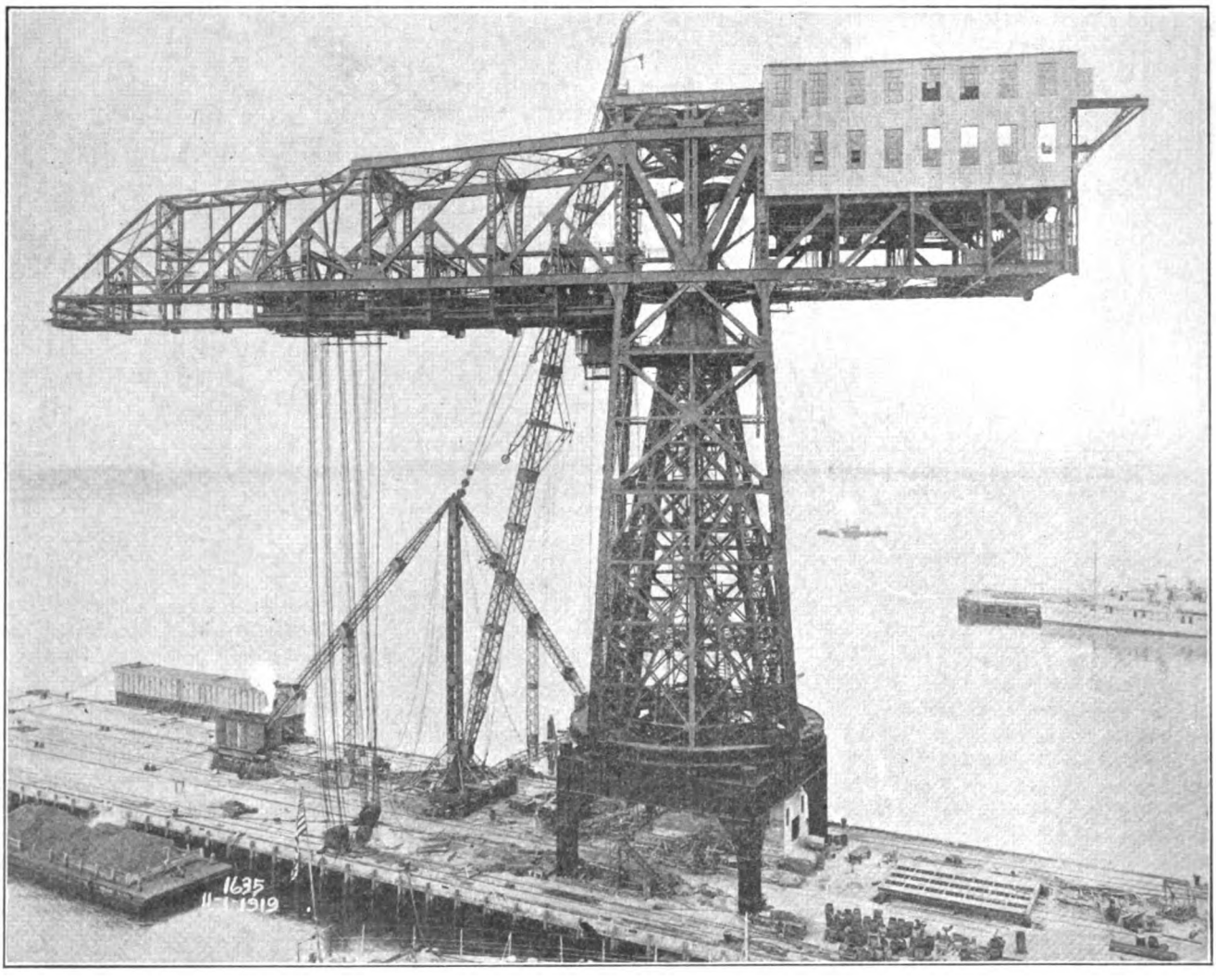
It would prove an economic failure and a waste of money; prohibitive cost; fogs and ice would make St. Lawrence Route too hazardous; ocean vessels cannot use restricted channels or afford lockage delays; no return

*Above illustration, from an article by Mr. Robert G. Skerrett, reproduced by courtesy of the *Scientific American*.

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loads, one-way traffic cannot be developed; underlying purpose is Canadian control of grain exportation; designed to destroy competition of the New York Barge Canal; the power is not needed; exposure to British naval attack.

Dismissing for the time being these questions of opinion it should be of interest to look into the real facts regarding the present condition of the Great Lakes-St. Lawrence water route. From our U. S. Lake Survey Charts, and they are thoroughly reliable, one can readily see that the Great Lakes generally are navigable for vessels of 21-foot draft.

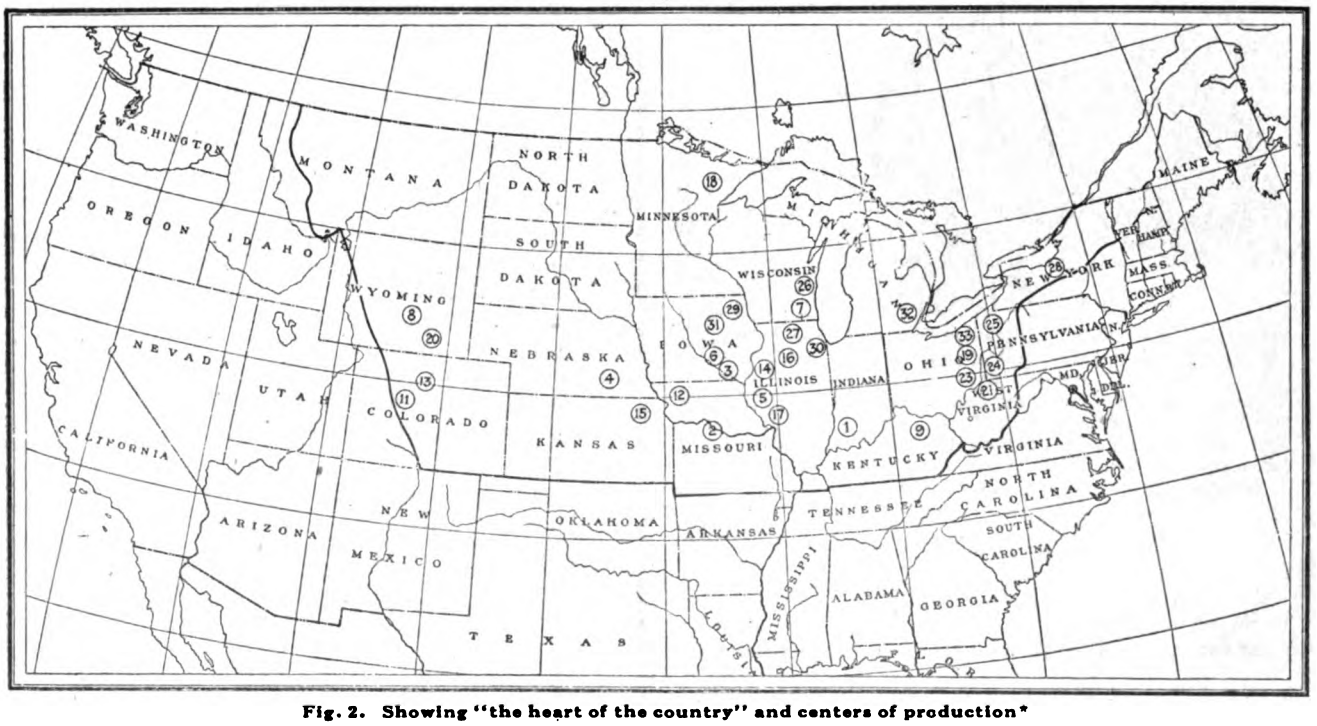


Fig. 2. Showing "the heart of the country" and centers of production*

The principal harbors have been dredged to this depth. Between the various Lakes of different level there exist certain natural barriers.

Between Lakes Superior and Huron the Rapids of the St. Marys River are now overcome by two large American locks, affording full depth, and by one Canadian and two American locks of lesser depth.

Between Lakes Michigan and Huron there is no important difference of level. The straits of Mackinac afford ample passage.

Between Lakes Huron and Erie the St. Clair River, Lake St. Clair and the Detroit River have been improved by the United States so as to afford 21-foot navigation.

Between Lakes Erie and Ontario stands the greatest barrier, Niagara Falls and Rapids. Our National Government has never undertaken the task of constructing a waterway around this barrier, although the matter has often been considered. The Erie and later New York State canals have been the only American developments. Canada, however, has had 14-foot navigation by means of her Welland Canal since the eighties. In 1913 she commenced a project to improve this canal to 25 feet, the twenty-five old locks to be replaced by seven lifts affording 30 feet over the mitre sills. Pressed by the demands of the war, Canada tried to push the work, but had to drop it in 1916 with the task about one-third completed. Work, however, was resumed last year and afforded employment to many discharged soldiers. Progress is being made in all sections and there is no doubt that its 25-foot navigation will be opened well before any channel of similar capacity can be completed along the St. Lawrence route below.

This new Welland Canal is an essential and therefore interesting link in the chain. Its line follows the old location from Port Colborne on Lake Erie as far as Thorold. Here, cut through almost solid rock, twin locks of three flights are being built. From that point the channel is practically straight, using four single locks, to the new Port Weller on Lake Ontario. Each lock has a lift of 46½ feet. The channels will be 200 feet wide on the bottom, 310 on the surface. The canal is 25 miles long and the time required for passage is expected to be about 8 hours. The original estimated cost was 50 million dollars; probably it will total between 80 and 100 million.

The barriers below Lake Ontario consist of the rapids of the St. Lawrence River between Ogdensburg, N. Y., and Montreal. Parts of this stretch are navigable. The Canadian Government has for years been operating a series of ship canals giving 14-foot navigation around the different rapids. Some of the rapids are navigated by down-bound vessels, but up-bound vessels must use the canals.

It is in this section that the real problem lies, the problem of opening deep water navigation from the Lakes to the Sea. Below Montreal the Canadians have already provided a 30-foot open river channel to the Atlantic.

The United States Rivers and Harbors act approved the 3d of March, 1919, carried a provision requesting the existing International Joint Commission (created by treaty, 1909, between Great Britain and the United States for boundary matters) "to investigate what further improvement of the St. Lawrence River between Montreal and Lake Ontario is necessary to make the same navigable for ocean-going vessels; together with the estimated cost thereof; and report to 'both governments' recommendations for co-operation by the United States with the Dominion of Canada in the improvement of said river."

Accordingly, both our government and that of Canada

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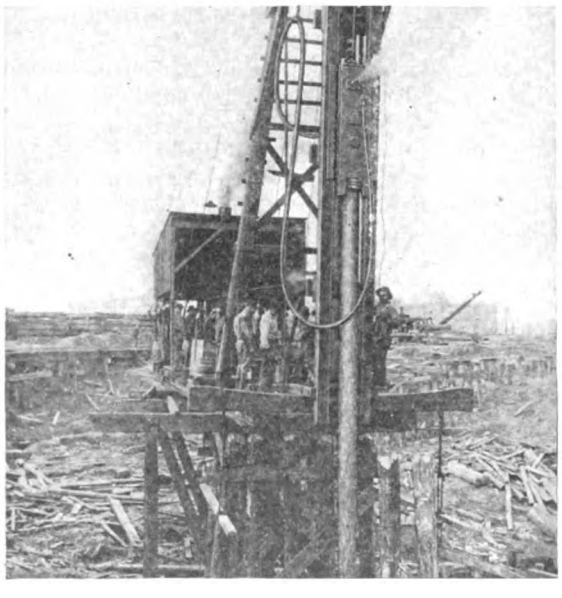
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asked the Joint Commission definite questions, the most important of which are: "What further improvement is necessary—for deep-draught vessels of either the lake or ocean-going type; what draught of water is recommended; and what is the estimated cost?"

In answering these questions the Commission is requested to consider:

(*a*) Navigation interests alone, whether by the construction of locks and dams in the river; by side canals with the necessary locks; or by a combination of the two.

(*b*) The combination of navigation and power interests to obtain the greatest beneficial use of the waters of the river.

In order to facilitate and expedite the preparation of the report, each Government appointed an engineer, the two men having full authority to confer mutually and to co-operate in acquiring data and in preparing plans and estimates. These plans and estimates must be submitted to the Commission within one year after the engineers were named. For the United States, Col. W. P. Wooten, Corps of Engineers, was appointed in January, 1920. Colonel Wooten is the officer in charge of the United States Lake Survey. For Canada Mr. W. A. Bowden, Chief Engineer of the Canadian Department of Railways and Canals, was appointed in March, 1920. All concerned are now busily engaged in the collection of information and in the preparation of plans and estimates. The Joint Commission has been holding public hearings for several months.

Between Lake Ontario and the International Boundary the United States Lake Survey had already covered the St. Lawrence with accuracy greater than was possible to repeat within the allotted time. Similarly, the Canadian Government had charts of the river below the boundary. It has, therefore, become necessary only to supplement this information by more detailed surveys and borings at critical points. At such places investigations are being pushed with energy and thoroughness.

The writer has corresponded and consulted with the two engineers, and through their courtesy is able to outline briefly the essential physical data now known. Of course, neither engineer can properly express an official opinion at this time, and neither could with propriety be quoted personally. There are many problems to be considered; navigation depths, discharge, compensation of water levels, flowage areas and damages, power development costs and possible market value, construction difficulties, foundations, ice obstructions and many others. The report of the Engineers to the Joint Commission will be a statement of such facts and estimates as they can, in general, present in so limited a time. There is no reason to believe, however, that sufficient data will not be available to enable the Commission to arrive at a sound recommendation.

It is of interest to look at those characteristics of the St. Lawrence already of record—the better to understand the problem that confronts our engineers. The river's tributaries above Lake St. Louis, where it is joined by the Ottawa River, are relatively insignificant. Its waters, therefore, having been subjected to long periods of sedimentation in the various lakes, are clear and carry practically no matter in suspension. Its flow is governed by the elevation of water in Lake Ontario. As that lake has an extreme fluctuation of about five feet and an ordinary annual fluctuation of very much less, the St. Lawrence naturally has a remarkably steady flow. No other river of its size compares with it in this respect. Its flow varies ordinarily from 200,000 to 280,000 cubic feet per second, although during the period 1888-1919 it has at times dropped as low as 186,000 due to a certain amount of ice choking. During extreme high water it has once or twice reached 300,000. Its lack of material in suspension, its constancy of flow, the stiff and stable quality of the material through which it flows, combine to render its banks and bed remarkably constant. Natural changes within the memory of man are practically unknown.

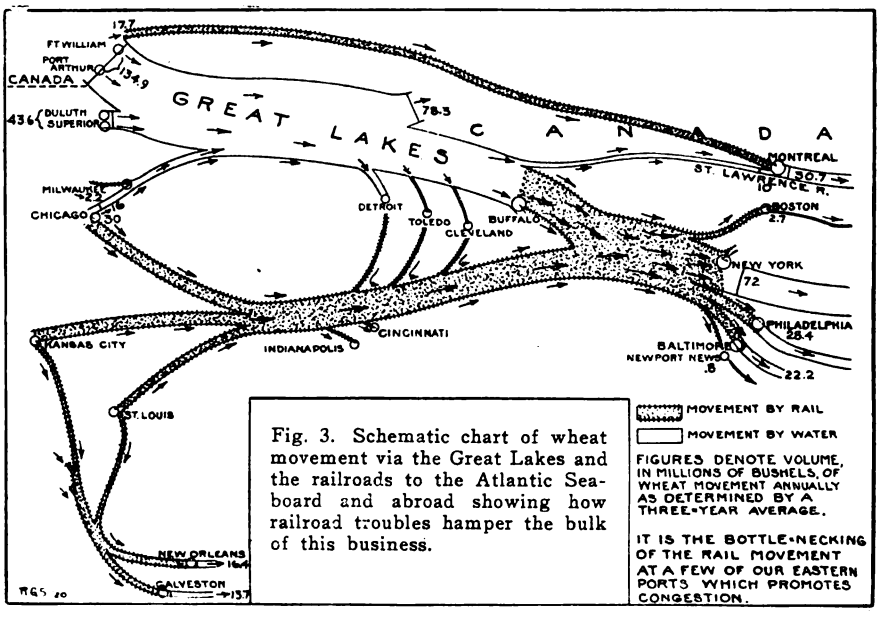


Fig. 3. Schematic chart of wheat movement via the Great Lakes and the railroads to the Atlantic Seaboard and abroad showing how railroad troubles hamper the bulk of this business.

Just above Montreal, in Lake St. Louis, the Ottawa River offers an additional problem. This stream has a very wide fluctuation, reaching a discharge in high water approximately equal to that of the main river. However, this condition affects only the lower end of the stretch requiring improvement. It is practically a local problem.

The river distance from Lake Ontario to Montreal (see Fig. 8), is about 182 miles and the total fall is between 220 and 225 feet. Considering that there are several long broad reaches, approximating lakes, it is evident from even a cursory examination that this length of the river naturally divided itself into six distinct sections of quite different local characteristics, each requiring special study and consideration and possibly its own special method of improvement.

The first section extends from Lake Ontario to just below Ogdensburg, N. Y. The total fall in this 62 miles is less than 1 foot. As one would expect, the river is broad and deep, and the velocity is low. The channel gives depths of 40 to 120 feet. Except in two places the width is better than 500 feet. Where the river passes the Thousand Islands and again at the Brockville Islands, the present ship channel is only a little wider than 400 feet and would probably require some work. For security of deep draught vessels this entire stretch should be "swept" in order to locate isolated pinnacles which may have escaped the soundings of previous surveys.

The second section extends from below Ogdensburg to

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the head of Lake St. Francis, or where the St. Regis River comes in at the International Boundary. From this point on, the St. Lawrence flows entirely in Canadian territory. The length of this second section is about 54 miles and its fall is about 90 feet. Three rapids account for the greater part of this drop; the Galops Rapids, the Rapids Plat and the Long Saulte. The Canadian Government operates side canals, affording 14-foot navigation around these various rapids. The Galops Canal takes care of the rapids of the same name. The Morrisburg Canal overcomes the Rapids Plat. The Farrin Point Canal provides passage around a small drop of 4 feet. The Cornwall Canal takes care of the Long Saulte. Otherwise, vessels use the open river. Descending vessels habitually shoot all rapids except the Long Saulte. This rapid is navigated only by passenger boats featuring the excitement of the trip.

This second stretch offers quite a problem for improvement. One can hardly expect that dams and slack-water will be recommended for the entire section because sufficient water to flood out the upper (Galops) rapids would raise the level of the upper river and Lake Ontario about 15 feet. It would seem after brief study that dredging would be practicable in the upper Galops provided the lower part is drowned out by slack-water backed up by a dam further down stream. If dredging here were resorted to, care must, of course, be taken to provide a sufficiently large cross section to keep down the velocities in the ship channel.

It would seem that a dam in the general vicinity of Cornwall, and possibly another somewhere above, would provide sufficient depth for navigation while developing well over a million horsepower.

It is understood that a commercial project was at one time planned for a power dam near the head of Croil Island. Our engineers have made borings above Cornwall, as well, and have found rock at what might seem to be desirable elevations. The solution of the problem must, of course, be based on a balance of costs against the facilities developed. If the rock for the foundations of the upper dam is found at about the same elevation as at the lower site, then a single dam project would probably have an advantage in cost of dam construction, cost of power installation and better provision for navigation. The flowage damage or cost of dykes would be greatly increased between the two sites.

Realizing that the power developed at this section of the river could be delivered to the greater part of New England and New York (see Fig 1), there should be no difficulty in disposing of it at a figure sufficient not only to pay interest on the investment, but also on other work of the same project, if not indeed to give ultimately a return on the original investment. Considering the steady flow of the river and the high machine efficiency now possible, it would seem sound to count on about 75 per cent of the total theoretical horsepower or at least 1,750,000. If this were sold at $20.00 per horsepower per year it would return 7 per cent on $500,000,000.

The third section may be taken as Lake St. Francis, where for some 28 miles the river widens to four or five miles. In some places the channel will require widening and deepening. There is no apparent reason why open lake navigation cannot be provided for ocean-going craft at a low cost.

The fourth section is a stretch of 14 miles connecting Lake St. Francis with Lake St. Louis. In this length is a series of rapids; the Coteau, the Cedars, the Split Rock and the Cascade—a total fall of about 80 feet. At present a few down-stream boats "shoot" the rapids. The Soulonge Canal provides 14-foot navigation on the northern side. The old Beauharnais Canal lies on the southern side.

This section offers a problem similar to the second, but probably with not as many factors. There are apparently good general locations for a dam in one or two sections at the head of Lake St. Louis, just above the mouth of the Ottawa River. Judging from their practice in the past, however, we can expect the Canadians to consider seriously, if not indeed to favor, a ship canal around the rapids. A cursory examination would indicate that such a plan is practicable on the southern side. If no great obstacles are encountered, say in the valley of the St. Louis River, such a project should be considerably cheaper than a fixed dam and slackwater. Moreover, it is possible that if a fixed dam developing the full power head were installed and the power offered at the same time as that of section two, there would be little chance of complete utilization for several years. If this be true, if the power could not be immediately marketed, it might prove economical to provide the cheaper ship canal for the first decade or so, and later, if conditions seem to justify, make provisions for further development of the power.

The fifth section is Lake St. Louis, 15 miles long and rather shallow through the greater part of its 5 to 6 mile width. There exists, however, a fairly good channel which will require deepening and broadening, at least in parts. Due to the influence of the Ottawa River, whose variation in flow

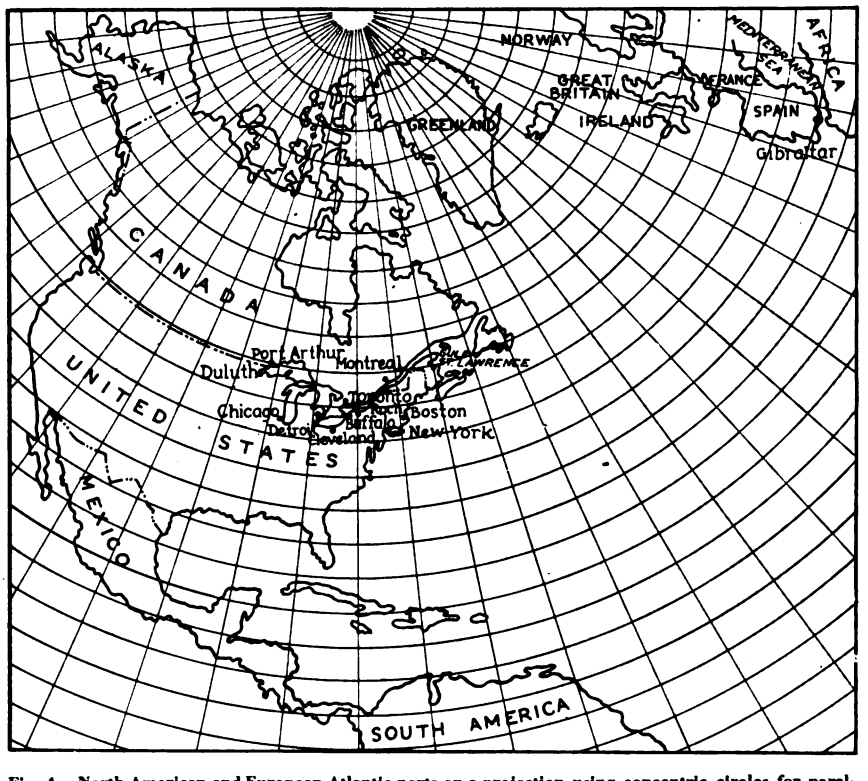
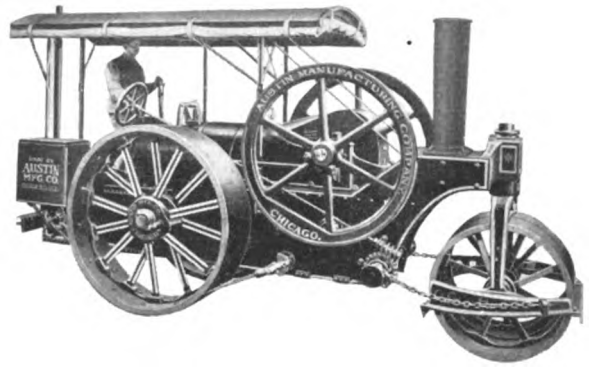


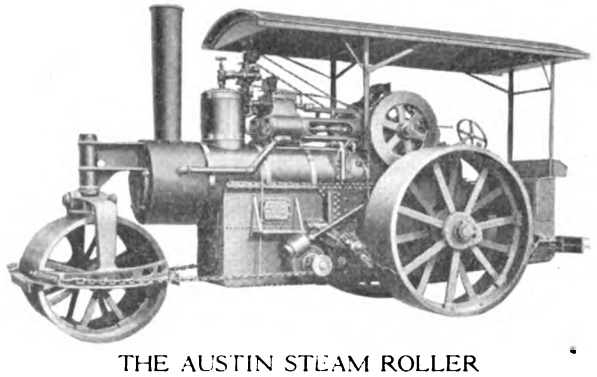
Fig. 4. North American and European Atlantic ports on a projection using concentric circles for parallels and radial lines as meridians. (Courtesy of Mr. C. Gardner.)

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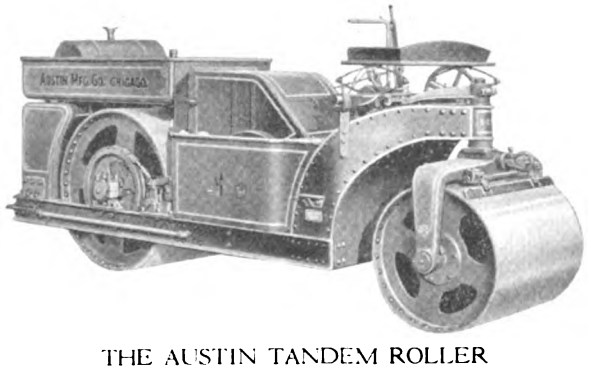
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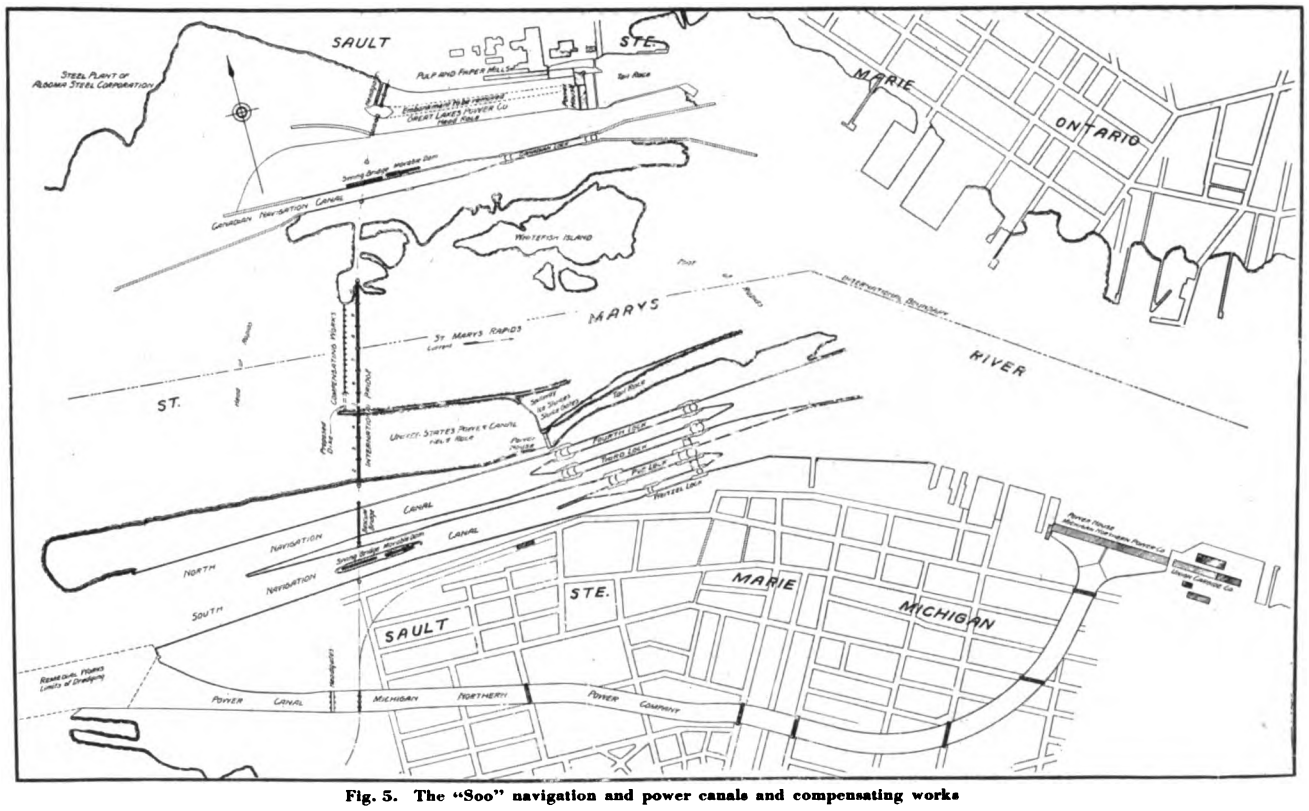


Fig. 5. The "Soo" navigation and power canals and compensating works

is quite large, the characteristics of the St. Lawrence below this point are less constant than above.

The sixth section is 9 miles of river between Lake St. Louis and Montreal. The river pitches down the Lachine Rapids, thence through the Prairie Basin, a broad and shallow lake with low banks. The total fall is about 50 feet, most of it confined to the Lachine Rapids which are navigated only by a few down-bound passenger boats. The Lachine Canal passes around them on the northern side, affording the regular 14-foot navigation. The improvement of this stretch is a problem in which the Canadian engineers can be expected to have most serious interest. Safeguarding the city of Montreal against the combined waters of the St. Lawrence and the Ottawa will play an important part. A power dam opposite or below Montreal, near the mouth of the present Lachine Canal, would require long dykes or levees to protect the city. Moreover, due to the low lying banks, a great flowage or very extensive dyke construction would be required on the southern side. This expense, coupled with the unreliability of the Ottawa River's discharge, would probably raise considerable opposition in the vicinity of Montreal. Moreover, it is understood that practically the only open opposition to the project in Canada is centered around Montreal, the present head of deep water navigation.

It is not improbable, therefore, to expect that some project such as the improving of the existing Lachine Canal will be seriously considered. If power is to be developed further, the site will probably have to be located above Prairie Basin at the foot of the main rapids. If navigation were locked past such a dam, there would remain the shallow Prairie Basin to be considered. The Basin has sufficient slope to make dredging through it perhaps a double task. As in the Galops Rapids of section two, if a single 600-foot channel 30 feet deep were cut through, hydraulic conditions would be so improved as to develop velocities probably beyond those desirable for navigation. Either additional cross section could be dredged, or the adjacent water kept out by a dyke, thrown up from the spoiled material which would be mainly rock.

This brings us to the head of existing 30-foot navigation to the sea. The Canadian Government has now provided at considerable expense, a good sailing channel through which some four million tons per season come up and go on through the cramped upper canals, to the lakes. The river and canals are usually open to navigation from the middle of April to the first part of December. During the winter and early spring ice closes the route.

Thus we see confronting the engineers and the Commission, six sections of river, three of which offer little or no difficulty; the upper river and the two "lake" reaches. There remain three stretches of rapids requiring individual study and investigation. Possibly they will require separate and different treatment.

The engineers are confronted with several interesting side problems. One of the first is the regulation of water flow in the river by the control of water level in Lake Ontario. A steady flow of large volume is desired in the river, yet a maximum and minimum level must not be passed in the lake. Naturally, the property owners on Lake Ontario care neither to be flooded out nor yet left high and dry. The power and navigation interests along the river cannot be given a perfectly steady flow, but it should be possible to guarantee them a minimum of about 200,000 c. f. s. without detriment to Lake Ontario interests. This takes into consideration 10,000 c. f. s. for the Chicago drainage district.

Another problem is that of ice. The Canadian engineers, and our own to a more limited extent, have been working on the problem for years. There is surface ice, "snow" ice, "frazil" ice and "anchor" ice. Rapidly moving water exposed to the bitterly cold air becomes chilled below 32 degrees, and then will frequently perform unusual things. For example, zero temperatures lower even the

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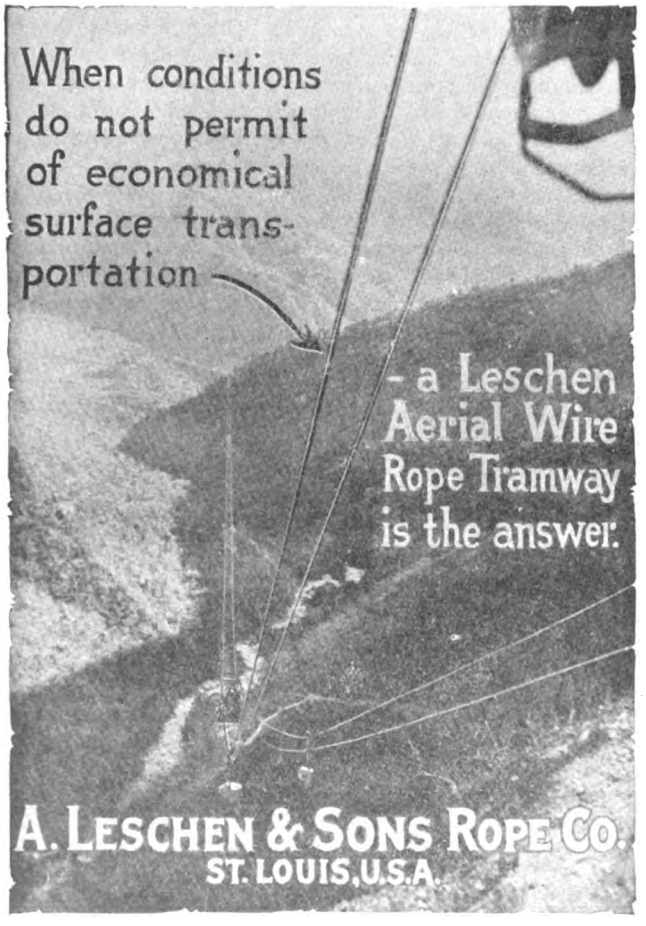
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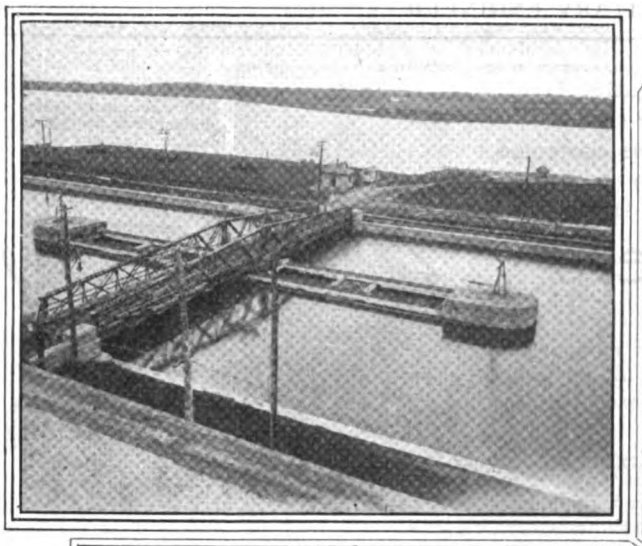
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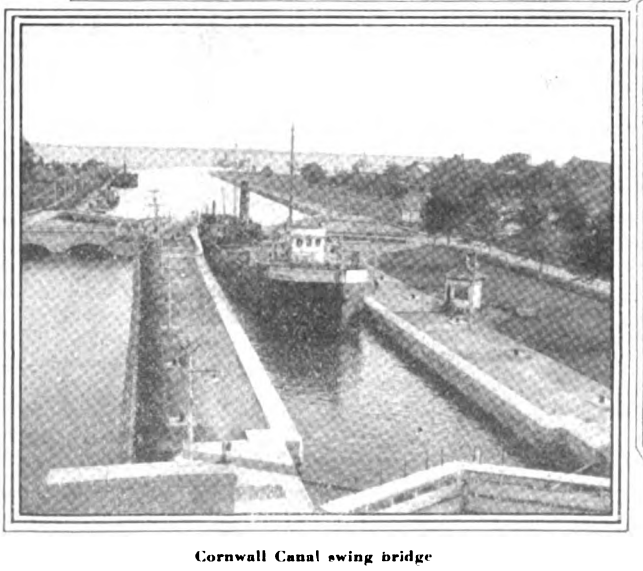
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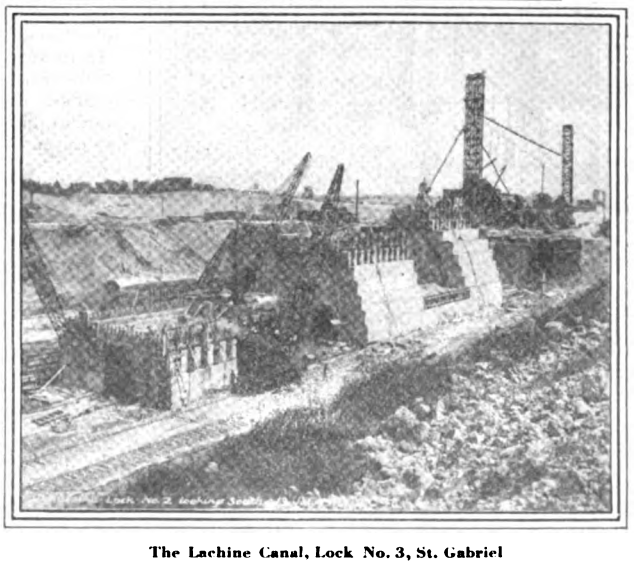
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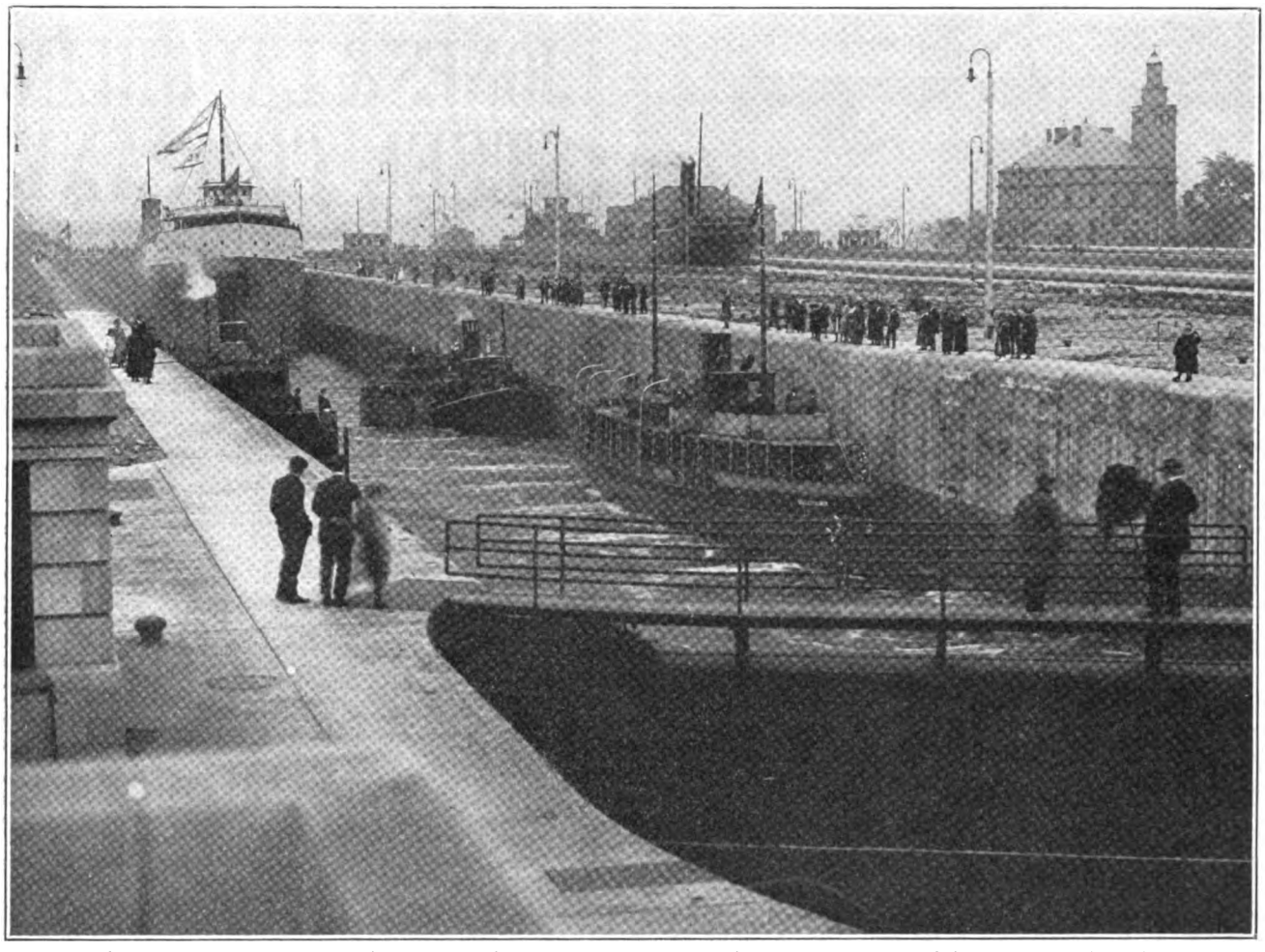
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The "Soo." The most important link in the world's greatest waterway. First lockage in the new fourth lock, September 18, 1919

deeper water almost to freezing. When further exposed to the air at the swift and shallow rapids the water temperature falls to and below 32 degrees. Churned up among the rocks of the rapids it freezes much as do water ices or sherbets in an ice cream freezer. This is called "frazil" ice. Moreover, snow falling on such water does not melt but remains in suspension, floating along with the frazil ice. When quiet water is reached with its hard surface ice, the frazil and snow ice flows under at reduced velocity. The soft ice floats to the top and becomes congealed to the bottom of the surface ice, rapidly deepening it and causing unusual conditions. Anchor ice is solid and grows gradually from the bottom up. Ice packs and gorges often cause grave concern, with their attendant high water, but the river has a way of working under the ice and freezing itself. The engineers admit that the problem is extremely interesting, but there is no indication that they think it insurmountable.

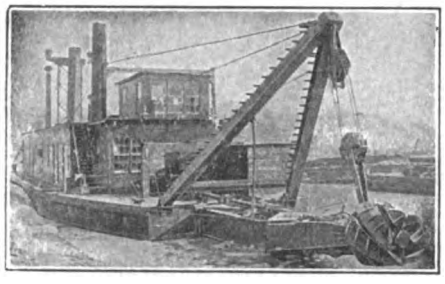
The construction of dams in the main river bed should prove an engaging task to the men who may have to do the field work. Naturally the choice of dam sites will have to be governed to no small extent by this consideration. There is no way of shutting off the water during the working season. The flow is then distressingly steady. There is no "low water" as on the Ohio or the Mississippi. The task, if undertaken, must clearly be considered in its entirety, otherwise great difficulty, if not disaster, may result to construction work due to damming below or dredging above.

The economic feasibility of developing at first the full available hydro-electric power opens a serious question. Between Lake Ontario and Montreal the total theoretical horsepower is readily computed as over 6,000,000, 75 per cent of which totals some 4,500,000 horsepower. Whether or not this amount should be made available from the start or be provided for at an increasing rate, is a problem of industrial economics *vs.* costs and interests on costs of installation. To date only about 200,000 horsepower is actually being developed. Most of this is at two plants, one at Massena, N. Y., and the other at the Cedar Rapids between Lake St. Francis and Lake St. Louis. Plans for damming the river at the Long Saulte Rapids were prepared by a company some ten years ago. Failing to get legislative authority the project was finally abandoned. It is of interest to note, however, that financial interests were anxious to back the project for its power development and income. Although such a company would have to put in locks for the passage of navigation, the interests backing the scheme would derive little direct benefit therefrom. They merely recognized that the power would pay well on their investment.

Such being the general project, there naturally arises in one's mind the question: Is it practicable? Within a year the Joint Commission advised by the United States and Canadian engineers will make its report and recommendations. We can rely on them to recommend soundly. In the meantime we can do little more than consider the opinions of eminent public men on the question.

The writer has been told that a proposition has been suggested by a group of railroad engineers to lay a new

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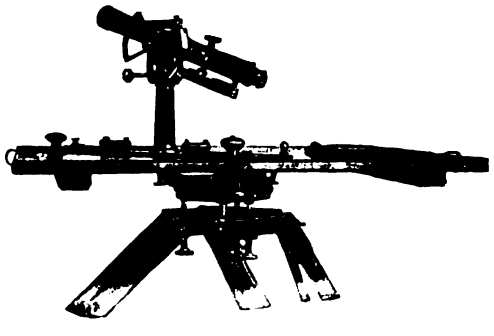
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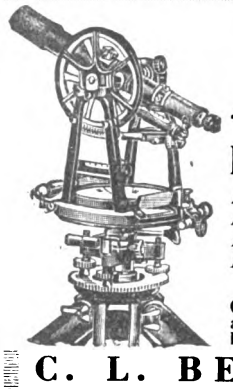
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four-tracked-trunk-freight-line from a suitable point in the middle west, direct to a suitable eastern seaport, avoiding all existing railroad centers with their attendant congestion. The writer has been unable to get the details of this plan, or the names of the gentlemen responsible for it. It is said that they claim great saving would result and the first cost plus operation would be cheaper than any water route.

Mr. Herbert Hoover, in his study of the food and transportation situation, stated: "One of the first things which an engineer in surveying this problem would advise, would be the creation of a water-way all the way from the Great Lakes to the Sea by way of the St. Lawrence River. An engineer knows that this could be done at less expense than would be involved in increasing our railroad facilities to care adequately for our marketing."

Certain Eastern opponents of the plan claim that it is not practicable. *The Engineering News-Record* of New York, on the other hand, has said: "The opposers are those New Yorkers who fear for the prestige of the country's principal port and foresee the abandonment of the costly barge canal." Then it goes on to say, "New York, a year-round port, fed by the great railroad systems of the Nation, blessed by a magnificent basin of deep and still water at its very warehouse doors, has nothing to fear from the St. Lawrence Waterway; there also need be no fear for the abandonment of the Barge Canal following the canalization of the St. Lawrence."

The Merchants Association of Greater New York in April, 1920, condemned this project as chimerical and resolved that the delegates recommend to their respective chambers and commercial organizations that they use all reasonable means in opposition to a recommendation on the part of the International Joint Commission in favor of the United States joining with Canada in the construction of the proposed Ship Canal.

The New York State Legislature went on record last spring as emphatically disapproving the St. Lawrence project and sent copies of the resolution to the New York Senators and Members of the House of Representatives.

In this regard it is interesting to note that Dr. Roy S. MacElwee, Director of our Bureau of Foreign and Domestic Commerce, in advocating the St. Lawrence project, says: "It does not mean that all the traffic which will go out through the opened St. Lawrence will be traffic taken away from New York. On the contrary, it will be largely traffic that New York never can get because the merchandise at present can not bear the cost. It will be new business. The St. Lawrence will furnish abundant cheap power. The revival of lake shipping and cheap power are the two things needed to give the new barge canal the success it deserves. The New York state barge canal will be the greatest beneficiary of the St. Lawrence project."

Former Secretary Lane says: "It will make the Great Lakes the American Mediterranean for at least eight months of the year, making the lake cities practically sea ports, relieving the burden of the railroads, giving the Middle West more rapid dispatch to foreign markets at a saving of at least 5 cents per bushel." He adds that primarily he favors the project because of the tremendous electrical development and its subsequent saving to the country.

Governor Wm. L. Harding, of Iowa, has said: "Iowa knows that it is impossible to move its farms to the ocean but believes that through the St. Lawrence and the Great Lakes the ocean can be brought to them, and so Iowa is heartily in sympathy with the plan of developing the great water course to the extent that it will carry ocean-going vessels."

Dr. MacElwee, in his recent address before the Waterway Congress, asked: What ships will come into the Great Lakes from the ocean? Then he presented the figures of the United States Shipping Board, which show that the great majority of ocean going freighters today can navigate channels of 21 to 26 feet. Ships drawing 25 feet will be able to reach upper Lake Erie, while the 21-foot vessels will go beyond. Vessels can load to 21 feet in Superior, Michigan, or Huron, and complete their loading in Erie or below, to 26 feet, taking on the remainder to 30 feet at Montreal. Then, Dr. MacElwee asks, since they *can, will* they? His answer is based on the extensive use of the Manchester Ship Canal, where some 5,000,000 tons pass Liverpool annually and go through 36½ miles of restricted channel in order to reach a single city. The Kiel Canal, 61 miles long, is used in preference to the open sea in order to save a few hundred miles. And he shows further that many European ports, particularly in the Mediterranean and Black Sea, offer little or no greater depth than our lake harbors. Dr. MacElwee strongly favors the project.

Mr. Alex T. Vogelsang, 1st Assistant to Secretary of the Interior, stated, while acting as Secretary of the Interior: "Enlightened selfishness, the truest and highest interest of our country, our duty to all mankind, alike dictate that our back door as well as our front door be opened to ocean borne commerce." Moreover, he says, and his opinion de-

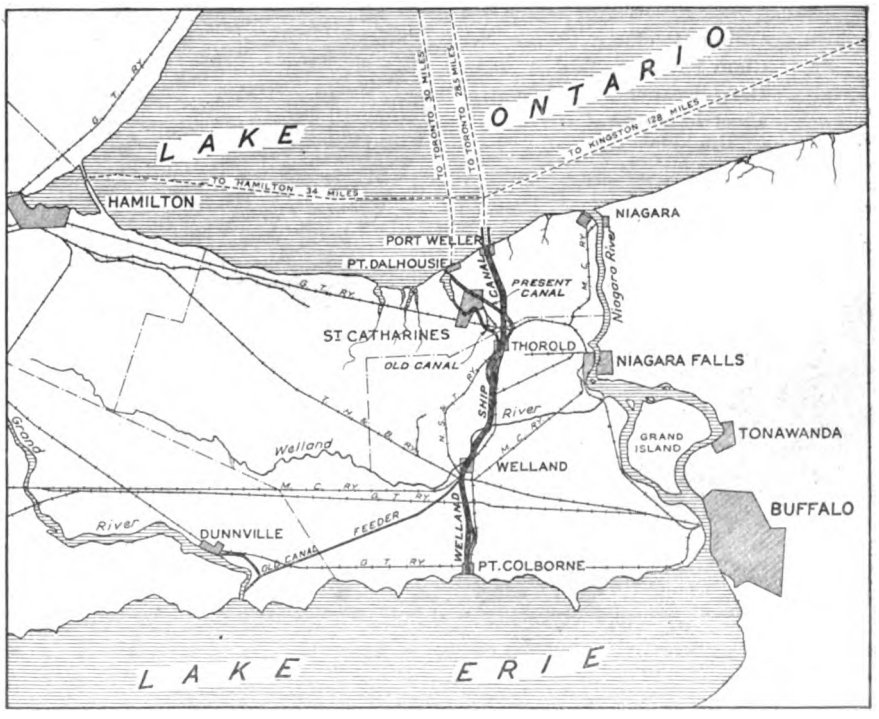


Fig. 6. Welland Ship Canal

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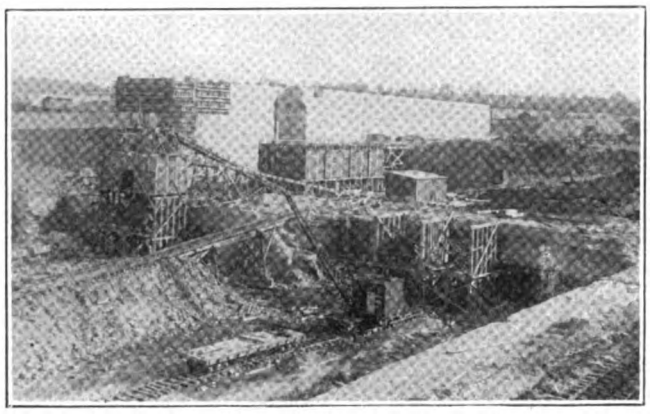
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mands respect, that the power development can pay for the job.

Senator Chas. E. Townsend, of Michigan, said in a recent address: "We spent something over $400,000,000 to build the Panama Canal, but as far as serving the business interests of the country and of the world are concerned, the benefits are not comparable to those that would come through the development of the St. Lawrence Waterway to the Sea." Opponents of the plan might reply that the Panama Canal was not built entirely for business reasons.



Welland Ship Canal. Thorold locks, flight 4, 5 and 6

Mr. Julius H. Barnes, recent head of the United States Grain Corporation, says it may safely be estimated that from 5 to 6 cents per bushel on the exportation of grain could be saved via the St. Lawrence route over present facilities. If we continue to export 300 millions of bushels of grain, a saving of 15 to 18 million dollars would result in that trade alone. He points out that while to-day the railroad method of shipping grain to our eastern seaports keeps a heavy majority of our freight cars in the east for a majority of the months, if lake ports could be used for exporting grain the freight cars could make several short hauls to the Lakes during one season, and move largely under their owners' control. Union Pacific and Rock Island cars would not habitually winter in eastern yards.

Mr. Charles Whiting Baker, Consulting Editor of the *Engineering News-Record,* who has severely criticized what he terms our "lavish" national expenditures for inland water navigation, contends that generally speaking rail transportation is cheaper in the interior than canals and improved rivers, but nevertheless favors the development of a deep waterway connecting the Lakes with the sea. He contends that the final governing economic factor between railroad and water routes, lies in the cost of terminal charges, and therefore that the New York Barge Canal, necessitating a shift at Buffalo and again at New York, will prove prohibitive in cost for export commerce. He points out what has already been accomplished by the Shipping Board in a steamer sailing from Chicago direct to Liverpool. He believes that very capacious and seaworthy vessels can be built for the draft of 21 feet, and while habitually plying between sea ports during the greater part of the year, would then be released for coastwise trade during the closed lake season. Mr. Baker indicates a belief that the St. Lawrence project is a worthy one, but cautions that adequate terminal facilities must be provided if commerce is to be properly developed.

A statement of Mr. Baker on one point is of interest: "Lowering the cost of transportation between the Atlantic Coast and the interior cities on the lakes will benefit the Atlantic seaport cities ten times as much in domestic traffic as any loss of foreign business could injure them."

Open opposition to the plan seems to center in New York State. Before the National Rivers and Harbors Congress in December, 1919, Mr. Edward S. Walsh, Superintendent of Public Works, State of New York, spoke against it, as did also Mr. Geo. Clinton, of Buffalo. In addition to the contention before mentioned, these gentlemen declare that the St. Lawrence improvement would help a few states to the great injury of Southern, Southwestern, Middle and Atlantic states; that it would let Great Britain become a serious competitor in Great Lakes traffic; that our expenditure would greatly benefit Great Britain and Canada; that the improvement, lying largely in Canada, would menace our lake states in case of trouble with Great Britain; and that there would be no saving of coal by production of electric power, because almost all of the power would go to Canada.

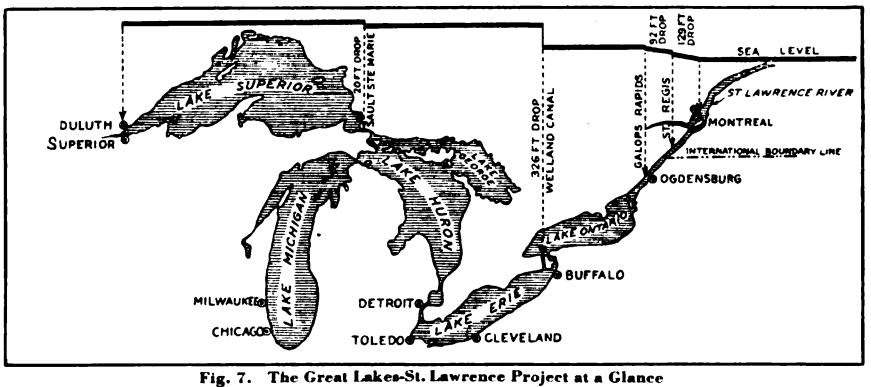


Fig. 7. The Great Lakes-St. Lawrence Project at a Glance
Courtesy of the Tidewater Association

The way opened

At the Soo—
Depth in Locks, 24½ feet.
Length of Locks, 1350 feet.

Connecting Waters
Channels, 20 to 21 feet.

The work in hand

At Niagara—
The New Welland
30-Foot Locks
25-Foot Channels
Total Lift, 326 Feet

The rest of the job

"A Short Stretch of Tumbling Rapids in the St. Lawrence"

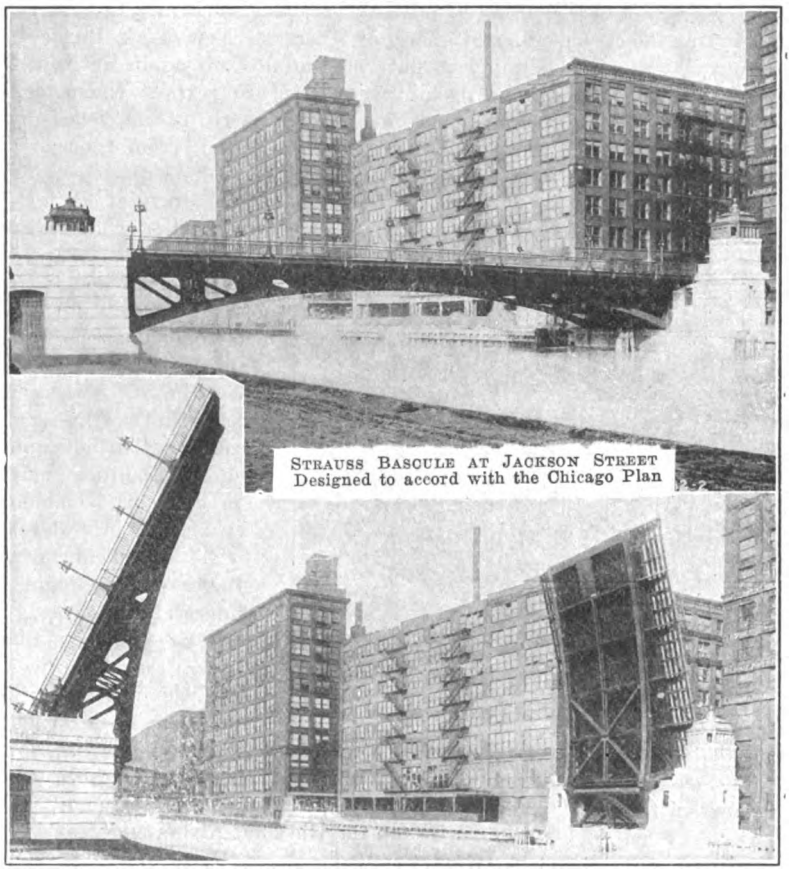
Ontario to Tidewater	181 miles
Navigable River	135 miles
To be Improved	46 miles
Total Lift	221 feet
Estimated Cost—	
International River	$60,000,000
Canadian River	50,000,000
Estimated Power—	
International River	2,000,000 hp.
Canadian River	2,000,000 hp.

Senator Lenroot, of Wisconsin, before the same Rivers and Harbors Congress, replied to the above objections. Whether or not they were answered is a matter of opinion. These papers can be readily obtained.

Proponents of the scheme claim that a very large amount of power would be used in New York, developing industries along the barge canal where raw materials could be brought in and the finished product sent out by the water route. They say that not only will the newly developed power replace that now made from coal, but will save the coal used in transporting the power coal, as transportation lines will become electrified. All in all an annual saving of many millions of tons of coal is predicted, as well as the labor of thousands of men.

In his speech before the House, in

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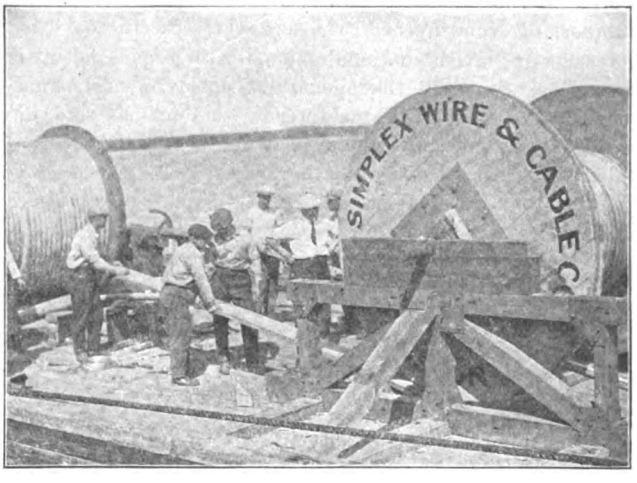
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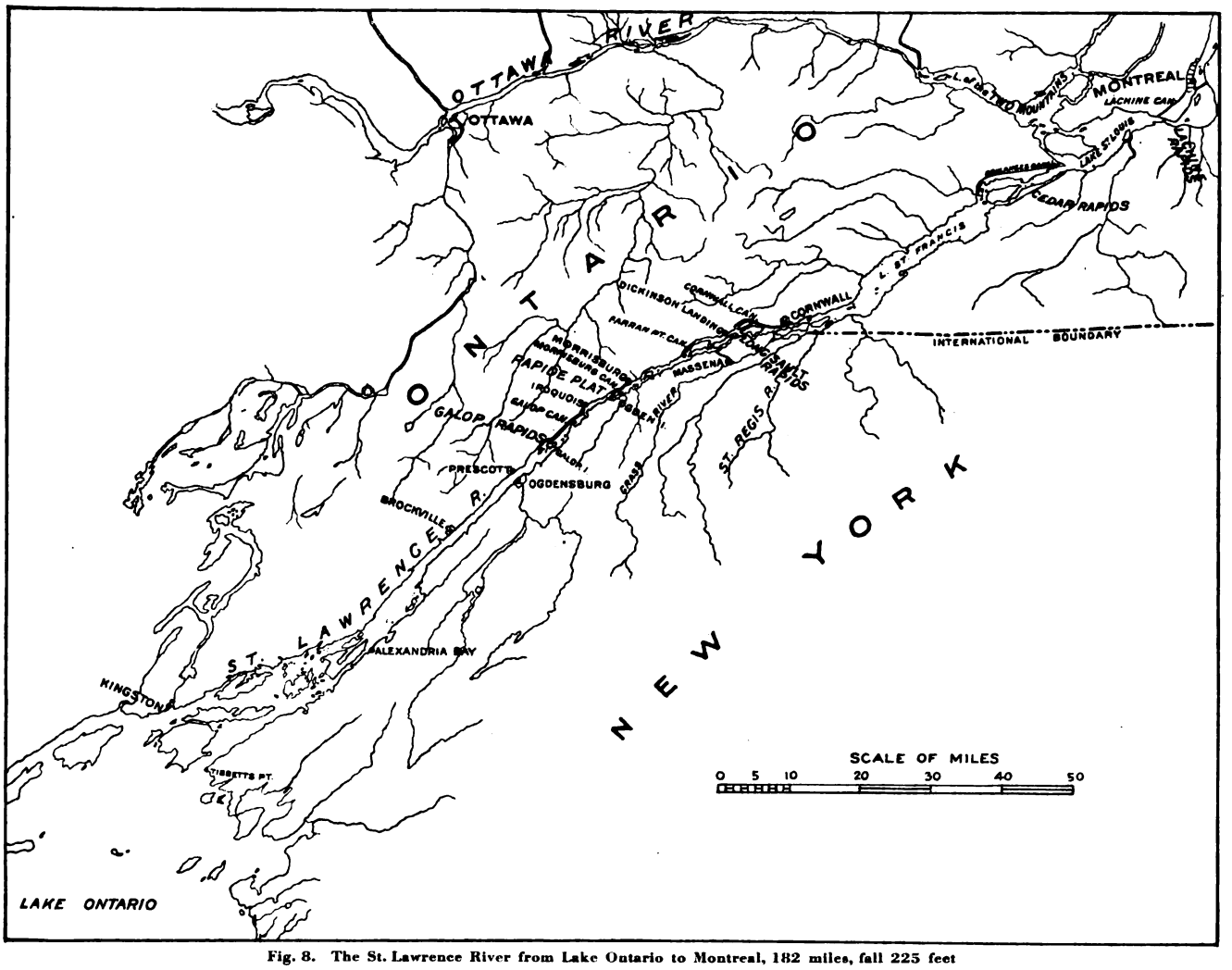


Fig. 8. The St. Lawrence River from Lake Ontario to Montreal, 182 miles, fall 225 feet

March, 1920, the Hon. D. P. Nelson, of Wisconsin, quoted the following public men as strongly in favor of the project:

Franklin K. Lane, then Secretary of the Interior; Leonard Wood, of the Army; John Barton Payne, Chairman of the U. S. Shipping Board; Herbert Hoover, United States Food Administration, and others.

Mr. Nelson presents the argument in favor of the project in a very comprehensive manner.

Apparently against the project stands the recommendation made by Colonel Warren, United States District Engineer Officer, Buffalo, concurred in by the Board for Rivers and Harbors and approved by the Chief of Engineers in 1918; that the improvement of the St. Lawrence River from Lake Ontario to the Canadian border with a view to providing navigation facilities for ocean going ships was not deemed advisable at that time. The official reports, however, carefully stated that this decision depended upon the facts that Canada, due to the war, had stopped work on the Welland Canal, and that apparently no steps were being taken to provide deeper navigation in the St. Lawrence from the Canadian border to the sea. Obviously, it was not worth while for the United States, during the war, to start a 21-foot project shut in by 14-foot water at both ends.

There can be little doubt but that one of the most vital factors in the development of our huge and economical lake borne commerce has been, is now, and will always be,

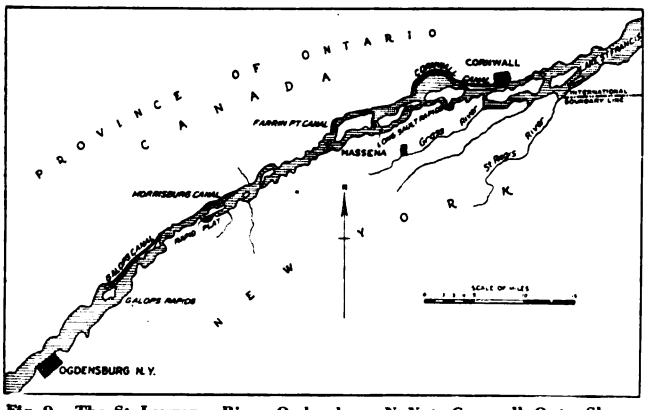


Fig. 9. The St. Lawrence River, Ogdensburg, N. Y. to Cornwall, Ont. Showing section 2 and parts of sections 1 and 3

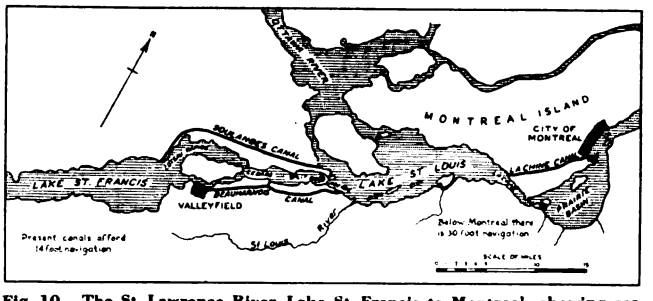
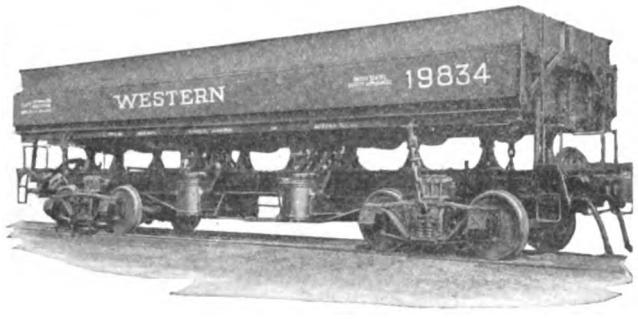


Fig. 10. The St. Lawrence River, Lake St. Francis to Montreal, showing sections 4, 5 and 6, with part of section 3. From U. S. L. S. general chart

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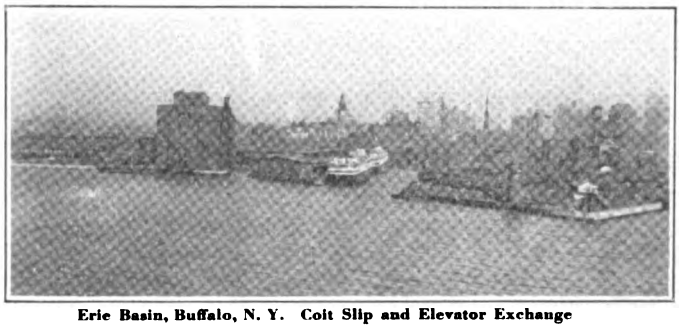
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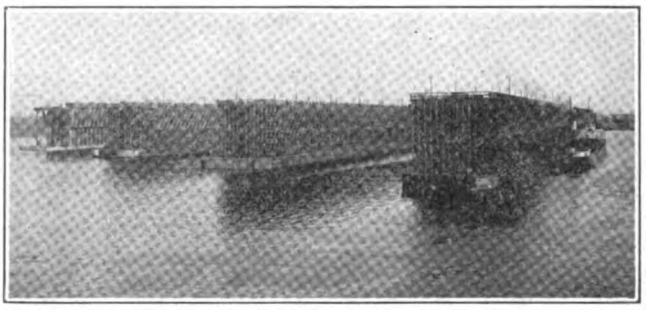
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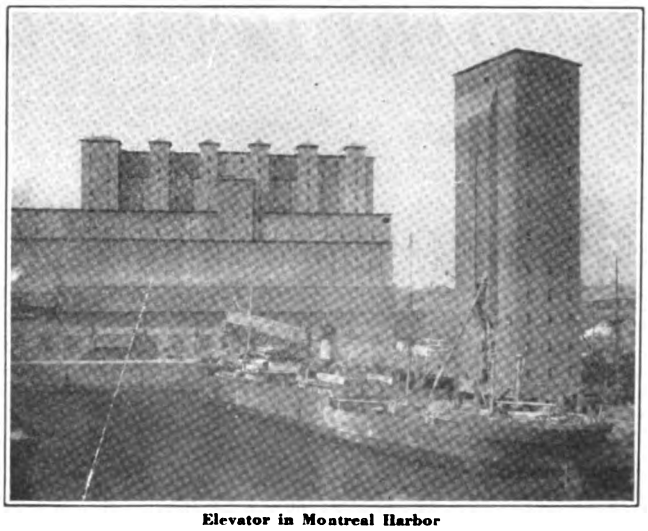


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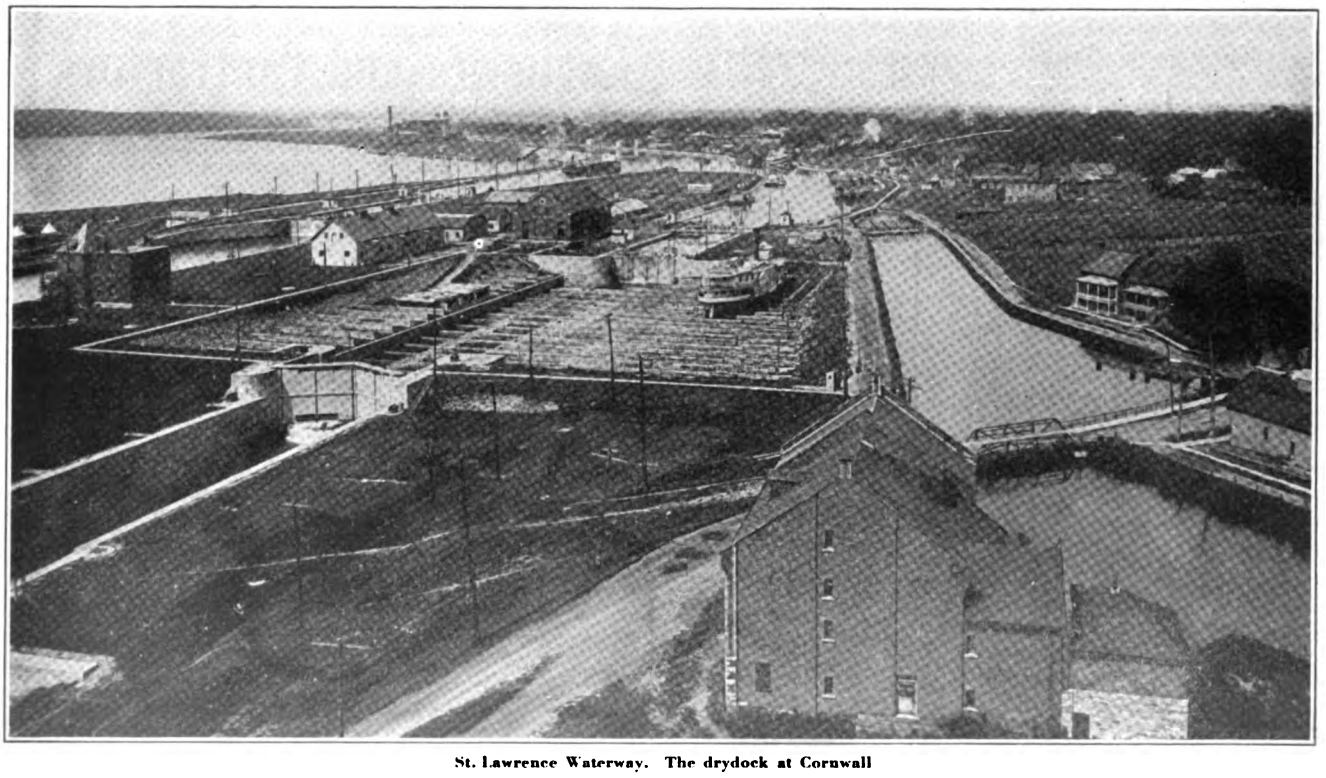
the provision of adequate and economical terminal facilities. In this the Great Lake ports have led the world. Herein, to no small extent, can be found the secret of their low ton-mile rate. Vessels are delayed a minimum time at port, and cargoes are rapidly handled at a minimum cost. If the Lakes do become the American Mediterranean, ports such as Chicago can well take to heart the advice of Mr. Charles Evan Fowler in his address before the Great Lakes Tidewater Congress during this last July. After pointing out the need of keeping port facilities ahead of actual requirements, Mr. Fowler explains the need of centralized authority and administration of port control; the need of permanent construction in not only piers and docks, but adequate and wisely located storage space. He closes with the remark that: "The final word may be to point out the great need for more labor-saving cargo-handling machinery and then to recommend still more cargo-handling machinery. What shall it profit a port in the future if it has fine natural advantages and yet is not built of the best plan and construction and lacks besides labor-saving equipment in sufficient amount to handle large cargoes quickly and cheaply? Let the Great Lakes cities profit by the mistakes made by their elders, the great salt water ports."



Elevator in Montreal Harbor

While awaiting the report of the Joint Commission it would not be amiss for the leading lake ports, such as Chicago, to examine into their own terminal facilities, the layout, their supervision and control, their future development. Great commerce will not come to crooked, bridge-cramped rivers, nor to poorly equipped and undersized wharves.

In a few months this question will be up for public discussion and possibly Congressional consideration. Laymen will turn to their engineer friends for sound opinions based on facts. It is only hoped that this necessarily brief resume of the matter may be of some small assistance to members of this Society in sifting out the truth and in arriving at a sound opinion.



St. Lawrence Waterway. The drydock at Cornwall

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The Capture and Defense of Hill 269 by the 1st Engineers

By

T. F. Farrell

Captain, Corps of Engineers, formerly Major 1st Engineers, A. E. F.

[NOTE—On many occasions during the late war the engineer troops with our combat divisions were called upon to take their places as infantry in the line of battle, both in attack and in defense. In a recent issue we related some of the battle experiences of the 2d Engineers in the second battle of the Marne. In the article which follows Major Farrell describes in most entertaining fashion an important offensive and defensive operation carried out by the engineers of the 1st Division in the Meuse-Argonne.

The habitual use of the engineers in combat, especially in attack, naturally interferes greatly with the performance of their proper duties, and is to be discouraged. We say the *habitual* use. Our engineers were frequently so employed and may always be so employed at the will of their division commander. And it must be said that the opportunity to occasionally engage in battle and prove that they are good fighting men, as well as good engineers, raises the morale of the engineers, and increases their efficiency in all their work.

To find their places in line, after a long march in inky darkness, mud and rain, seems to be the usual thing for the engineers. To acquit themselves with credit under such trying conditions seems to be invariable.

The confusion incident to battle, the tremendous difficulties to be overcome, and the tenacity of the American soldier, are well brought out in Major Farrell's story.—ED.]

DURING the second phase of the Meuse-Argonne operations, the First Division attacked in a northerly direction east of the River Aire, starting their attack about two kilometers south of the village of Exermont.

From October 4 until October 7, 1918, the division advanced about 4 kilometers against very stubborn resistance and at a very heavy cost. The reserves had become so depleted that it was decided to use the engineers in the attack.

Just outside of the limits of the division sector on the right was a hill, the possession of which was absolutely essential in order to continue the advance. It was an elevation with three knobs, the knob on the right being the highest; this one was designated Hill 269. The front line of the division on our right was about 500 yards in rear of our line and Hill 269 was slightly in advance. On October 7, some of the elements of our division and of the division on our right (the 32d) succeeded in gaining a foothold on the lower knob of the elevation, and as the country was quite heavily wooded, it was erroneously assumed and reported that they were on Hill 269. Two infantry companies of the adjoining division and a small patrol from our division were maintained on the rear slopes of this western knob of the elevation. At our division headquarters it was thought that the high knob of Hill 269 was in possession of the American troops, and a flanking operation to the right was planned, using Hill 269 as a pivot for the operation. This attack was scheduled for the morning of October 9th, and the plan was for the division to swing to the right while standing fast on Hill 269, and thus outflank the enemy on our right. The First Battalion, First Engineers, was detailed to relieve the elements of the adjoining division at Hill 269 and later to be the pivot troops for the attack. The first orders were to proceed during the night of October 7-8 to Tronsol Farm, about 600 yards in rear of Hill 269, during the day of the 8th to reconnoiter a route to Hill 269, and during the night of the 8th-9th to relieve the troops on Hill 269 and be prepared to participate in the general attack.

The engineers had been steadily engaged night and day since the 4th on road work and on the construction of a position of resistance a short distance behind the front line; the battalion had sustained about 100 casualties. About 5 p. m., on October 7th, orders were received by the battalion commander to assemble the battalion, to move it after dark to Tronsol Farm, a distance of about two miles, and to report in person to the commanding general of the 2d Infantry Brigade for orders. That sounds like a comparatively simple order to execute, but it was fraught with countless difficulties. It was pouring rain, the night was pitch black, and we knew neither the location of the brigade commander nor of Tronsol Farm; our men were scattered over the division area and the enemy shelling was particularly heavy. By earnest effort the battalion was assembled shortly after 6:00 p. m., the command was turned over to the battalion adjutant to march to Tronsol Farm, and the battalion commander set out through the rain and darkness to search for the brigade commander, concerning whose location he had a very indefinite idea. The battalion was marched to its destination with the aid of an engineer marching compass, and fortune smiled upon it since it arrived about 9:00 p. m. Each man had an engineer shovel and provided himself with cover as soon as possible; the previous fatigue was forgotten, and a long line of fox-holes soon made an appearance.

The brigade commander had been driven out of his post by a direct hit with a gas shell, and had taken up new quarters some distance away. It took a considerable search to find him; but that done, we thought we were to remain fairly comfortable for the night. No such good fortune, for about 10 p. m. telephone orders were received for the battalion of engineers to relieve the two companies of infantry at Hill 269 before daylight. The battalion was two miles away in unknown territory and neither the rain, darkness nor shelling had abated in the least. In fact, quite the contrary.

The men had their fox-holes just about completed, and were preparing for a night's rest after a strenuous day, when the battalion commander arrived with the orders to go forward. They shouldered their packs, rifles and shovels and started out over the slippery ground for a destination, the location of which was absolutely unknown. The ground here was strewn with dead, both ours and German; the enemy artillery was putting down a heavy bombardment of high explosive and gas. The problem of getting the battalion to Hill 269 in a heavy rainstorm and in the dark night with no one who knew the way, was not easy. There were no runners nor guides who could lead us there, but at brigade headquarters we got a runner who led us as far

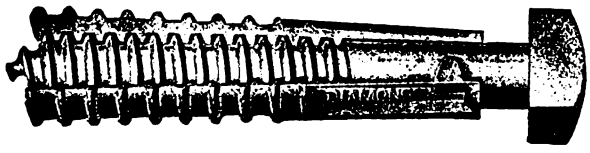
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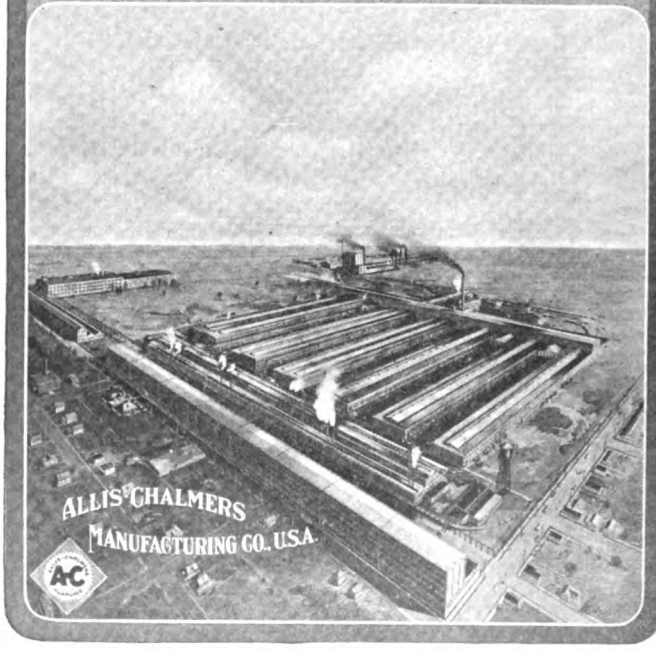
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as regimental headquarters of the 26th Infantry; there we got a runner to guide us to the battalion P. C. of the right battalion, and there we were furnished a runner to the right company. This company furnished us with our final guide. Several times the guide went astray and we doubled back more than once; we forded a stream waist deep and climbed a bank so steep and slippery that it was necessary for two men to work together in order to reach the top. The shelling was so heavy that the men were marched single file with a couple of yards distance between men to prevent heavy casualties. Once we lost a whole company and spent an hour looking for it. We were so close to the enemy positions that it would have been a simple matter to have strayed into German territory. As we were making the final stage of the journey the enemy put down a particularly heavy bombardment on the tail of our column and dispersed the last company. It took until daylight to collect it again. As the crow flies the distance to be covered was about two miles, but we plodded wearily through mud and rain the whole night long and just as daylight began to break we reached our destination, about 100 yards from the enemy position and got our men under cover of the woods and brush.

Here we found two infantry companies of the adjoining division who were worn and depleted, but pleased beyond words to relinquish their hold on that particular piece of territory. From them we learned the true state of affairs: *i. e.*, that the Germans held the crest of Hill 269 as well as the entire northern slope of all three knobs of the hill and the eastern and southern slopes of the high part of the hill. They were firmly established on top of the hill with machine guns, and were sweeping all the slopes with machine gun fire. In other words the key-point of the next day's attack was held by the enemy, and if he continued to hold it, he could seriously embarrass any operation planned by our troops, because the hill overlooked all the surrounding territory and his machine guns could sweep the country in all directions.

The commanding officer of the Engineer battalion took over command at 5:30 a. m., October 8th, and made the following disposition of his troops: One company was placed on the western knob, another on the center knob, and the third company was placed in reserve on the southern slope. The elevation ran almost due east and west and the enemy held the eastern and highest knob. A flank guard was placed on our right facing the southern slope of the knob. The nearest friendly troops on our right was about 500 yards to the rear. Eight outposts were established on the western and northern slopes of the hill, and a patrol was sent to connect across a gap with the troops on our left. Liaison was also established by our flank guard with the troops on our right rear.

The situation was reported to the brigade commander, and in the meantime reconnaissances were made to determine if the hill could be readily captured. A patrol was sent along the southern slope and another along the northern slope with orders to occupy the top of the hill if the enemy were not there in force. Both met with heavy machine gun fire from the top of the hill, and after sustaining some casualties retired, having learned something of the nature of the enemy's position and his strength. The hill was covered with trees and underbrush so that it was possible to do considerable moving around without coming under observation.

The brigade commander said he would send some trench mortars and 37-millimeter guns to assist in the capture of the hill, but about 4:30 p. m. it was decided not to wait longer, but to capture the hill before the enemy had an opportunity to reinforce the garrison. As engineers the only weapons we had were rifles and bayonets—not a rifle grenade, a hand grenade nor a "37," any of which would have been of great assistance in the capture of the machine guns. Our officers and men were not highly trained in infantry tactics, but they were possessed of a courage and determination that boded well for success. Furthermore, they had absolute confidence in their ability to carry out any operation planned for them. They had never failed on a task, and the fact that this one was considerably different from any other, did not in any way effect their viewpoint.

Along the top of the hill was a narrow ascending ridge which broadened out into a sort of an elongated plateau on reaching the crest. The slopes of the hill on the northern, eastern and southern sides were steep and wooded. It was from the west along the ridge that our attack was launched. Three parties were formed; one proceeded along the northern slope, one along the southern slope, and one advanced straight along the ridge toward the top of the hill, thus meeting the enemy in front and on both flanks. The advance was timed that all three parties would reach the enemy simultaneously. The men had only rifles, bayonets and belts loaded with ammunition. Several of the men normally armed with the pistol, borrowed rifles for the attack. They advanced about half the distance before being detected by the enemy, who immediately opened fire with machine guns and rifles. Our men then advanced by rushes, taking such cover as was available and finally went forward in a bayonet attack. The attack was carried out with such precision and energy that the top of the hill was taken. A great number of the enemy were killed and wounded; forty-three were taken prisoner, and the booty included five machine guns, two anti-tank rifles and a number of rifles.

The Germans still held the slopes of the hill and were defending them with machine guns cunningly hidden in the woods, and up in the trees, so that our men were fighting until dark trying to clean up the slopes. There were many acts of individual skill and heroism. One sergeant, leading a few men to the capture of a machine gun, which was firing directly at his party, three times wounded the gun operator with fire from his rifle, but the German continued firing. Advancing in a final rush straight toward the gun, the sergeant, dropping his rifle, seized the wounded gunner in his arms and carried him back a prisoner, only to have him die a short time after he administered first-aid treatment. Another man, a bugler, had his mind set on capturing a prisoner and chased a German all over the top of the hill with a bayonet until he finally caught up with him. He would not shoot him because he wanted positive proof that he had gotten his man.

After dark we established three outposts about 500 yards north of the hill and formed a visiting patrol of an officer and two squads to keep in touch with these outposts. Once during the night this patrol encountered a large party of the enemy and avoided an engagement by detouring. The enemy were still holding part of the eastern and southern slopes of the hill. During the night four machine guns sent by the brigade commander reported and were posted in position to help defend our precarious position. Virtually our position on top of Hill 269 was surrounded by the enemy on three sides—front, right flank and rear, and could not in any way be called secure.

The division attack for October 9th was scheduled to take place at 8:30 a. m., and our part in the attack was to hold fast to Hill 269 while the whole division pivoted to

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the right; furthermore we were given about 500 yards of line on which we were to attack. The battalion was being formed for the attack in two lines extended to the left from Hill 269, when at 7:30 a. m. the Germans launched an attack on the hill accompanied by a violent bombardment. The attack was a complete surprise and could not possibly have come at a worse time, because our own attack had to be carried out and this would use up practically all of our troops. And it was absolutely essential to hold the hill, or the entire operation of the division would be jeopardized. The attack came mostly from the south and east, which was really the rear and right flank of our garrison on the hill. Very heavy machine gun cross-fire from two neighboring hills swept the top of our hill, and shells of all calibers pounded away on this narrow strip of ground. Far down on the eastern slope we had an outpost—all of these men met their fate in the first rush of the enemy. Farther up the slope were two machine guns and they held out but a short time before they were captured.

For a while the situation was critical, with the grey masses coming from three sides up the hill. Lieutenant Bourland, the company commander of the right company, at the start of the attack, rushed down to his outpost in a vain effort to save them. He was killed before reaching the post. Lieutenant Trowbridge, who succeeded him in command, met the same fate. Most of our outposts had been withdrawn about 7:00 a. m. in order that they might escape our own barrage. This accounts for the fact that the enemy was well up on the slopes of the hill before we had any knowledge of the attack. Our men fought admirably, and contested every foot of the ground. The line was slowly forced up the hill to the crest where a determined stand was made and all the assaults were repulsed. Seven squads were drawn from the troops on the left scheduled to attack, and were sent to the top of the hill. Later on six squads more were sent, thus using up the last available reserves. The fighting for the possession of the hill continued through the whole morning, and it was 1:00 p. m. before the enemy definitely ceased his efforts to take the hill. It was truly a bitter contest and the small garrison put up a wonderful defense. The order was given "Hold the hill to the last man!" and it was carried out to the letter.

There were acts of heroism too numerous to mention. Immediately after Lieutenant Bourland was killed, the line was forced back slightly and the enemy captured his body and began to strip it. A young corporal refused to retire but advanced to protect the remains of his commanding officer. Three hours later, when the line was pushed forward again, the dead body of the corporal lay across his rifle near that of his commanding officer and there were six dead Germans in a narrow circle facing him. He had taken heavy toll before he "went West." A private remained fifty yards in front of the line and alone stopped a formidable attack on his slope of the hill. He killed twelve of the enemy with his rifle. Another man captured a German machine gun, turned it and used it on the enemy until he was shot through the shoulder. Then, taking up a pick handle, he smashed the gun and retired. A sergeant, who was later killed, captured a machine gun, using a German hand-grenade as a weapon. The brigade commander, hearing we were attacked, sent us message after message that we should hold the hill at all costs. We held the hill, and the cost was heavy.

At 8:30 a. m. the remainder of the battalion attacked as a part of the division operation, with two successive objectives. Both of these objectives were reached on schedule time. The two left companies, less the men who had been already sent to the defense of the hill, participated in the attack. The companies were in line, each company being formed in two lines of skirmishers 50 yards apart with the remainder of the company in squad columns about 500 yards in the rear. The left of the battalion swung to the northeast and drove the enemy toward the right of the battalion; the company on the right captured 80 prisoners during the attack.

On reaching the final objective the battalion dug in. The right company was in touch with the troops on top of Hill 269 who were still fighting to hold their ground. There was an open meadow at the left of the battalion which was under good observation as well as fire of the enemy and no liaison was established here until dark. Patrols were sent out in front of the objective and the position was organized for defense. We had no reserves, so a call was made on the brigade commander for reinforcements, as our position was rather precarious in case of a strong counter-attack. These reinforcements did not arrive until dark, and it was an afternoon of uncertainty and anxiety because a counter-attack on our line was momentarily expected, and we had barely held our own in the defense of Hill 269. Furthermore, the enemy's artillery action on our line and on the hill was extremely violent. They literally tried to blast us off the hill.

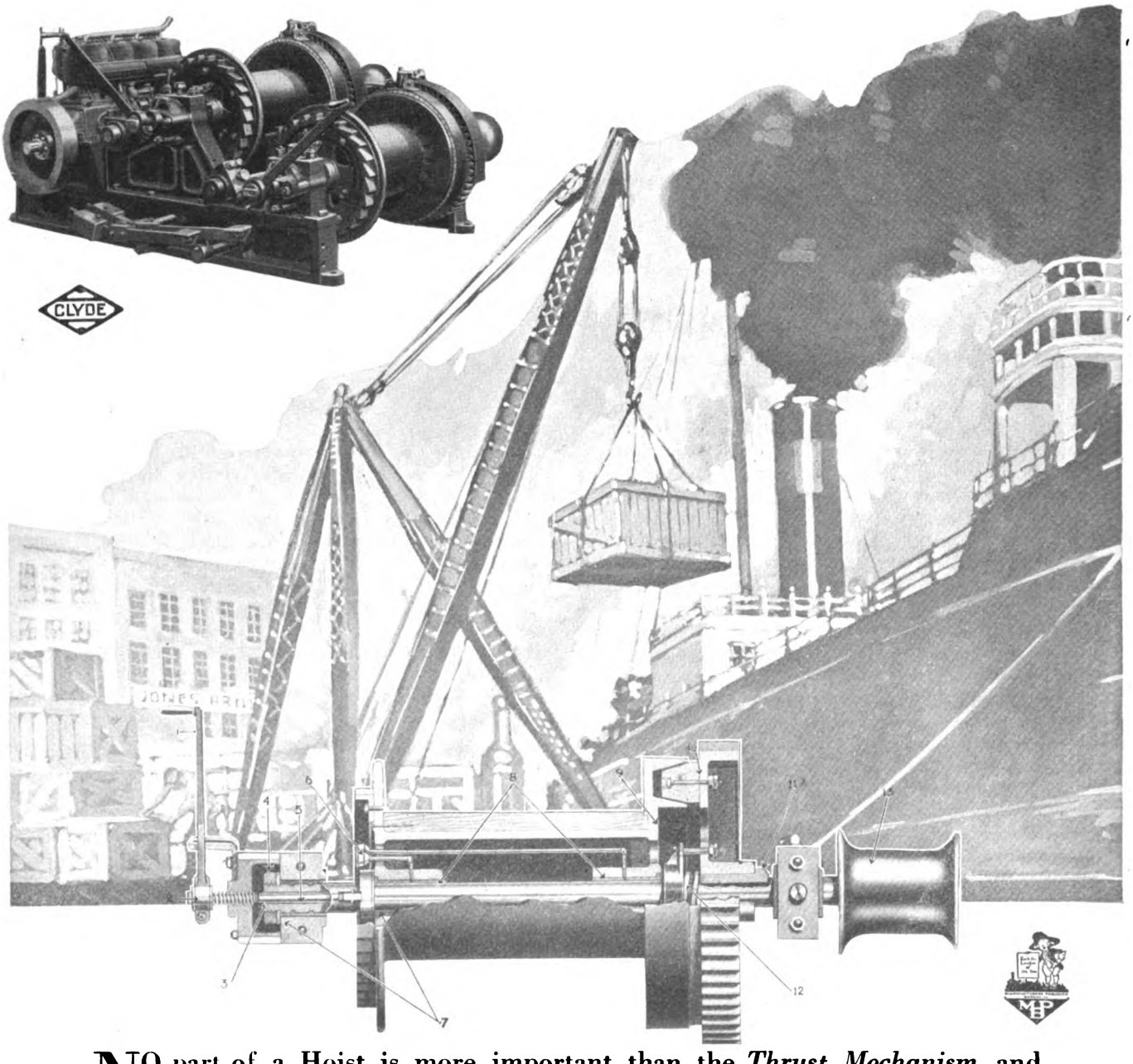
About 1:00 p. m. a company from the division on our right came up toward our position from the rear. Their orders were rather indefinite, so the battalion commander used them to clear up the southern slope of Hill 269 which was still occupied by enemy machine guns hidden in the bushes and in the trees. Placing their left flank on top of the hill they extended in a southwesterly direction and then swept around until the company was lined up east and west, cleaning up the machine gun nests as they went. Thus, for the first time since our arrival was our right flank protected.

During the night of October 9-10 we held our position at the "alert," and in the morning took part in the next day's attack by sending a party due north through the woods for a distance of one kilometer. The enemy had retired as a result of the division maneuver, and this advance was not difficult. For the next two days the battalion maintained its position as a security garrison for the protection of Hill 269. We were heavily bombarded on both days, and lost many men from artillery fire. At one time we had about fifty prisoners on the rear slope of the hill awaiting evacuation. The enemy started a violent bombardment. Such cover as was afforded by shell holes was already taken by our men and a large number of the prisoners were killed or wounded. Some of them started to run, but they were stopped by a few rifle shots.

During the attack and defense of the hill the battalion suffered heavy casualties in officers and men, but they captured 150 prisoners, 16 machine guns, 2 anti-tank rifles and a large amount of small arms and equipment. There were more than one hundred German dead on the slopes of Hill 269, giving proof of their earnest desire to get possession. After the first night our men were hungry, and it was a difficult matter to get food, but our pack mules came to the rescue. The valley behind was being filled constantly with gas and high explosive shells. One night the pack train started up for our position loaded with rations, but they were shelled and gassed. One of the mules was killed, an officer was wounded and all the food was spoiled by gas. Not daunted by this reverse, they tried it again the following night, and this time were successful. They brought the food up and unloaded it within a hundred

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yards of the enemy. As the little animals came plodding up the slope they were greeted with a cheer from the hungry men, and we felt repaid for all the care we had taken of our hitherto burdensome pack train.

We were relieved at dark on the night of October 11th by an order from the brigade commander, and it was a weary but lighthearted battalion that turned over to the incoming division. For the five days every man had carried a heavy engineer shovel, and so well had they proven their worth that not a man left his shovel behind when we started out—a significant if silent tribute to the value of the oft-despised tool. As our men filed out in a long line, they passed the relieving troops, who were equipped only with the infantry intrenching shovels. The newcomers repeatedly asked for our tools, but for once the despised shovel of the engineers became a thing beyond price. We did not know how soon we might be called upon to take and hold another hill. In this operation the engineer battalion did credit to themselves, to their division and to the Corps of Engineers whose high standards they tried hard to maintain. The following Corps order from General Summerall, who commanded the First Division in this operation, tells in official language how well they performed their task:

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France, *February* 16, 1919.

GENERAL ORDERS
No. 2.

The following citation is announced:

The First Battalion, First U. S. Engineers, for distinguished service in the taking of Hill 269, Bois de Moncy, France, at 4:00 p. m., October 8th, 1918, during the Meuse-Argonne operation.

This Battalion of Engineers with great courage and determination captured Hill 269, Bois de Moncy, together with many prisoners and machine guns, and successfully held it against strong enemy counter-attacks. On October 9th, 1918, and afterward, this Battalion of Engineers participated in the general attack of the First Division, attaining all their objectives, and capturing prisoners.

The action of this battalion in the capturing of Hill 269 without the assistance of the special infantry weapons other than the rifle and the bayonet, is especially to be commended, in that they carried out a difficult mission outside of the line of their normal engineer duties, with great skill, initiative and courage.

C. P. SUMMERALL,
Major General, Commanding.

OFFICIAL:
HARRY C. KAEFRING,
Adjutant General.

Activities of Our Local Posts

Chicago Post

On the evening of June 15th, Col. Wm. V. Judson, Corps of Engineers, U. S. Army, called a meeting in the rooms of the Western Society of Engineers, for the purpose of organizing Chicago Section of the Society of American Military Engineers. About thirty-five persons were in attendance, and interest in the new society was manifested by signing an application for a charter, as well as by submitting a number of additional applications for membership in the National Society.

Colonel Judson called this meeting to order, explained the purpose of the meeting and the aims and objects of the National Society, after which the following temporary officers were elected, and proceeded with the organization:

President, John de N. Macomb; Secretary and Treasurer, G. B. McClary.

At this meeting the following committee was appointed to draft a Constitution and By-laws, and to nominate permanent officers for the Local Section: Mr. C. M. MacChesney, Mr. Walter A. Hill, Maj. John C. H. Lee.

In order to give the Committee an opportunity to prepare the draft of the Constitution and By-laws, the meeting adjourned to meet at the same place on the 28th of June.

At the adjourned meeting on June 28th, 1920, about thirty-six persons were in attendance. The draft of the Constitution was presented by Mr. MacChesney, Chairman of the Committee, and after discussion was adopted. The draft of By-laws prepared by the Committee was referred to the Board of Directors. The report of Committee on Nominations was presented, and the following permanent officers elected:

President, Christopher Van Deventer; 1st Vice-President, William Godfrey Arn; 2d Vice-President, William Ward; Secretary, John Tull Montgomery; Treasurer, Col. William V. Judson.

Board of Directors: Henry A. Allen, Edward J. Blair, Gen. W. H. Bixby, Horace S. Baker, W. A. Hill, John de N. Macomb.

The meeting closed with a discussion of the objects of the Society by Maj. John C. H. Lee.

The directors met at luncheon at the Union League Club on September 1st. This was an important meeting. The By-laws were adopted and a program for future policy discussed. It was a pleasure to have Maj. Arthur S. Dwight, of the New York Post, present at part of the meeting. It was recognized that Chicago should be an army headquarters; that provision should be made to mobilize and house all the technical services required by an army. It was also recognized that cities had problems with boys which should be considered, and if possible these future citizens should have such direction and assistance as would make them good citizens. Many boys up to fifteen are interested in the Boy Scout movement. At about that age they lose interest. They want to be men. It was thought that to make the military service attractive to these young men—good citizens would be the result. The outcome of this meeting was to recommend at the meeting of the Society September 15th certain resolutions. The first that the parent Society so modify their By-laws as to permit Junior memberships, thus opening the doors to the boys. The second was to pledge support to an Engineer Armory, which would house equipment, and provide for division, corps, and army troops. The necessity for troops is very great. This is evidenced by the conditions during the floods of the Ohio a few years ago. The water was contaminated throughout the river's course. The State Military Department was able to secure two men only from the State University to use in the emergency. With proper listing of personnel and with necessary equipment available such emergencies can be met with efficiency and success. It is the aim to prepare for similar occasions. The armory project was endorsed by the Western Society of Engineers, The American Association of Engineers, and Castle Post of American Legion. Many of our members hold important and prominent positions in these organizations, and their assistance has been of great benefit. Castle Post declared their intention to follow a plan of

Continued on Page 63.

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The Military Engineer

Dedicated to the National Defense

Lt. Col. P. S. Bond, C. of E. *Managing Editor*
Maj. W. H. Lanagan, C. of E. *Assistant Editor*
Lt. Col. G. A. Youngberg, C. of E. *Consulting Editor*

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The Society Emblem

IN the issue of this Journal for July-August, 1920, we published an illustration and description of an emblem which had been tentatively adopted by the temporary Board of Directors at a meeting held in Washington in June. On the front cover of this number is a new design, or more accurately speaking, a revision of the former tentative device. This new design is now the official insignia of the Society by unanimous vote of the Board of Directors, acting under powers vested in that board by the constitution and by-laws.

The changes in the emblem merit some explanation. The committee appointed to devise an emblem attempted to ascertain the opinion of the membership of the Society, and to produce a device in harmony with the wishes of the Society as a whole. The original insignia was accordingly designed and adopted only after an extended discussion as to what should be the predominant character—the motif of such a device. Although the castle was embodied in the very first study it was omitted from the design as eventually published. This omission was in accord with the consensus of opinion expressed up to that time. It will be remembered that after the Armistice there was a rather violent reaction and officers and soldiers alike seemed to feel that one war was quite enough and that they "were off the military" for all time. Many of the most emotional, or the most articulate, had grievances, either real or fancied, and they took it out on the Regular Army and all its works, not overlooking the Corps of Engineers. Their criticism even extended to the castle as one symbol of the military authority which they fancied to have been unnecessarily oppressive. The occultation of the castle in the proposed emblem was therefore but a manifestation of the war fatigue.

Judging opinion as best it might, the committee felt that the castle, being identified with the Corps of Engineers, might convey a false impression concerning the Society, to-wit: That it was an organization primarily for officers of the regular service, or for their especial benefit. It was conceived also that the castle might not adequately represent the professional attainments of our members who derive from all branches of the engineering profession —civil, mechanical, electrical, mining and all their various ramifications.

The Society, even in its earliest days, was not an association of the Corps of Engineers of the United States Army. It has never been dominated, nor is it desirable that it should be dominated, by the Corps. At the present time the membership in civil life vastly exceeds in numbers that in the Regular service, and its form of government was carefully devised to insure an equitable representation therein of all classes of membership. Furthermore, there are thousands of engineers and technicists—physicists, chemists, metallurgists, geologists and other specialists—who did their part in the war in other branches of the service. Many of them, indeed, elected to serve as officers of Infantry or Artillery, or identified themselves with the Signal Corps, the Tank Service, the Chemical Warfare Service or the Air Service; others cast their lot with the Quartermaster Corps or with the Railway or the Motor Transport Branches. Not a few served in The Adjutant General's Department and in other branches not named herein. The fact that they donned the uniform indicates their firm belief in the purposes for which the Society was founded and they are eligible to membership notwithstanding that their personal inclination or their opportunity for service did not admit of their wearing the engineer castle on their uniform.

For these various reasons, the castle was deliberately omitted from the original emblem of the Society and an attempt was made to represent the major engineering activities by more specific emblems—the thunderbolt of Jove for the electrical arts, the cogged wheel for the mechanical and the bastioned fort for structural or civil engineering applied to military operations.

However, with the publication of the tentative design in The Military Engineer, new voices were heard in criticism. Many felt that it was too elaborate and that it attempted to convey too many ideas in small compass, especially in view of the necessity for reducing it to lapel button size; but, more important still, the war reaction against the Regular Army, if, indeed, it had ever really existed, had spent itself and the pendulum had entered upon its return movement. It became evident that the omission of the castle from the Society's emblem was unfortunate. One of the critics voiced the views of the great majority when he said: "The castle was the emblem of engineer service in the War. It was universally known as such by ourselves and our Allies. We wore the castle on our collars, we fought under it and we are proud of it. It should be the emblem of our Society—a source of in-

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spiration to every engineer who has served or will serve his country."

It is quite true that the castle is the emblem of the Corps of Engineers. Since 1840, and possibly from an even earlier date, it, in its present form, has graced the uniform of the Engineers. In some shape or other it has been identified with the engineer service since the dawn of our history as an independent nation. The circumstances under which it was introduced in our army are not known, but it undoubtedly traces back to the gallant and talented French engineers who served with the Continental Forces. It did not, however, originate with these early members of the Corps of Engineers. In some form the castle, and not infrequently that with three turrets, has been used in heraldry from its earliest days to signify fortification, or the art of the military engineer. To this day it is borne in the coats-of-arms of many cities of Europe, having been granted them in recognition of services rendered in defense of their sovereign and his state. By reason then of its heraldic meaning the castle was adopted by the progenitors of the Corps of Engineers to indicate their function as military engineers. With the evolution of warfare it has come to mean engineering in war. It is worn by the engineers of the National Guard and of the Reserve Corps as well as by those who have chosen engineering in the Regular Army as their life's profession. In view of the fact that the military art turns to its uses all branches of science, and in view of the great number and great diversity of activities devolving upon the Engineers during the World War, it can now justly be said that the castle is the ægis of all branches of engineering and allied sciences in their special application to military purposes. Its signification is no longer restricted to those only who deal with the art of fortification in its narrow sense.

In the light of after events it appears that, in their effort to avoid conveying a false impression, the designers of the first emblem "leaned over backward." To-day the majority opinion appears to be that the castle is so identified with the military interests of the great body of our membership as to warrant its adoption to the exclusion of devices having a more special signification. Better than any other symbol it appears to represent the practical patriotism of the engineering profession as a whole, irrespective of the arms or branches of the war establishment in which its various members served the nation during the World War. It appears that it should be the outstanding feature of the emblem of our Society.

The committee charged with the design of a suitable device have taken cognizance of the views so expressed and in the new emblem have attempted to symbolize the dominating purposes of this Society. The American eagle, grasping the traditional olive branch and sheaf of arrows, has thus been retained as emblematic of American independence, to be maintained by peaceful methods if possible but to be maintained by force if recourse to force should be necessary. The national shield has been retained as the symbol of defense, in recognition of the world as it is and the consequent necessity for a wise preparedness. The laurel has also been preserved in the device in honor of those who have achieved in the past, as a tribute to their spirit of intelligent unselfish devotion and as a token of our aspirations and determination for the future.

The new design has been prepared by Mr. C. A. Houston, of the Bureau of Engraving and Printing, who executed the original device. It is believed that he has succeeded in retaining many of the artistic features of the original emblem which were most favorably commented on, and that he has incorporated in an attractive setting the castle as the emblem of engineering in war. It is believed that the device in its present form symbolizes the aims and purposes of the Society and its members, all of whom recognize that the privileges of citizenship in a republic such as ours carry with them the obligation to serve their country to the limit of their powers in any hour of need.

The Significance of the New Army Organization

WE are very glad to be able to present to our readers in this issue an article on "The Organization of the Engineer Service for Military Operations," showing the approved project for the reorganization of the Army under the Act of June 4, 1920, in so far as it relates to the Engineer Service. In the article will be found not only a concise statement showing the engineer components for the various tactical units—including the normal assignment of Engineer troops to G. H. Q., Reserve and the Communications Zone for expeditions of various sizes—but also a brief statement of the duties and functions of the various Engineer units proposed, together with the salient features of their equipment. Detailed tables of organization are shown for the Combat Engineer Regiment (war strength) as proposed for assignment to the Infantry division—the unit in which all Engineer officers are most interested.

The new army organization, as finally approved, represents the mature judgment of many of the best minds in the service, fresh from experience in the greatest war in history. One can be assured that the lessons of that war were carefully considered, and that an honest effort has been made to incorporate in the new organization those changes which actual experience in war have demonstrated as necessary, without regard to the special interests of any one arm, but with the single object in view of providing the most effective war machine for future military operations, whatever their nature, or wherever they may occur.

In general, the organization adopted has followed that used in the A. E. F., with radical reductions in the size of all tactical units, and with only such auxiliaries permanently assigned to the division, corps, and army, as are certain to be needed at all times.

The reduction in size of units has been accomplished, by limiting the infantry companies to 200 men instead of 250; by omitting one rifle company in each infantry battalion, and replacing it by one machine gun company, thus eliminating all machine gun battalions; by withdrawing heavier types of artillery and special troops to the next higher unit, or to a G. H. Q. pool; and by reducing the number of divisions in a corps, and the number of corps in an army. The net result of these changes has reduced the division to an aggregate strength of 19,385; the corps to 79,966; and the army to 302,220—creating a more flexible and mobile organization than that used in the A. E. F., and therefore one which would be especially suitable for operations on this continent.

With reference to the Engineer components of the new army, it will be noted that many kinds of special troops have been eliminated, and that very few special Engineer troops have been permanently assigned to the Combat Zone. The elimination of numerous specialized Engineer units reflects a careful consideration of our own experience during the World War, as well as a consideration of our probable future needs. When we went into the World War we naturally looked to the organization of those who had been in for nearly three years, and found therein a bewildering variety of special units. This was due in part to the pe-

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culiar type of warfare which required all sorts of special services, and in part also to the fact that the average European craftsman is more narrowly specialized than the American and lacks the ready versatility of the latter. When the war of movement was resumed, the need for many of these narrowly specialized units disappeared and simultaneously the need was augmented for all-round handy men capable of meeting new situations and solving the new problems characteristic of that style of war. In this war of movement the American engineer soldier was in his element, and, although we had units bearing various specialist labels, they at once turned their hand to the work of the combat engineer and got away with the job to their everlasting credit.

Maps, highways and railways are, of course, always needed, irrespective of whether the war is fought out by maneuver or in trenches, and it is therefore eminently proper to incorporate the nuclei of these services in our peacetime establishment.

The engineer strength of each tactical unit throughout the new organization has been kept at this minimum, additional men needed for occasional operations being drawn from the next higher unit, which, in the case of the army, is from a central pool called the G. H. Q. Reserve.

The Combat Engineer Regiment assigned to the Infantry division while small in size, is well organized and equipped to carry out its mission. Noticeable improvements which may be mentioned, are the provision of an adequate Headquarters and Service Company, including the old Engineer train as well as the band, and a mounted platoon with pack transportation (formerly with the companies); the provision of automatic rifles at the rate of two per platoon; and the substitution of 1½-ton trucks for the heavier type, including one for the use of each company.

In spite of the fact that the percentage of engineers with the Infantry division has been reduced from 6.5 to 4.35 per cent—a fact which all Engineer officers, as well as many officers of other arms will keenly regret—it is believed that the organization of the Engineer Service, as finally adopted for our new Army, is sound in principle. While not perfect in all their details, the new tables indicate, in the main, a correct comprehension of the lessons of the recent war. They will be welcomed by all officers of the Corps of Engineers as a measure for placing the engineers in future wars on a sound working basis at the start.

Our National Society and the National Military Policy

THE Treaty of Versailles does not mean the end of all war, any more than the olive branch which the dove brought to Noah, aground on Mt. Ararat, meant that man need no longer fear the devastating power of floods. The Deluge did not revoke the laws of nature or destroy the causative forces of floods, and no more did the event at Versailles remodel human nature or remove the causes of war. The recurrence of war is as natural and inevitable as is the recurrence of floods.

Just before the World War certain purblind idealists told us that war was impossible. And now after the war they persist in telling us that there can never be another.

The best argument adduced in support of the belief that there can never be another great war, is that any nation contemplating war would shrink from the enormous expense involved. Let us see just how much this argument is worth. True, any nation must shrink from the expense of such a war as that through which we have just passed. But the World War was no more expensive in proportion to the wealth of the nations engaged than some wars of the past have been. Many previous wars have impoverished the nations who took part in them. All of the combatants of the late war will eventually recover. The wealth of the world was quite sufficient to support even so great a conflict. The casualties of the war were an insignificant percentage of the total population of the world.

Many a man has lost his life in personal combat. This fact may deter, but certainly does not prevent other men from engaging in mortal combat when vital interests are at stake. There are few of us indeed who will not risk our fortunes and even our lives in a just cause of sufficient importance. Too often we risk them in a cause we know to be unjust.

What is true of individuals is true of nations. Mere expense alone will prevent few nations from defending their sacred rights. Such nations would not have sufficient virility to continue to exist. If there be any nation that is afraid to go to war because of the expense, there are other nations prepared to take full advantage of that fact. The individual or nation that is afraid to defend its rights will soon find that it has none which others are bound to respect. There are things which all men and all nations value above wealth. And in defense of these things they will continue to risk their wealth and their lives. Patrick Henry's impassioned words: "Give me liberty or give me death!" were not mere words. They expressed a sentiment, an ideal, which in all ages has shaped the destiny of nations, controlled the course of history, and—incidentally—caused many wars.

And, finally, there is usually the expectation, and always the hope of victory. Successful war generally improves the condition of the nation. Several of the victorious combatants of the late war are better off as the result of it—including ourselves, provided we have the sense to "dig in and hold our gains."

We believe that considerations of mere financial cost, while undoubtedly they exercise a powerful regulating influence, cannot be relied upon to prevent all wars. There has never been any nation that was too poor or too proud to fight. It is rather wealth than poverty that has made nations disinclined to war.

It has been said also that since war is so expensive in these days, only the wealthy nations can enjoy the excitement of combat in future. But now comes so great an authority as George Bernard Shaw, saying that, in future, small nations can wage war just as effectively and be just as dangerous as the large ones.

The World War, far from quieting the mutual distrusts and fears, and dispelling the mutual animosities of nations, has roused them to a higher pitch. Nations which were united in war now regard each other with jealous distrust. Never since the disintegration of the Roman Empire and the ensuing flux of mediæval states were governments and international relations in a more unstable state than at present. Never was the world such a seething caldron of unrest and discontent.

As to our own United States, we may keep out of "entangling European alliances," perhaps, but we are apt to do so at the sacrifice of European friendships. We cannot keep away from contact with the world, out of the public eye. We cannot prevent the eyes of less fortunate nations being turned enviously towards us. We are already entering the competition for World Trade, the "cradle of war," as it has been called. Any trade agreement is an "entangling alliance" of most potent strength. We do not know to-day who our friends may be. Some pessimists even say we have none. We do not know what sudden untoward event (such as refusal to cancel a debt) may

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change a friend to an enemy. But we do know that the only sure basis of international friendship is mutual advantage or profit. And which of the great nations of Europe will profit by our control of the trade of the world? Every one of them is a competitor in some line, and every competitor is a potential enemy.

Never before in our history have we been so much in the thoughts and calculations of others. Never have we been such an object of envy, not to say fear (for our strength has not heretofore been realized). And never, therefore, have we needed "preparedness" as much as we need it now.

And we must beware of a one-sided preparedness which would provide a huge navy and make no provisions at all for an adequate land force. The honor and independence of the nation we must be ready to defend on land or sea. Of the many elements of preparedness the most important is the recognition of the principle of universal obligation for service, and universal training to render that service.

As we cannot surely foresee the participants of the next great war, so we cannot foresee the course it will take nor the place in which it will be fought. We do not know what storm may in future threaten our Ship of State. We only know that every timber of the ship must be stout enough to weather any storm—and *that*, in plain language, means preparedness on land and sea, under the sea, and in the air.

Our Society of American Military Engineers is dedicated to such a policy of adequate defense. In general we aim to secure the adoption of such a policy by our country, and in particular we shall make certain that the American engineering profession is prepared to do more than its share—great as that will be. We have the noblest of missions to perform, and the highest of ideals for our guidance. To the accomplishment of this mission we pledge our sacred honor. We must stand together, work together, fight together to achieve it. We must gather strength and determination as we grow in numbers.

Our Society with its high aims is worthy of all success—it must be preserved and strengthened. Let this be the New Year's resolution of the Society and its every member!

The Training of Engineer Officers

THE "Proceedings of the American Society of Civil Engineers," for October, 1920, published in full a Progress Report rendered by the Military Affairs Committee of Engineering Council. The Committee was composed as follows:

Col. William Barclay Parsons, Chairman; Messrs. Paul G. Brown, Harold W. Buck, George Gibbs and Spencer Miller, D. Leonard Waldo, Col. R. D. Black, Col. F. J. Miller, Col. F. A. Snyder, Col. Lincoln Bush, Col. W. A. Starrett, Col. H. S. Crocker, Col. G. R. Solomon, Capt. A. B. Fry (Navy), Col. F. A. Molitor, Col. B. W. Dunn, Col. J. J. Carty (resigned), Lt. Col. F. E. Humphreys, Maj. A. S. Dwight, and Lt. Col. George D. Snyder, Secretary.

This report has been abstracted and published in various engineering periodicals, and it is believed that its essential features are now known to those members of the engineering profession who are at all interested in the usefulness of the civilian engineer in a national emergency, and in his proper relations to the regular military establishment in peace and in war.

The Committee deals with a subject of greatest importance to members of civil and military engineering circles throughout the United States in respect to the training of Engineer Officers for our country's future military needs. The difficulties inherent to the publication of a bi-monthly journal have unfortunately prevented THE MILITARY ENGINEER from making earlier mention of this highly valuable contribution to the cause of national preparedness.

The distinguished personnel composing the committee justifies the belief that its report embodies the best thought available on this subject from the point of view of the civilian engineer who has seen military service.

In brief, the Committee recommends taking advantage of every opportunity; first, for widening the experience of the Regular Engineer officer by making it possible for him to take an active and responsible part in engineering operations outside of the army, and, second, for increasing the Reserve Engineer officer's chance for an up-to-date acquaintance with the demands of the service by having him called to active duty with the Corps of Engineers at stated intervals.

For a number of years those officers of the Corps of Engineers in positions of high responsibility have recognized the great desirability, or it might even be called the urgency, of providing wider experience for the membership of the Corps by affording the officers opportunities for taking part in construction operations outside of the military service, and of establishing a sound policy concerning the additional supply of Engineer officers that must always be drawn from civilian ranks whenever the Army is expanded to meet an emergency.

Under pressure from both civil and military sources, Congress in the Act of June 4, 1920, authorized the Secretary of War, "in his discretion, to detail not to exceed 2 per centum of the commissioned officers of the Regular Army in any fiscal year as students at such technical, professional, and other educational institutions, or as students, observers, or investigators at such industrial plants, hospitals, and other places, as shall be best suited to enable such officers to acquire a knowledge of or experience in the specialties in which it is deemed necessary that such officers shall perfect themselves. The number of officers so detailed shall, as far as practicable, be distributed proportionately among the various branches; *provided*, that no expense shall be incurred by the United States in addition to the pay and allowances of the officers so detailed, except for the cost of tuition at such institutions."

The distribution among the various branches above prescribed has not yet been made, but it is understood that this question will be decided before the end of the present fiscal year, June 30, 1921, in the best interests of the service as a whole. If the distribution be made strictly on the basis of the authorized commissioned strength of the various branches, the Engineers (who furnish about 3⅔ per cent of the officers of the entire commissioned strength of 18,000 in the Regular Army) will be able to detail only twelve officers annually for the duty contemplated under this law. This is a very small number, and such restriction would seriously interfere with existing plans for the technological education of the younger officers of the Corps. On account of shortage of officers and lack of funds the Army as a whole has not been able to take full advantage of the Act, but the Corps of Engineers, with funds provided for the purpose in the appropriation for the Engineer School, has 41 officers taking courses this year at educational institutions as follows: Cornell, 1; Columbia, 1; Massachusetts Institute of Technology, 39.

No officer has as yet been detached for duty at an industrial plant, but in view of the great benefit to be expected from such practice, it is hoped that it will soon be inaugurated. There is no denying the necessity for thor-

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ough technical preparation, but assuming a fair share of such preparation, it is safe to endorse Shakespeare's verdict, That our eyes are wiser than our ears—a literary way of reiterating the well-established truth that practical experience is by far the best of teachers.

Turning to the other half of this matter, that is, the calling into active service of the Reserve Officers, we find that the situation is not so encouraging. The Act of June 4th provides that Reserve Officers may, *to the extent provided for by appropriations for this specific purpose,* be called into active duty, with the reservation that in time of peace no Reserve officers shall be employed on active duty for more than 15 days in any calendar year without his own consent.

The crux of the entire question of calling Reserve Officers into active service lies in the appropriation by Congress of funds for the purpose. The office of the Chief of Engineers has been advised that for the present fiscal year no money is available to cover the pay, mileage and allowances for Reserve officers on active duty status except for a limited number assigned to General Staff duty and to fill vacancies temporarily in the Medical Corps. Furthermore, speaking unofficially, there appears little prospect of funds being appropriated for this purpose for the coming fiscal year. It is true that the War Department estimates for next year include an item of $3,000,000 for this feature (sufficient to make it possible to call to active duty about 900 Reserve officers in the average grade of captain and for a 1-year period) but, under the urgent necessity for reducing outgo, it appears only too probable that Congress will not see its way clear to granting the needed appropriations, and the Army will be unable to avail itself of the benefits of one of the wisest provisions of the recently passed law. It is to be hoped that the writer will prove a poor prophet in this instance, but in the face of the present situation it would be ill advised, to say the least, to encourage any member of the Regular Army or of the Reserves in the hope that the latter may expect soon to be called into active duty.

The officers of the Corps of Engineers have, as a group, always prided themselves upon being "liberal minded." The river and harbor improvements work entrusted to them has always been most highly regarded both because such operations furnish experience on constructive work for which all real engineers yearn, and because the officers obtained while on such duty all the benefits accruing from free association with municipal bodies and business men generally.

We believe that few, if any, members of the Corps will attempt to belittle the benefits to be derived by the Regular engineer officer from association with civilian engineers and from observation of their methods. War is no longer the exclusive affair of a professional soldiery and the Army personnel should *not* be a class apart. It is evident that the War Department is now acting on the conviction that every agency should be employed that holds a promise of broadening the general knowledge on the part of the civilian and the Army officer of the ideas entertained and the methods used by another.

The World War gave to some 200,000 men an opportunity to see army life from the viewpoint of an officer. For the most part these men are again in civil life, but they are thinking hard about their army experiences and many are making suggestions looking to improvement in army methods. Some former officers of Engineers go so far as to maintain that very little time should be devoted to military training for the Regular Army Engineer officer and enlisted man, and that during the greater portion of their period of service they should be employed on public works in all positions from laborers to superintendents, regardless of the protests that such a policy might well bring from members of the civil engineering profession as well as labor unions generally. As a broad generalization this appears to be sound, but it is subject to the important reservation that the Engineer officers must have a thorough appreciation of strategical and tactical requirements governing the application of engineering to military operations. Enough military training must be given the enlisted man to teach him to shoot, to march and to take care of himself in the field, to put into his head the fundamentals of military discipline and to acquaint him with the principles of the science of handling men under the stress of military conditions. The time required for this training will vary with the man's application and his intelligence; and the minimum may well be greater than will be accepted as necessary by those whose experience in the Army is confined to service in France. Such former officers apparently overlook the fact that our Army's experience in the World War was unique, that never before and perhaps never again shall we be called upon to wage war under such conditions or in such numbers.

There are also those who contend that since the engineer soldiers perform in war tasks similar to those which they are accustomed to in time of peace, the ranks of our engineer regiments can be filled very effectively at the outbreak of war with men recruited from the industrial trades, regardless of the fact that they have had little or no military training. This reasoning is based on the fact that the great bulk of engineer troops during the World War were peacefully employed on construction projects miles behind the fighting lines, where the rifle gave way to the hammer and the saw and the workers never heard as much as "a single shot fired in anger." However true this description may be and however plausible may be the theories as to training evolved from such experience, it must ever be borne in mind that the fact that these thousands of workers were without military training did not constitute an advantage either for the men themselves or for the country which they served; rather did it constitute a grave handicap which would have made itself felt immediately had the Germans broken through on the West Front, forcing these untrained men to be called upon to play the part of seasoned soldiers in a strenuous campaign.

Moderation may be observed in military training as in all other activities. It can, in fact, be stated that moderation is the preventive of militarism, but it can also be said that it is not for nothing that all the nations of the earth have found it necessary in our present stage of development to maintain armies and to prescribe for their soldiers thorough and systematic military training.

To return to the question of the training to be provided for the regular officer of engineers, we firmly believe that it will be found most excellent if every such officer could have the experience of being placed in charge of a hired labor project with no agencies to assist him in controlling his employees other than the pay roll and his own personality.

It is safe to say that the members of the Corps of Engineers are a unit in endorsing the plan of detaching regular officers for duty that will bring them into closer contact with civilians throughout the United States. This is necessary if preparation is to be made to meet effectively the military crises that may confront our country in the future. The Act of June 4th wisely provides for a constant interchange between the activities of the Regular

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officers, who are primarily military men, and the Reserve officers who assist in carrying on the industrial business of this nation.

In order to derive from the law the benefit which it is designed to give our Army and our country, it remains with Congress to provide the funds needed to put the law into effect. While we recognize the need for true economy in governmental affairs, we hope that considerations of a false economy will not defeat the purpose of this wise legislation nor prevent the country from reaping the results the time, money and effort spent in organizing the Reserve Corps.

The Boy Scouts

AS the twig is bent so the tree is inclined. Bend and shape the boy into proper lines of right thinking and clean living and the ultimate result is a hardy upstanding tree in the form of an American citizen, whose roots have taken such firm hold in the soil of loyalty and devotion to country that he withstands and defies the blasting storms loosed by radical agitators, and whose straight trunk reaches ever higher and higher toward the heaven of the ideals that inspired the founders and the defenders of our country.

Preparedness involves not merely willingness to serve but also training that will enable the spirit of service to manifest itself in an effective form in time of emergency. The Boy Scout movement has demonstrated beyond all doubt that boys are not only keenly interested in and absorb readily much of the technique that is a necessary part of the training of a soldier, but, what is of much greater importance, that they acquire under proper direction an appreciation of the necessity and value of discipline and teamwork that is much harder to inculcate in grown men. Training therefore should start with the boy; not because such training will make him a soldier when he grows up, but because it will make him a citizen, in the fullest sense of the word, a citizen who loves peace and who follows peaceful pursuits, but who feels within himself the potentialities of the soldier.

The chief problem in connection with the Boy Scout movement is direction. Driving power, in the form of boyish enthusiasm and energy, is available in abundance, but skilled sympathetic personnel to direct this superabundant energy along proper lines is difficult to obtain. The work of the scoutmaster is not easy, but the rewards are great, for the results are immediate and tangible. Much of the training of the scout falls within the province of the Engineers. The Reserve Engineer officer has the opportunity of rendering valuable service by interesting himself in the work of the Boy Scouts. When active participation is not possible, mere interest on his part will serve to enhance the importance of the work in the eyes of the boys themselves. Contact with the work is inspiring and will well repay anyone who will devote himself seriously to it.

Local sections might well give serious consideration to the question of co-operation with this movement, in order that the transition from Boy Scout to Reserve Officer may be an easy and a natural one.

Activities of Our Local Posts

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preparedness submitted in November, 1919, and is working in close harmony with our Society.

The directors held a meeting at the Union League Club on November 22, 1920, at which time they had the pleasure of entertaining Major General Leonard Wood and Colonel Nathan William MacChesney. At the meeting held later in the rooms of the Western Society of Engineers, these distinguished officers addressed the members. The enthusiasm resulting from the information, advice and council of these gentlemen was of real benefit to the members and of great value to the Society. This being the annual meeting, reports were read, after which the following officers were elected: President, C. Van Deventer, former Lieutenant Colonel with Office of Chief of Engineers, A. E. F.; 1st Vice-President, Wm. G. Arn, former Lieutenant Colonel, 13th Engineers; 2d Vice-President, Col. John Millis, Corps of Engineers; Secretary, J. T. Montgomery, former Captain Personnel Adjutant, 55th Engineers; Treasurer, Maj. John C. H. Lee, Corps of Engineers. Directors: Col. W. V. Judson, Corps of Engineers; Edward J. Blair, former Lieutenant Colonel, 311th Engineers; Horace S. Baker, former Colonel, 111th Engineers; Henry A. Allen, former Colonel, 108th Engineers; Walter A. Hill, former Major, commanding 46th Engineers; John deN. Macomb, Major, formerly commanding 548th Engineers (Serv. Bn.)

The officers and members of the Chicago Section recognize that there is much to be done, that only a start has been made. They are committed to a big project. They are, however, animated with both determination and enthusiasm, and intend to combine both slogans of the Engineers—"Essayons," and "Go ahead and do it."

New York Post

The New York Post has now had two very successful meetings; the Board of Directors has had five meetings; a Membership Committee has increased our membership 60 per cent in 60 days; and our Program Committee has a continuous program built on our last two meetings to take us through the year, so we think we may safely say we have established a healthy successful post.

The first step toward organizing a New York Post, S. A. M. E., was a meeting held June 15, 1920, at the Army Building, New York, in response to a call sent from Washington to erstwhile emergency officers in New York vicinage. One hundred attended and enthusiastically and unanimously voted to form such a post.

Temporary officers and a committee on organization were appointed, which at the next meeting in the Army Building, June 29th, presented a constitution and a slate for officers. The constitution was adopted after a slight amendment which made the By-laws amendable by vote at a general meeting, thus yielding to the figment that has led half the world astray—making things safe for democracy. The following are the officers of the Post:

Col. F. A. Molitor, President; Col. Geo. D. Snyder, Vice-President; Maj. Percy E. Barbour, Secretary; Sgt. Alan D. Fitzgerald*, Assistant Secretary; Maj. Phillip D. Fleming, U. S. A., Treasurer.

Directors: Col. Roger D. Black, Maj. E. F. Robinson, Lt. Col. Arthur S. Dwight, Col. B. W. Dunn.

The matter of dues was put off until the annual meeting in January, it being deemed sufficient to assess an entrance fee of $1.00, which would take care of expenses until that time. There are so many calls on the purse these days that it is felt that this movement at its inception must not be an expensive one. It is a patriotic effort and must generate its own momentum, for the country has already forgotten the lesson it was about to be taught when the too early signing of the Armistice convinced it that we can become prepared any old time on short notice and are invincible.

*Since promoted to Lieutenant 22d N. Y. Engineers.

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The Program Committee laid out a very ambitious program, and the intense interest aroused by the meetings thus far justifies its effort. It reported in part:

1. It is believed that to achieve the greatest usefulness to and through its members the Post should evolve a definite Purpose and a Policy to further its Purpose. To this end it seems desirable at the outset to enunciate a tentative Purpose and Policy as a basis on which to work.

2. *General Purpose—*

To foster that active co-operation between the technical personnel of the regular army and the personnel of the civilian engineering profession which will result in the greatest efficiency on the part of all concerned when mobilized for war, either as part of the armed forces or in war industry.

3. *Specific Aims Corollary to the General Purpose—*

(a) To maintain and build up mutual respect and confidence, and prevent jealousy, misunderstanding, suspicion and conflicting activity.

(b) To cultivate acquaintance and co-operate activity between the regular army, the national guard, the reserve corps and civilians.

(c) To assist in the development of a sound military policy and the formulation of legislation and regulations thereunder tending most effectively to carry out the "General Purpose."

(d) To promote military education.

(e) To build up the reserve forces, particularly in the technical services.

(f) To prepare for the most effective use of the reserve forces and civilian personnel on mobilization.

4. *Premise for Policy—*

(a) The Post believes that both mutual confidence and efficiency are based primarily on real ability to perform a present or contemplated service. Such ability is based on character, experience and theoretical training. The first two are related only incidentally to the possible activities of the Post.

(b) It also believes that military training involves; *first,* a definite knowledge of function, that is of what is required of the individual, and *second,* the necessary technique to perform the function, that is, the ability to do what is required.

(c) Knowledge of technique is of little avail in organized work, such as that of a large army, without the corresponding knowledge of function.

(d) The technique of military engineering in its various branches is relatively simple, and the greater part of it can be based on the technique of corresponding civilian activity. The balance, that is the strictly military technique, can be best learned in training camps or left to the agencies of actual mobilization and service.

(e) To know his function, every individual in the military service must know the functions of all with whom he deals. This requires, for officers of the technical services, a broad and uniform general knowledge of the principles of military organization.

(f) A study of military organization involves a study of military policy, which in turn will result in informed and useful convictions on all of the "Specific Aims" cited above.

5. *The Policy—*

Therefore it will be the present policy of this Post to develop to its utmost the knowledge of the proper functions of its members, whether in the military service or in war industry, and in preparation for both.

The Policy will be Pursued—

(1) By a study of—

(a) Military Policy.

(b) Principles of military organization.

(c) Principles of organization of munition supply.

(d) The application of all these to the local situation as it affects our members and their activities; and

(2) By such line of action as will seem best as a result of this study.

After full consideration of the subject your committee recommends that the Local Post of the Society of American Military Engineers follow the lead of the various alumni associations and have four regular meetings, one smoker and one annual dinner each year, together with one or more outside trips to nearby points of interest or military importance. With respect to the scope of subjects to be treated at regular meetings, it is recommended that broad military questions bearing on the purpose and policy be discussed rather than technical details.

The following schedule is being followed:

Fixed date October 26th—Army Reorganization Bill and Opportunities for Reserve Officers and Organizations.

Tentative date December 14th—Relations between Staff and Services.

Tentative date January 26th—Annual Dinner.

Tentative date February 10th—Functional Organizations of Engineers.

Tentative date April 13th—Military and Engineering Defense of New York—War Game.

Tentative date May—Trip to West Point, N. Y.

The April meeting will be held jointly with the New York Section meeting of the American Society of Civil Engineers.

At the first meeting, besides the set speakers, a letter from General Haan was presented containing a scheme for "Training Courses for the Organized Reserves" with the request that it be considered and an expression of opinion given.

Col. Wm. Barclay Parsons prepared a reply, which he read. The fact of the presentation of such a plan for opinion was of no small importance. It indicates how the post may be of assistance not only to the parent society but to the Government, and fills us with courage and hope.

The progress report of the Military Affairs Committee of Engineering Council was considered in abstract and briefly discussed.

At both meetings we have had the privilege of addresses from distinguished members of the general staff in Washington, officers from Governors Island, and various reminiscences from officers who returned from France rich in trouble and experience.

Philadelphia Post

At a meeting of the Philadelphia Post, Society of American Military Engineers, held at the Engineers' Club, Philadelphia, Monday, October 25th, 1920, the constitution and by-laws of the local post were adopted and the following officers elected to hold office until January, 1922:

Col. W. B. Ladue, Commander; Maj. Marshall R. Pugh, Vice-Commander; Maj. H. W. Goddard, Adjutant; Capt. J. C. Hinton, Finance Officer; and the following staff officers were elected for two years: Lt. Col. Henry S. Spackman, Maj. Thomas W. Battin, Captain Clarence Roberts; and for a period of one year, the following: Capt. R. W. Robinson, Lieut. Robert L. Harding.

It was also decided to hold regular meetings the fourth Thursday of each month during the winter.

At a meeting of the Philadelphia Post, Society of Ameri-

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can Military Engineers at the Engineers Club, November 30th, 1920, Lt. Col. Henry S. Spackman gave a very interesting talk on relationship of military to general engineering, which was followed by a general discussion by members and invited guests.

Washington, D. C., Section

On Friday, December 17, about 75 members of the Society of American Military Engineers gathered at luncheon at Washington.

Dr. Alfred Brooks of the U. S. Geological Survey presided. Dr. Brooks was formerly a Lieutenant Colonel of Engineers and was Chief Geologist of the A. E. F.

Brigadier General Henry Jervey of the General Staff, was the first speaker. He abandoned the material realm of engineering and spoke eloquently of the research spirit as a source of inspiration in the everyday affairs of life. Dr. Augustus Trowbridge, of Cornell, now serving on the National Research Council, gave a brief but interesting sketch of the activities of the Council, which is continuing the investigations along scientific lines that were started by this body during the war. Dr. Trowbridge was a Lieutenant Colonel of Engineers in the A. E. F., and was charged with the development and practice of sound and flash ranging for the determination of location of enemy guns. The last speaker, Mr. O. C. Merrill, Executive Secretary of the Federal Power Commission, outlined the vast problem that confronts the Commission in its task of working out a feasible policy for the development of the water power resources of the country.

This is the second of a series of luncheons to be held in Washington. A committee has been appointed to draw up plans for the formal organization of a Washington Post of the Society.

The Chesapeake and Delaware Canal

By

J. P. Jervey

Brig. Gen., U. S. A., Retired

[*Note.*—Somebody once propounded the theory that it required less power to move a ton of freight a given distance by water than by rail. This is true. It has been frequently seized upon as a proof that water transportation is inherently cheaper than transportation by rail, and has been responsible for the waste of many millions of dollars. The facts are that this consumption of power is only one of a vast number of items that enter into the cost of transportation, and sometimes it is a very insignificant item.

The best system of transportation to employ, and whether or not it will pay to employ it, must be determined by investigation of each case on its own merits. Transportation by rail is certainly cheaper than transportation on the backs of coolies or mules. Yet there are many situations in which the latter form of transportation continues to be used. If we wish to move the household furniture from one room to another, we do not put in a railroad, nor even employ a motor truck to do it.

General Jervey, in the entertaining article which follows, points out the fundamental economic conditions on this canal and indicates what it has already accomplished, and what it may accomplish in the future. Had more of our water-way projects been examined and studied in like intelligent manner before money was spent on them, many millions of dollars would have been saved the tax payers of the United States.

A deep intra-coastal waterway between Chesapeake and Delaware Bays, thence to New York Harbor and Long Island Sound, would have a tremendous value to the national defense. In providing a number of available outlets it would render it impossible for the combined navies of any probable opponents to blockade our fleet. The intra-coastal waterway, accordingly, finds its chief justification as an element of the National Defense.—ED.]

Historical. Fully two hundred years ago the question of constructing a canal through the upper part of the Maryland and Delaware peninsula was under consideration. Toward the end of the eighteenth century this agitation resulted in definite action and a charter was issued in 1799. Vigorous efforts were made to secure funds, the general government and the states of Pennsylvania, Delaware and Maryland all contributing. After twenty-five years of effort the necessary money was raised and in 1824 the construction of the present Chesapeake and Delaware Canal was begun. The water was let into the canal on July 4, 1829, and in the same year the canal was opened for traffic. The total cost was $2,250,000, of which the United States furnished $450,000; the state of Pennsylvania, $100,000; the state of Maryland, $50,000; the state of Delaware, $25,000, and the citizens of the several states the remainder.

This waterway, ordinarily known as the Chesapeake & Delaware Canal, but officially as the Inland Waterway from Delaware River to Chesapeake Bay, comprises at present a short tidal stretch at its Delaware River end (which is 40 miles below Philadelphia); a slack water section 4.3 miles long from Delaware City to St. Georges with a level 7 feet above mean low water in Delaware River; a slack water section 9.3 miles long from St. Georges to Chesapeake City, Md., with a level 17 feet above mean low water in Delaware River and a tidal section 4.2 miles long from Chesapeake City to the junction of Back Creek and Elk River, in which certain cutoffs must be made, sharp curves and detached shoals eliminated. The total length of the slack water section is 13.6 miles and of the tidal sections about 4.3 miles. All locks have horizontal dimensions of 24 by 220 feet.

An interesting feature of the canal was its use during the Civil War, in 1861, for moving troops to the defense of Washington. On the night of Friday, the 19th of April, all bridges on the Philadelphia, Baltimore and Washington Railroad from Baltimore to the Susquehanna River were totally destroyed by Confederate sympathizers and the Federal Government had then absolutely no means of transporting troops along the seaboard by rail to Washington. On April 20, however, the United States commandeered all the propeller steamers in Philadelphia that could traverse the Chesapeake and Delaware Canal, and these were passed through the canal, arriving before daylight on the morning of the 21st at Perryville, on the Susquehanna River. Early that morning the troop trains from the North arrived at Perryville and the troops were transferred to the steamers which then steamed down the river and bay to Annapolis, whence all troops were moved by rail to Washington, arriving just as the Confederate outposts appeared at the Virginia end of the Long Bridge in Washington. It is probable that this prompt and efficient use of the canal saved the city of Washington from capture by the Confederate forces. Subsequently, throughout the war this canal played an important part in supplying the Army of the Potomac with munitions and other stores.

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Among such national activities as the publishing to the profession of a Code of Ethics, written for A. A. E. by the late Isham Randolph, the maintenance of a Practice Committee to enforce the Code, a great compensation service conducted in accordance with professional ethics, the Service Department stands in the forefront.

The positions filled during July saved members $35,000 which commercial agencies would have charged to place them in the same positions. This is more than two times the total monthly dues of the 21,000 members of the Association. Furthermore, the department did not fill all the positions on its list. It has 200 vacancies a month for mechanical engineers.

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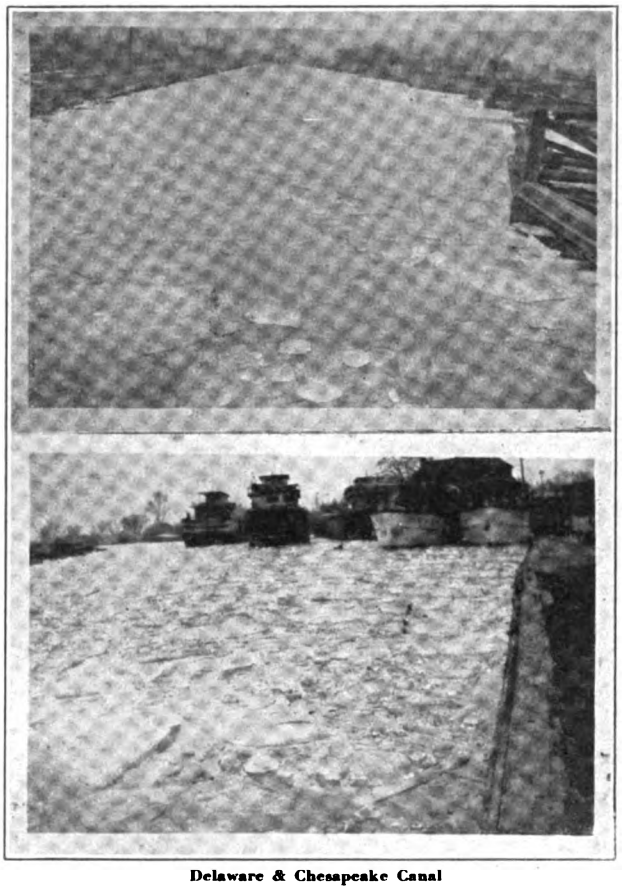
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by water the question of the saving of time is a vital consideration. Any improvement or modification of our waterways which will result in the shortening of distances and the saving of time therefore deserves careful consideration. The conversion of the Chesapeake and Delaware Canal into a ship canal will shorten the distance between Philadelphia and Baltimore by 323 miles and the distance from Baltimore to the mouth of the Delaware by 184 miles. This will mean a saving of time in the first case of from 30 to 36 hours and in the second case of from 16 to 18 hours. When it is considered that the operating expenses alone of a freight-carrying steamer under present conditions runs from $300 to $500 per day and that if depreciation, loss of freight, etc., are considered, the total cost of avoidable delay will be from 50c. to 70c. per ton per day, it is seen that a very large saving will result due to the shortening of time between Baltimore and Philadelphia and Baltimore and the mouth of the Delaware River. Again the loss of vessels and lives which now takes place annually between Cape Charles and Cape Henlopen, between which points there is no harbor of refuge, except the inadequate one at Chincoteague, will be greatly reduced. The cost of marine insurance and of new construction will also be lessened. For outside runs insurance rates range from 8 per cent to 12 per cent annually as against the average of 4 per cent for an inside run. If the cost per ton capacity of a barge suitable for inside work to be considered as unity, that for a lake vessel will be 3.6 and that for an ocean-going vessel 6.3. If the entire waterway were completed from Norfolk to Boston for seagoing vessels delays to shipping on account of storms would be largely reduced. At times, barges and sailing vessels have been compelled to wait at Hampton Roads two to three weeks for favorable weather and as many as 75 to 100 vessels have at times been seen thus waiting in the Roads. Delays of this character would be almost entirely eliminated by the use of the Intracoastal Waterway.



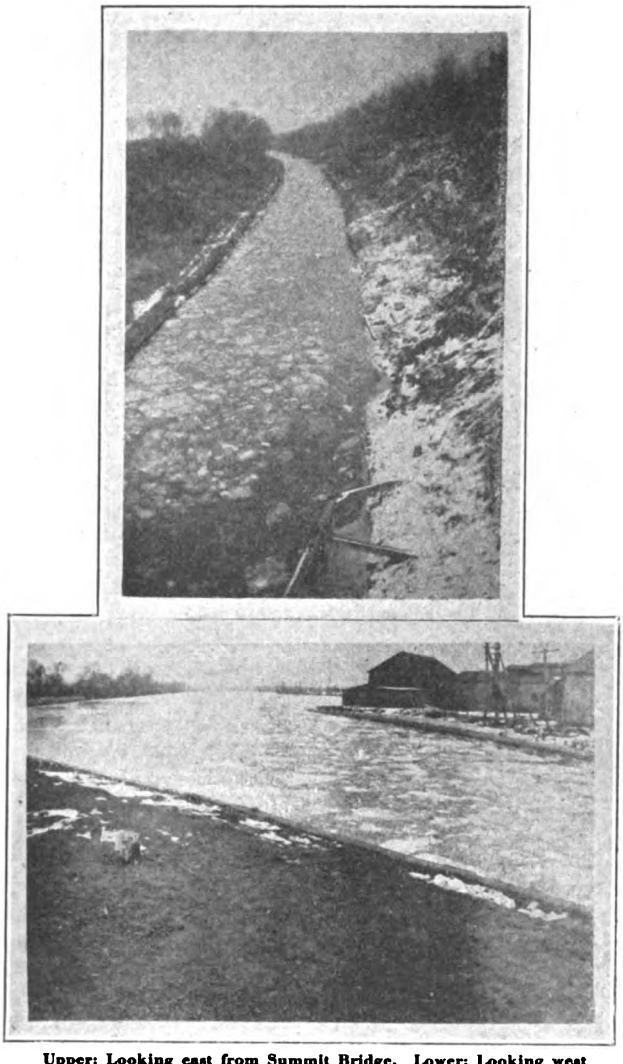
Delaware & Chesapeake Canal

Upper: Looking east from Delaware City breakwater. Lower: Looking west from Delaware City lock

Commercial and industrial. The Chesapeake and Delaware Canal is a waterway connecting very directly two of the most important ports of the United States, namely, Philadelphia and Baltimore, and even with its present restricted dimensions carries an important commerce between the two points mentioned. In addition, the Delaware River from Wilmington, Del., north is probably the greatest manufacturing district in the United States; south along the shores of the Chesapeake Bay is one of the richest agricultural regions in the United States, and still further south at Norfolk three great coal-carrying roads bring to seaboard the products of the mines of Virginia and West Virginia; while from sounds of North Carolina come great supplies of lumber both for building and paper manufacturing purposes. Delaware and Chesapeake Bays have a combined shore line of 2,500 miles with 500 tributary streams, and more than 10,000 registered vessels ply on these waters. The registered tonnage operating on each bay is about 25,000,000 tons, to which may be added an unregistered tonnage of an equal amount, making a total tonnage on both bays in the neighborhood of 100,000,000 tons. The population of the states and portions of states bordering on the two bays and its tributaries is probably now in excess of 15,000,000. The canal may be therefore considered a great link connecting sources of raw material and agricultural products with the manufacturing centers, where these materials and products are consumed. In addition to its local value, the Chesapeake and Delaware Canal is the central link in the chain of waterways proposed between Boston and Beaufort, and it is essential to the construction of any intracoastal waterways connecting New York and Philadelphia with the South. It is difficult to estimate the amount of coastwise traffic which would use the canal, as, unfortunately, coastwise vessels are not required to furnish manifests of their cargoes to customs collectors. It has been estimated, however, some years ago, from very incomplete data, that the total inland traffic north and south via the canal, after it was made into a free canal, would be at least 2,500,000 tons valued at over $14,000,000 per annum, and that the annual saving, not considering the saving in insurance, on known existing coastwise commerce which would use the free canal would not be less than $2,230,000. The actual saving would probably be in excess of this. An investigation made in 1910 shows that the annual traffic between Baltimore and domestic ports which would be benefited by the free canal affording 25-foot navigation would be in the neighborhood of 4,500,000 tons, and without predicting any increase in navigation it was then estimated that the total saving including foreign commerce, due to a free canal affording 25-foot navigation would be $1,414,000. Since the date of this report the commerce of both Philadelphia and Baltimore has greatly increased, costs in nearly all cases have advanced more than 100 per cent, and it is probable that the benefits accruing from deepening the canal to 25 feet would show a corresponding increase, making the probable saving about $3,000,000 or more. With reference to Baltimore, the *Manufacturers' Record* of June 3, 1920, states:

> Baltimore's advantages include lower railroad freight rates than those of points to the north. The city's longitudinal location enables it to obtain freight differentials under New York, Philadelphia, and

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Upper: Looking east from Summit Bridge. Lower: Looking west from St. Georges Lock

New England points on shipments to and from Buffalo, Pittsburgh and the Middle West.

To the prospective industry Baltimore presents the advantages of saving in labor cost, lower freight rates, lower taxes and cheaper rates for power than prevail in most other cities.

Steamships are operated between Baltimore and practically every important port of the world.

In a report of the Export and Import Board of Trade of Baltimore dated August 5, 1920, it is also stated:

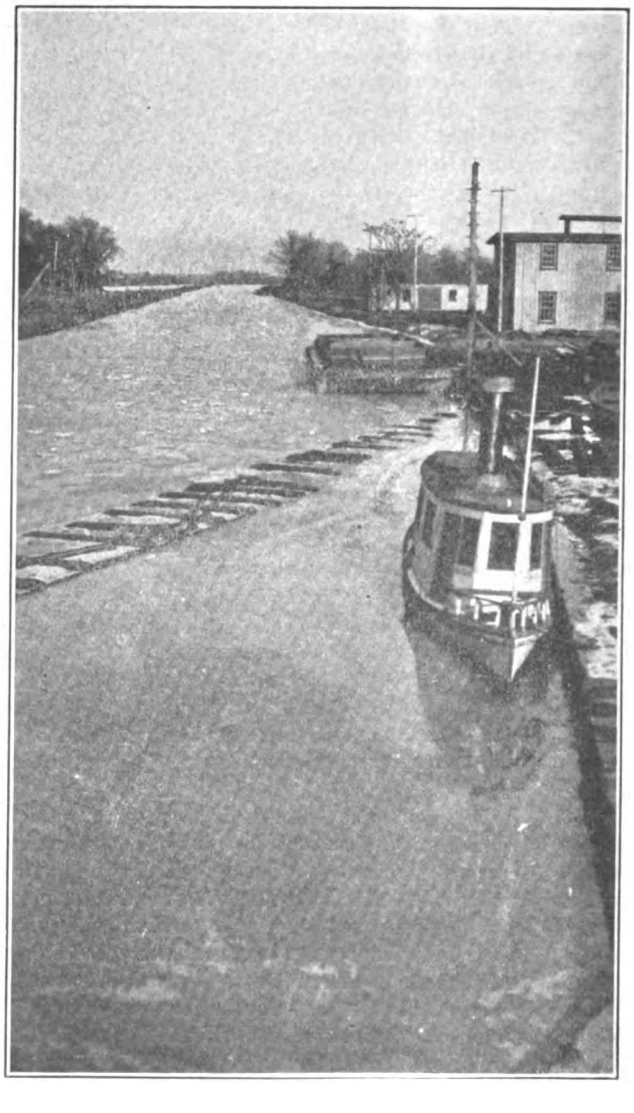
Baltimore's foreign trade has more than tripled in value since before the war, and the present outlook for 1920 indicates new records in every branch of shipping, including export and import business.

There are now 42 steamship lines operating more than 150 vessels on 59 services to over 80 foreign ports from Baltimore.

Exports and imports pass through this port without congestion or delay. The "turn around" of steamers costs less in this port than in New York, recent comparisons showing an average saving of more than $4,000 per vessel each time on similar ships and cargoes in favor of Baltimore.

The report of the Chief of Engineers for 1920 shows that the total tonnage and value of commerce of the port of Baltimore for the calendar year 1919 was 14,055,906 short tons valued at $873,891,200, and of the port of Philadelphia for 1918, 21,000,000 short tons valued at $2,600,000,000. It does not, therefore, seem extravagant to predict that the Chesapeake and Delaware Canal considered alone has promising prospects of being a successful investment for the Government. With the deepening of the canal to even 12 feet and its widening and conversion into a sea-level canal, the time between Philadelphia and Baltimore will be so reduced that the steamers will be able to make the distance easily under 12 hours and will need a crew consisting of but one watch. In addition, passenger steamers of practically the same type as now operate so successfully between Baltimore and Norfolk could also be operated between Philadelphia and Baltimore. The country along the upper Chesapeake, particularly along the Elk River, Back Creek and the line of the canal is a beautiful rolling section, which is being rapidly bought up and improved by residents of Philadelphia and Baltimore. The Delaware River is most interesting on account of its great industrial and commercial development. The passage by water between Philadelphia and Baltimore should therefore be most attractive and instructive.

Canals vs. Railroads. Due to the decline of all waterborne commerce in recent years, it has been claimed that large outlays for the improvement and construction of intracoastal waterways are uneconomical when compared with the cost of freight carriage along the coast by ocean-going lines, and internally by the railroads. So far as the comparison with ocean-going vessels is concerned, it has already been pointed out that the cost per ton of capacity for the construction of a barge for an inland waterway is less than one-sixth of that of an ocean-going vessel. In addition the cost of insurance on vessels using the inland

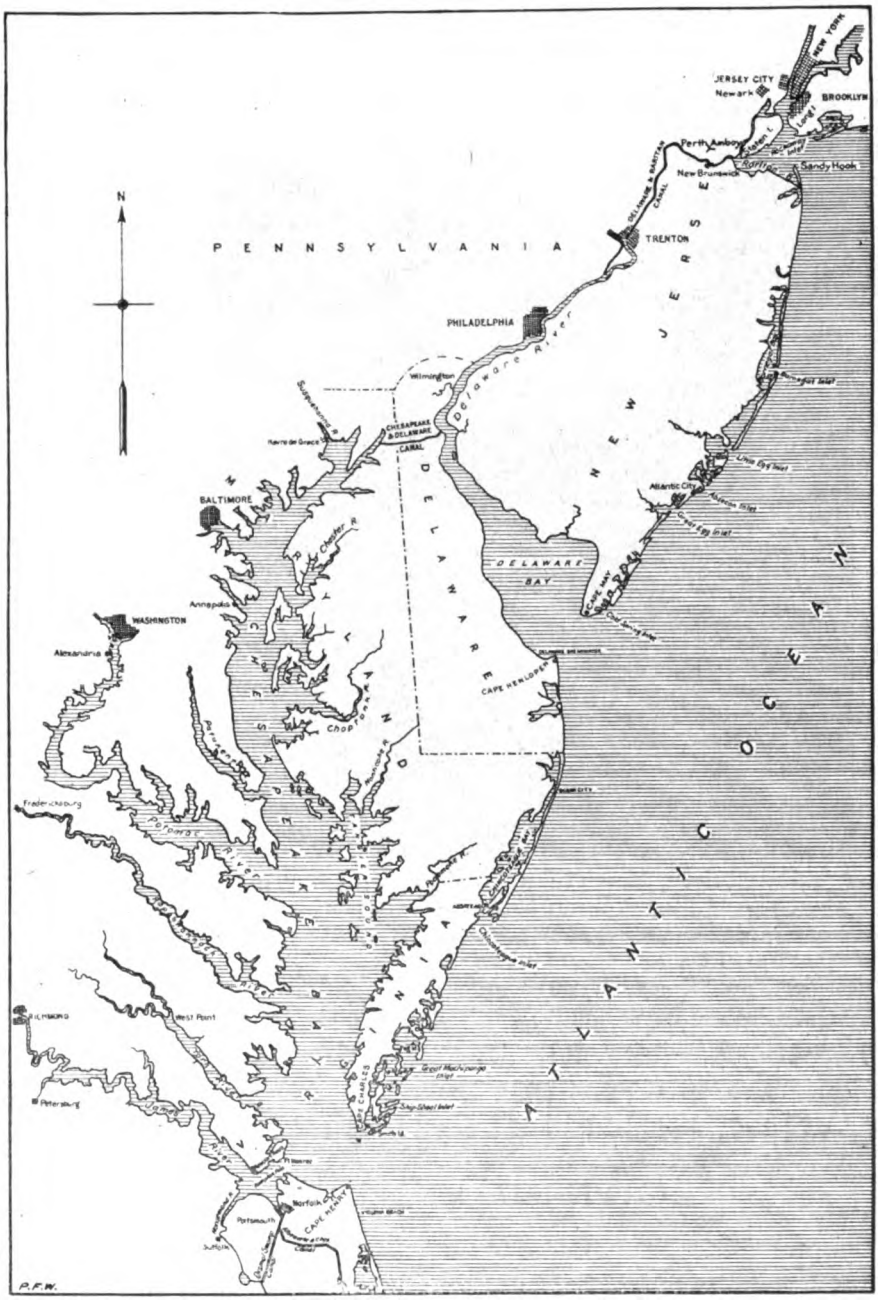


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waterway is only one-half to one-third that for vessels operating on the high seas. The greater safety for human life of the inland route is most important.

In the early days of the development of commerce in the United States there was a heavy traffic first on our natural waterways and then on the many artificial canals which were constructed by State, Federal or private funds. As the railways were constructed the water-borne commerce declined, and in many cases disappeared, as the population was not sufficiently dense to provide traffic for both methods of transportation, and the railways, due to the fact that they were able to place cars either for shipment or delivery at the exact spots desired by their patrons, presented great advantages as compared with shipment by water. As the population increases, however, it is reasonable to suppose that there will be a revival of water-borne commerce.

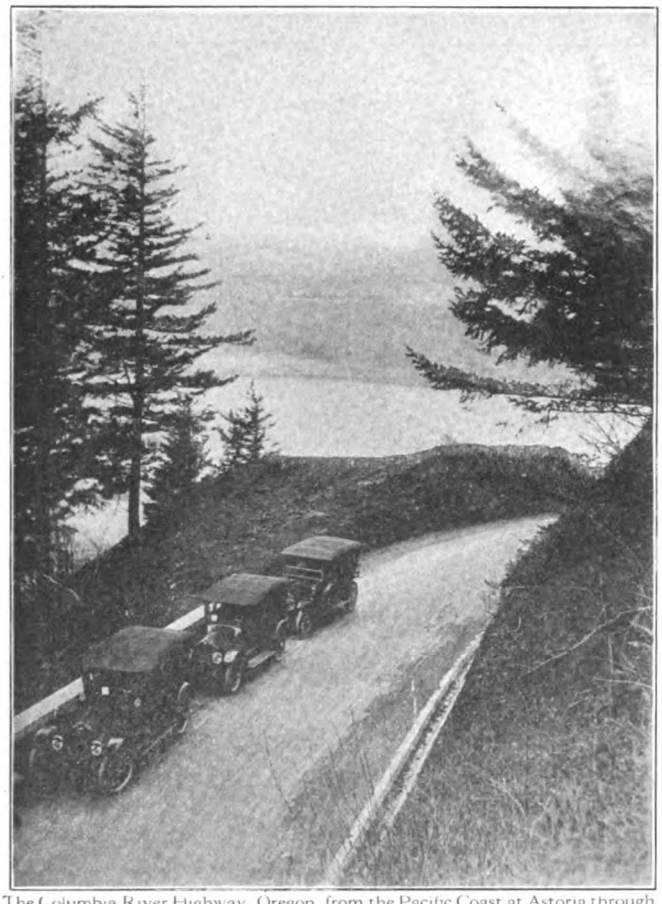
In the past, railway development in the United States has in many cases been unjustified and in advance of the actual necessities of commerce. In their consequent fight for existence the railways have been permitted to make discriminating rates to points where water competition was possible. As a result, lower rates were granted to such points and these rates had to be compensated by imposing higher rates on interior points not so fortunately situated. In other words, the interior population has had to pay, in part at least, for the freight service to the population on the waterways.



Moreover, in the past, it has been the policy of railway companies to obtain possession of all available wharfage space in terminal cities, partly with a view to preventing water competition. The requirements, however, of the last River and Harbor Bill as to public terminals should eventually counteract this evil. In many cases, also, the railways have refused to grant through bills-of-lading or pro-rate freight charges in connection with water carriers, thus making the all-rail carriage more advantageous. Since railways are public-service institutions, owing the possibility of their existence to certain rights granted in their charters, a policy of this kind which is manifestly contrary to the public interests must eventually be changed. From a report published in 1910 as to conditions in Germany, it would seem that as the population becomes more dense there should be sufficient traffic both for railways and waterways. This traffic will be divided so that each carrier will transport the character of freight most suitable to its particular form of carriage. In the report referred to above it is shown that in 1875 the traffic over 26,500 kilometers of railway amounted to 10,900,000,000 kilometer tons, and that over 10,000 kilometers of waterways amounted to 2,900,000,000 kilometer tons. In 1905 the traffic over 54,400 kilometers of railways was 44,600,000,000 kilometer tons and that over 10,000 kilometers of waterways was 15,000,000,000 kilometer tons. The increase of railway mileage was 105 per cent. There had been no increase in waterway mileage. The increase of railway tonnage was 400 per cent and of water tonnage, 500 per cent. There seems, therefore, no grounds for the fear that under favorable conditions it will not be entirely possible for both waterways and railways to operate successfully.

Military and naval uses. The Chesapeake and Delaware Canal would form a convenient and useful interior line by which troops or small vessels could be readily moved from Delaware Bay to Chesapeake Bay or vice versa. In order, however, to have any particular value from a naval standpoint the depth should be at least 16 feet, which is the minimum that would permit the passage of destroyers, submarine chasers, or submarines. If the canal is eventually deepened to 25 feet it would permit the passage of prac-

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tically all coastwise vessels of the United States Mercantile Marine and would then become a convenient means of moving troops in large bodies from north to south or vice versa. For the moving of troops sheltered water transportation affords many advantages over transportation by rail. Among these advantages may be named:

a. The possibility of keeping the larger administrative units united in a single carrier.

b. The diminished chances of delay to an entire expeditionary force by the loss or delay of one of the transporting units.

c. The smaller number of transporting units required.

d. The greater freedom from ordinary delays in transit due to ordinary commercial traffic.

In the future, if a still further deepening of the canal is undertaken, it might be possible to pass commercial ships and battleships of the largest class conveniently and safely between the great commercial and naval establishments at Philadelphia and Norfolk.

Methods of construction and dimensions. The approved project for the greater canal provides, for the present, for a depth of 12 feet and a bottom width of 90 feet. It is proposed to carry on the work of improvement so that traffic will not be interrupted. This will require the work of reconstruction to commence on the summit level and be followed by the removal of the locks as the canal is gradually deepened. The question will naturally be asked why the 25-foot depth is not provided at once. The answer to this is that in order to economically dispose of the spoil from the excavation it will be necessary to provide at the outset a channel on which barges loaded with excavated material may be readily moved to the disposal areas at the eastern end of the canal without interfering with commercial traffic. A sea-level canal 12 feet deep and with a bottom width of 90 feet will be sufficient for this work. Again, a depth of 12 feet and a width of 90 feet is sufficient for all barge traffic, and it is believed that a very large percentage of the traffic between Chesapeake Bay and Delaware Bay will be carried in fleets of barges towed by tugs. The question of coastwise ships and ships bound to foreign ports moving out of Baltimore is principally a local one in which Baltimore is largely concerned, and it is thought that a large measure of co-operation by that locality would be proper before a 25-foot or greater depth was secured. After the 12-foot depth and 90-foot width have been obtained a further deepening will be comparatively a simple matter. It may be noted that in reconstructing the bridges, pier and abutment foundations will be carried deep enough to provide for a future depth of at least 25 feet and possibly more. The revised estimate of the cost of construction of a canal 12 feet deep with a bottom width of 90 feet, is $12,000,000. In order that the construction may be economically carried on, whether done by contract or by hired labor, this money should be appropriated so that the canal may be completed in four to five years. This will involve annual appropriations of $2,500,000 to $3,000,000.

Reports and surveys. A wealth of information in great detail as to the various surveys, examinations and reports on the Chesapeake and Delaware Canal is found in official documents. The most important of these are the Angus Commission Report submitted to Congress by the Secretary of War on Jan. 7, 1907, and published in Senate Doc. No. 215, 59th Congress, 2nd Session; the Intracoastal Waterway Report submitted to Congress on Jan. 4, 1912, and published in House Doc. No. 391, 62nd Congress, 2nd Session; the final report on sections of the Intracoastal Waterway from New York Bay to Delaware River and from Delaware River to Chesapeake Bay submitted to Congress Aug. 12, 1913, and published in House Doc. No. 196, 63rd Congress, 1st Session, in which is contained the basis of the present approved project; summaries of reports of Government Commissions, Officers and Engineers made upon a canal to connect Chesapeake Bay and Delaware River submitted to Congress March 11, 1915, and published in Senate Doc. No. 14, 64th Congress, 1st Session; and finally a letter from the Secretary of War dated December 14, 1918, recommending the purchase of the Chesapeake and Delaware Canal and published in House Doc. No. 1600, 65th Congress, 3rd Session. As a result of this last named communication the existing project was adopted by the River and Harbor Act of March 2, 1919, under which $3,000,000 was appropriated and which provided for the purchase of the Chesapeake and Delaware Canal at a cost to the United States not exceeding $2,514,289.70 and its enlargement to a sea-level barge canal, extending from the 12-foot curve in Delaware River to the 12-foot curve at the intersection of Back Creek and Elk River, a distance of about 19 miles.

Another Use for the Cement Gun

The cement gun, in experienced hands, lends itself to the solution of many of the more difficult problems of engineering, as is amply proven by the results already attained.

One of its latest achievements is the renewal of a battery of 42 cylindrical steel tanks whose plates had been rusted through by the acids contained. These tanks were 16 feet in diameter and 8 feet deep.

The tanks occupied a restricted space in a building, and to have replaced the damaged plates would have required a suspension of operations by the plant to which the tanks belonged, which at the time was working night and day to fill delayed orders. This would have caused a great loss. An alternative but preferable solution was to replace the tanks one by one. This also would have been very expensive.

In this dilemma the cement gun was brought to the rescue. The tanks were repaired two at a time. The tanks to be repaired were drained and thoroughly cleaned of rust and scale, this producing many holes through the damaged plates. Steel reinforcing rods, ¼ and ⅜ inch in diameter were then placed vertically against the shell, both inside and out, being hooked over the rim. The inside and outside rods were wired together through the holes in the tanks. Wire mesh was then attached on both sides and a 1-inch layer of "gunite," consisting of 1 part cement to 3 of sand, was shot on. The outside layer was left with the rough finish, the inside was troweled smooth. The tanks were thus converted into stone jugs of 2 inches of gunite, with a steel plate in the center, and rod and mesh reinforcement on each side of the plate.

The tanks proved to be perfectly tight, the acid having no effect on the gunite. After two years' service they promise to endure at least as long as any other portion of the plant. —*Concrete.*

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Additional Roster of Charter Members

(This list consists of applicants whose names were not carried in the last number of THE MILITARY ENGINEER. Formal applications have been received from some of them; action will be taken on others as soon as their formal applications are received.)

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The Civil Activities of the Corps of Engineers*

Their Value as Military Training, and their Relation to the National Defense

By

Gilbert A. Youngberg

Lieutenant Colonel, Corps of Engineers

[INTRODUCTORY NOTE. For more than a hundred years the Corps of Engineers of the Army has faithfully and efficiently prosecuted the public works pertaining to navigation, and many other such works of a miscellaneous nature. And that record of a hundred years of honest and efficient service, attested by works that cover the country from the Atlantic to the oriental shores of the Pacific, and from Alaska to Panama, cannot be overlooked nor set aside by the American people.

But aside from the efficient prosecution of the works themselves, the training thus gained by the Corps of Engineers has, as Colonel Youngberg points out in this excellent article, a most vital relation to the national defense.

The Corps of Engineers knows that the success which its officers have achieved in war, both in the field of engineering and that of high command, is in large measure due to the training gained in the prosecution of the public works.

And in our desire to attain the utmost in economy and efficiency in our public works, we also must not overlook the value of the military training which they afford to our army engineers. Not on a doubtful chance of saving a few dollars a year on public works can we afford to entrust the engineering operations incident to a great war, to a body of men who are not both thoroughly trained soldiers and thoroughly trained engineers. For a single mistake in their judgment in the critical time of armed conflict might easily wipe out the saving of years of peace, and might even spell national disaster. Let us fully realize what it might have meant to our country and to civilization had the important construction work in France, on which the operations of the A. E. F. so greatly depended, fallen into the hands of incompetents, instead of trained soldiers and trained engineers.

And it is not a mere knowledge of construction methods which is alone or even chiefly of importance to our military engineers. The highest virtue of the soldier, whether as commander or as engineer, is not the physical courage which enables him to face fire, but the higher (and rarer) moral courage, self-reliance and resourcefulness, which enable him to face and shoulder grave responsibilities involving the lives of men and the fate of a nation.

And so the most important feature of the training gained on the public works, is the ability and courage to assume responsibility. These require training in *responsible charge* of work. If our military engineers merely occupy subordinate positions in a great Department of Public Works they will fail to obtain this vitally necessary training for *carrying responsibility*. And in the next great war the lack of such training would jeopardize our chances of victory.—ED.]

THE Corps of Engineers is charged by law with the executive direction of so-called civil or public works having to do with the navigable waters of the United States. This civilian activity of a technical staff service of the War Department, this civil (and hence apparently anomalous) employment of an inherently military force is a matter which is little understood by the people in general and there exists also throughout the army a prejudice against the Corps of Engineers being charged with this responsibility. There is a feeling that in some peculiar and not clearly defined way it constitutes a class distinction in that it affords the officers of engineers preferment in the matter of station and duty and that it must necessarily militate against their efficiency as military men.

This prejudice grows out of misunderstanding of the nature of this duty and a misconception of the relation which it bears to the work of the Corps of Engineers in war. It is fostered by the infrequent opportunity given officers of the line to observe this work and the lack of any occasion on their part to give it analytical study.

The civilian public at large, so far as it is acquainted with the matter, has no such prejudice and is satisfied that the Corps of Engineers has, in accordance with the enactments of Congress, administered this important national activity with entire credit to itself. There is, to be sure, at this moment a well organized and active body of propagandists whose purpose it is to take this activity out of the hands of the Corps of Engineers and the War Department altogether.

Statements made by accredited representatives of this body, as reported in the press, display a woeful ignorance of the duties of the so-called military engineer who, after all, is none other than the engineer of civil life with such an additional knowledge of military matters as will enable him most efficiently to apply his art in support of military operations. In view of the magnitude and variety of engineering operations executed by engineers in the military service in France, any one claiming that the work of the engineer in war is concerned only with fortifications or other work subject to enemy fire is guilty either of crass ignorance or of criminal misrepresentation.†

The Corps of Engineers has confidence that it has given a good account of its stewardship and is prepared to defend before any proper tribunal its efficiency in the conduct of the work entrusted to it. In this connection it is also well to bear in mind that the Corps of Engineers is not an independent governmental body possessed of unlimited powers in respect to public works. It is subject to the will of Congress and, to quote General Bixby, "it has been the established policy of the Engineer Department to avoid as far as possible any action that might be misconstrued into an attempt on our part to decide for Congress what it should do in river and harbor matters. The Corps of Engineers is the servant of the people and not their master, and while the recommendations of the army engineers, when asked for, have always been made according to their own best judgment, their actual work has always been restricted to what has been ordered by the United States Congress."

Historical

The connection of the Corps of Engineers with this work harks back to the early days of the nation. In the simple agricultural life of the colonists there was practically no work of a technical engineering nature, though in the progress of the Revolutionary War, the need for military and topographical engineers became urgent. This need was supplied by officers from foreign armies, principally French, though the colonists themselves produced a few practical military engineers of no mean ability. In 1800 James McHenry, Secretary of War, urging the re-establishment by law of a military academy and a corps of engineers, said, in his argument, that "fortifications is but a single branch of their profession" and "their utility extends to almost every department of war and every description of general offices, besides embracing whatever respects public build-

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†A comprehensive account of the work of the engineers in France during the World War was published in THE MILITARY ENGINEER for January-February, 1920.—ED.

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ings, roads, bridges, canals, and all such work of civil nature." In 1802 the Military Academy was established at West Point for the sole purpose of educating engineers for such service. For many years past, however, its graduates have been assigned to all combatant branches.

Up to 1824 West Point was the only school which taught civil engineering, and all engineering work was necessarily started under the guidance of West Point graduates. In 1824 a specific Act of Congress gave to the army engineers the definite charge of all government roads and canals.

The Rensselaer Polytechnic School did not start until about 1824, and the Sheffield Scientific School at Yale, and the Lawrence Scientific School at Harvard not until about 1847. When, after the Civil War, civil engineering and other technological schools began to develop all over the United States, the Military Academy graduates still held their own good standing in the civil engineering profession because of their added knowledge of governmental methods and their special military training as to careful observation, obedience, and rigid responsibility in all matters of engineering work, property and funds.

The road and canal work of this country, started officially under the charge of the army engineers in 1834, was soon extended to embrace occasional rivers and harbors, and so continued until naturally stopped by the Civil War. About 1867 such work came to the front again, mainly in the matter of river and harbor improvements, and was naturally reassigned to the army engineers, and there it has remained ever since.

The river and harbor work of this country has come, therefore, to the Army Engineer Corps by original endowment and by natural processes of national development and remains with it as a natural inheritance and duty in which its service has special value to the country at large by reason of its century of special training and of careful, efficient, honest stewardship.

Organization and Administration

The civil works under the supervision of the Chief of Engineers embrace the improvement of the rivers and harbors of the United States and other public works whose execution has been entrusted to the War Department, including the survey and preparation of navigation charts of the Great Lakes, the public buildings and grounds in the District of Columbia, the Washington aqueduct and filtration plant, and road construction in Alaska.

For purpose of administration and control, the country is divided into engineer districts, each in charge of a district engineer, usually an officer of the Corps of Engineers. The district areas are determined by the character and amount of construction work embraced in them. As the responsibility of the district engineer includes the enforcement of the laws for the protection and preservation of navigable waters as well as the supervision of construction work, the boundaries of the districts are usually based upon drainage systems and so drawn as not to cross any river system, except such large systems as the Mississippi and Ohio rivers, the work on which is divided into several districts. The districts are grouped into divisions, each of which is in charge of a division engineer, who has general supervision over the operations of the subsidiary engineer districts. The division engineers report directly to the Chief of Engineers.

Every precaution within its power is taken by the Corps of Engineers to protect the best interests of the United States. All specifications and contracts are examined and checked up by officers more experienced than those having immediate charge of the work. All projects for new work —and these are initiated in the first instance by Congress— are reviewed by the division engineer, by a board of engineers and the Chief of Engineer before any appropriation is made for the work itself by Congress. There are, of course, differences of opinion as to when improvement work is worthy to be undertaken by the United States, and in the system of reports, such differences are laid before Congress. Needless to say, when Congress makes an appropriation for improvement work, this action becomes the law of the land and the officers have no discretion in the matter of obedience to law, irrespective of their own personal opinions as to the merits of the case.

This river and harbor work is decentralized to the greatest degree permissible under existing law and these officers in the various districts and divisions operate under appropriations separate and distinct from the appropriations for the support of the army, under the general supervision of a "River and Harbor" section in the office of the Chief of Engineers. Not infrequently, however, these same officers, stationed on the seaboard, have charge of defensive works and their maintenance and so have duties under the heading of "Military Construction," which is administered through a construction section in the office of the Chief of Engineers. While this admixture of duties may appear illogical and inconsistent with good organization, it is done as a matter of economy for the same reason that in small military commands a single officer may, and often does, represent several staff corps, departments or operating services. This dual assignment to officers of the Corps of Engineers has other benefits in that it keeps them in intimate touch with distinctly military matters.

River and Harbor Works Afford a Reserve for Military Engineers

If it were indeed true that this civil work interferes with the military efficiency of the officers engaged in its administration, the objection to placing it in the Corps of Engineers would be legitimate and would logically lead to its separation from such work. The objection, however, is not well taken. The one purpose of the Army of the United States, the one reason for its existence is as a means of preparation for war. In war a large number of competent engineers thoroughly versed in military affairs and in military administration are essential. Experience has shown that for our service about seven per cent of the fighting forces at the front are engineer troops and that, including the troops needed in the services of supply behind the fighting lines, the percentage will mount up as the total strength increases until the troops required for engineering activities of various kinds may approximate twenty per cent of the whole.

During the World War we commissioned in the engineers alone over 13,000 officers, and on Armistice Day the enlisted strength was in the neighborhood of 285,000 men. It is obvious that however urgent may be the demand for their services in an emergency we cannot maintain in peace a sufficient number of military engineers to meet our needs in war. At the present time the War Department is bending its utmost energies to the establishment of a reserve corps to be composed of persons in civil life who shall be given opportunity to fit them for service as officers in war. It follows that there must be in the permanent service a suitable number to withstand the first shock of hostile attack and to serve as a nucleus to generate that vastly greater number to be drawn from civil life and to guide and direct them until such time as they shall have become thoroughly

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conversant with military conditions, until they shall have become in fact military engineers in the true sense.

Under existing conditions, an officer is trained for his work in the Corps of Engineers by an intensive course of study at West Point, including a thorough grounding in mathematical, mechanical, electrical and civil engineering subjects. This is followed by one or two years' service in the field with engineer troops and supplemented by two years' post-graduate work in civil, electrical and mechanical engineering lines and in military subjects at the Army Engineer School. Upon the completion of this course, it is the policy to assign the officers as apprentice assistants to the district engineers, and after a period of instruction in actual field and office engineering they are placed in responsible charge of separate construction works.*

The procedure is very similar for those officers entering the Corps as graduates of approved technical schools. The number of officers has, however, never been sufficient to provide for all such supervision and in each district there are also civilian assistant engineers, who in an emergency may and do replace the military personnel. As a consequence of this organization the officers of the regular establishment are not definitely tied to this civil work, but can be relieved for military duty whenever the necessity arises. It is to be noted also that in a war the amount of civil work is reduced to a minimum and the nation's funds and resources are turned to the prosecution of the war.

The employment of engineer officers of the regular army on civil works furnishes a reserve of military engineers instantly available for military duty. When not needed for strictly military duty they are economically employed on public works which are for the benefit of the people as a whole and the country thus obtains in time of peace an immediate return on its investment in its military establishment. In homely phrase, these officers, though not on military duty, still "earn their keep."

As a consequence of this reserve of engineer officers, the Chief of Engineers during the past war was able to successfully expand the organization of the Corps of Engineers much more readily and efficiently than other services which had no such reserve. Just before the entry into war, there were something over 100 officers of the Corps of Engineers engaged in construction work of whom 43 were on non-military duty exclusively. Just prior to the armistice this number had been reduced to five. If the Corps of Engineers did not administer these public works there would be no such reserve; the expansion to a war basis would be more difficult, and at the same time the country would be obliged to pay much higher salaries to civilians charged with equal responsibilities.

Educational Value of River and Harbor Work

A further most important consideration lies in the practice that this work of civil construction affords to officers of the Corps of Engineers. In common with all other forces, the military engineers must be schooled for their duties in war. The infantry, the artillery, the cavalry can all be trained in peace to a very appreciable degree to fit them for their military work. By means of target practice they are taught to shoot. In the absence of the actualties of war, it is possible to assume certain conditions and through the study of maps and the solution of map problems based on those conditions, officers and men receive instruction for their guidance in war. Through maneuvers, terrain and battle exercises on a suitable topographic field it is possible to gain a measure of training in the movements of war without the heart-breaking costs of tuition exacted by the sterner master—war itself. The circumstances of daily life with its incidence of disease and its recurrence of accidents, affords the military medical man most helpful experience.

For the military engineer the case is quite otherwise. It must be conceded that the mere study of text-books and the reading of engineer literature will not make an engineer. The solution of strain diagrams and mathematical computations involved in design, though valuable, are not sufficient to fit him to execute construction work of the variety and magnitude required in modern war. For such work actual practice is an absolute necessity. Without it an engineer may become a learned man but he will be no more competent to perform his duties than would a surgeon who has studied but has never performed an operation, or a prosecuting attorney graduated from a law school who has never appeared in court.

The practice of engineering involves the use of large quantities of material and the employment of great numbers of laborers. This nation, rich as it is, can not afford to expend public money for material or labor for the mere purpose of training its military engineers. Their work must at all times serve some direct utilitarian purpose. Special measures are therefore necessary for this training, though fortunately such measures need entail no great extra costs. The industrial life of the country provides the means, and all that is necessary is to recognize their existence and to so organize the military engineering service as to take advantage of them. This training can be obtained in time of peace through the employment of the Corps of Engineers on public works, that is on river and harbor improvements, construction of public buildings, the construction of various kinds required for the army itself and on other governmental construction affording practice similar to that required in war.

In considering the need for civil practice, a further desideratum may be referred to. During and since the war there has been much discussion of the defects of the so-called military frame of mind, and the failure of the average regular army officer to understand the psychology of the citizen soldier. The civil works upon which engineer officers are engaged bring them in contact with the professional engineers and contractors in civil life upon whom great dependence must be placed in time of war. It enables the engineer officer to grasp the civilian viewpoint and to deal on terms of mutual understanding and sympathy with those, who by reason of their own experience and habits of thought, must look at things from this view-point. In his intercourse with civilians, in or out of the employment of the United States, the engineer officer must so comport himself as to inspire respect for his judgment, his sense of justice, and his integrity of character.

It is believed that the training which many of our officers had received on civil work prior to our entry into the war was an asset of great value and gave them a broader outlook and a greater grasp of the problems presented, and enabled them to solve those problems with a great measure of success.

Engineer Work as Training for Military Command

Up to this point this discussion has been concerned with the employment and training of the officer of the Corps of Engineers in his capacity as an engineer or constructor. In some army circles, while it is conceded that the military engineer requires training for this specialty, it is nevertheless maintained that this class of work interferes with his development as a military commander or that it inculcates in

*During the current year 41 young officers of engineers are pursuing courses in engineering subjects at three of the leading technical institutions of the country—this in lieu of instruction in similar subjects at the Engineer School at Camp Humphreys, Va.—G. A. Y.

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fact a habit of mind which prevents such development.

Now let us consider the mental qualities required in a successful commander. These are:

First: The power of analysis so that the mind may reason to a logical conclusion; that is to say, the ability to weigh facts and figures, to detect and discard the false, the improbable and non-essential, to harmonize apparently divergent elements and to appraise each at its proper value; in brief to perform quickly and accurately those mental processes necessary in arriving at what in military parlance we call "the estimate of the situation."

Second: The power of synthetical decision, the ability to decide rapidly and unerringly upon measures, which, though not necessarily the best, shall nevertheless be adequate to meet the situation as it has been determined to exist, with a ready resourcefulness in devising ways and means to that end; the power to resist the temptation to temporize and delay while searching for the ideally perfect course.

Third: Steadfastness of purpose, confidence in one's own judgment, and the determination to abide by decisions previously made; the ability to pursue a course which once adopted, though not ideal, is yet sufficient to the purpose in view; the tenacity, the self-reliance, and the will "to fight it out along these lines if it takes all summer."

Fourth: Leadership involving initiative and readiness to accept responsibility; the faculty of judging men, their capacity and limitations; the ability to select assistants, the power to utilize all available resources and to operate them with the highest possible degree of efficiency.

These qualities are in constant daily exercise by the engineer officer engaged on civil work *where the full responsibility for such work is placed upon his shoulders,* and this to a degree seldom possible to an officer of the line in the ordinary discharge of garrison duties. In the conduct of his work the individual engineer must study cause and effect; must devise plans to meet the end required; must organize his force, alloting to each man his quota of responsibility; must see that this force is effective, and to this end must enforce discipline and an observance of sanitary measure; and this with men drawn from all ranks of society and without a military organization and without the aids of military law. He must purchase proper materials and in the most economical manner and must see to their economical use. He must learn to discriminate between the cheapness of first cost and economy in the results. Finally, he must be prepared to meet any emergency which may arise due to storm, flood, fire or accident, promptly, effectively and economically. The changing conditions cause a struggle frequently suggestive of a human enemy and afford "the special advantage given to the mind by the habit of coming to decisions in the presence of a real adversary and especially by resisting such emotion as naturally follows a blow." (Marshal Foch.)

An engineer officer of the rank of captain must at times organize from nothing a force of one thousand men of all grades of skilled and unskilled labor, install them in semi-permanent camps distant from commercial centers, supply them, care for their health, keep them disciplined and effectively at work. He must devise, supply and operate an extensive plant, comprising all classes of shop and field engineering, machinery installed on shore or on boats, with the complement of tugs, houseboats and other equipment.

On the other hand a captain in the ordinary military routine is afforded relatively small scope for the exercise and development of his powers of command. He has above him a battalion commander, who is over-topped in turn by a colonel and so on up through the grades of military command to the division commander or even higher.

Lacking the means of training afforded by active campaign, an attempt is made in peace time to simulate the school of war experience by map problems, terrain exercises, and maneuvers; but these, excellent as they are, lack one vital element as an educational force. The student never knows beyond a reasonable doubt that he has a correct answer to his problem. His mistakes are not materialized and they do not "come home" as in active campaign.

The engineer officer engaged on civil work, on the other hand, speedily receives a demonstration of his errors. If his "estimate of the situation" is faulty, if his plans and decisions are not logical, if he lacks tenacity of purpose, if his leadership is not efficient, if his organization is not sound—he soon rears a visible monument to his shortcomings. If in building a lock and dam he fails to meet an emergency due to storm or flood, much of his work may be swept away; if the dam should slip due to his failure to correctly appraise foundation conditions, he has at once a memorial to his discredit in the way of loss and avoidable high costs. If a dredge fails to achieve its proper output he has again in his accounts an ocular demonstration of his errors. The engineer officer on civil work deals at all times with hard cold facts which will not be denied and his actions must square with these facts day in and day out. As in actual war, the umpire is inexorable and his verdict can not be waived aside and glossed over by a glib explanation that the circumstances were not sufficiently set forth in the statement of the problem.

There is nothing in the practice of engineering as such which militates against the development of the engineer as the commander of a tactical unit, be it a battalion or an army. On the contrary most if not all of the mental qualities which make a good military engineer are necessary also to his success as a military leader.

I do not contend that all military engineers will necessarily prove to be good commanders of large military forces; there have been some notable failures and these failures have betrayed some army writers—reasoning from a few exceptional cases only—into the deduction that failure was due to their engineering training and experience. It might be said with equal propriety that they failed in spite of such training, or we should be equally justified in assuming that the failures on the part of those infantry or cavalry officers who have attained general rank were due to their infantry and cavalry experience.

In the absence of comparative statistics I venture the statement that the percentage of failures as commanders by former engineer officers is lower than that of either the infantry or cavalry. It may not be amiss to mention the fact that Robert E. Lee and George Gordon Meade who faced each other at Gettysburg had both been officers of engineers and had distinguished themselves in that capacity. Did one fail because of that fact? If so, why did the other win? Lord Kitchener, of England, and Marshal Joffre, of France, are more recent examples of engineers endowed with qualities of command to a superlative degree. Other examples might be cited, but to what purpose? The truth is that military failure or military success is dependent upon a large number of complex factors and their particular combination at any given moment, and that while we may train ourselves and develop certain qualities which are indispensable to success there will still be circumstances, combinations and causes beyond our power to foresee and much less to control, and for this reason the most skillful

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commander has never been beyond the danger of defeat. How else could wars be won?

One Element Lacking

Excellent as this river and harbor work is, it unfortunately does not cover the whole field of training necessary to the education of the military man. There is at least one phase, in addition to the four above discussed, which is indispensable to the development of the military commander and in which his work as a river and harbor engineer affords no experience. I now speak of the knowledge of strategy and tactics, of the handling of troops, their care, training and management as such, and experience in the routine duties of an officer. In other words, this river and harbor work fails utterly to teach the technique of the art of war. The fact, however, that river and harbor work does not afford instruction in this one class of military duties, important as they are, is no conclusive argument for the discontinuance of river and harbor work as a function of the Corps of Engineers. For if this deficiency is to be accepted as final then the detail of line officers to the staff bureaus or to desk duty of various kinds away from troops would bar their being considered for high command. There is, to be sure, a well recognized objection to the detail of line officers to staff duty for indefinite periods. Legislation requires them to exercise actual command of troops for a reasonable percentage of their time, and though this requirement is principally to maintain touch between the staff departments and the line, it is essential also in the interests of the officers themselves to maintain a just balance in their training and experience. On the other hand duty in command of troops to the exclusion of all other duty is also recognized as being too restrictive in its effect.

It is my contention that the principle which is now applied to officers of the combatant arms should apply also to engineer officers, and that they should all serve with engineer troops and with other troops for such periods and at such intervals as will serve to keep them in touch with military matters and make them proficient in the tactical handling of troop organizations suitable to their rank and to a grade at least one step in advance of their actual rank. In view of the small number of engineer troops in our peace time service, there will be some difficulty in accommodating all the higher officers with suitable frequency, but under the principles advocated for the adoption of a single promotion list, many of these officers could get the necessary training by service with other troops. This plan would be desirable for officers of all arms, but would be particularly appropriate for engineers who constitute an auxiliary service not intended for independent action and whose purpose it is to assist other arms. These officers of engineers should attend the general service schools and should be at all times "up" on all the military phases of their profession.*

Notwithstanding this one deficiency, as a post-graduate course in how to think and how to act in emergencies, there is no comparison between the results obtained through reading and study, no matter how conscientiously carried on, and the real school of experience given our engineer officers by the regular performance of their duties as district engineers on river and harbor work. The civil construction devolving upon the officers of the Corps of Engineers constitutes in fact a most powerful agency for their training in preparation for the emergencies which must fall to them in war. It should be retained for that purpose as well as to provide the reserve of military engineers necessary to the nation's preparedness for defense.

To fit their graduates for the practice of engineering the necessity for well-balanced courses is recognized by the leading technical educational institutions. So, to enable them to cope with the varied emergencies of war, officers of the Corps of Engineers should not spend their entire lives in charge of a special class of public works. They should be given experience in a variety of construction work and should also serve at suitable intervals with troops in positions of actual command appropriate to their grades. In the last analysis, the Corps of Engineers can only justify its existence as a component part of the military establishment by an adherence to its primary function as a corps of military engineers, and the officers of the Corps must at all times be prepared to take up their duties as military men. Nevertheless, a too narrow schooling in either military or civil engineering lines should be avoided. In the interests of national defense a thorough understanding of the role of the engineer in war and the necessity for affording him both civil and military experience must be brought home to those within the army and those without, who now seek to restrict the activities of the Corps of Engineers solely to duty with the very small force of engineer troops which the country can afford to maintain in time of peace.

*The Army Reorganization Act of June 4, 1920, included the Corps of Engineers in the combatant arms or the line of the army. This act also directs that no officer shall be detailed to or remain a member of the General Staff unless he has served for two of the next preceding six years in actual command of troops. It further directs that every officer below the grade of Brigadier General shall perform duty with troops for at least one year in every period of five consecutive years. —ED.

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More About Light Railways

By

J. P. Hallihan

Consulting Engineer; Major, Engineer Reserve Corps;
formerly Major, 70th Engineers, A. E. F.

[NOTE. Major Hallihan, the author of this article, has had an extensive experience in railroad location and construction. In 1899 he was assistant engineer in charge of the location and construction of the El Paso and Northeastern R. R. He left this road in 1901 to take charge of railways for the Cananea Consol. Copper Co. From 1907 to 1909 he was general manager of the company engaged in the construction of the Bolivia Ry., and subsequently he was interested in various projects in Peru and Spain. In 1913-14 he was in charge of the National Railway of Haiti, and in 1917 was Consulting Engineer and Assistant General Manager of the Brazil Railways (3,500 miles in southern Brazil). During the War Major Hallihan made an examination of and report on the damage to French railways.—ED.]

THE writer was much interested in reading in a recent issue of THE MILITARY ENGINEER the article on Light Railways by Colonel Kelly and in the discussion resulting therefrom. It may be that the subject will be better understood by reference to a few examples of extremes in both standard-gauge and light-railway construction taken from American and British practice.

The Alamogordo and Sacramento Mountain Railroad runs from Alamogordo, N. M. (elev. about 4300) to Cloudcroft (elev. 9200) and Russia, N. M. (elev. about 9000), a distance of 31 miles. It has a maximum grade of 4.5 per cent, maximum curvature, freely used, of 30 degrees, with all curves spiralled, and is laid with 60-pound rail, with tie-plates on all curves. The track is surfaced with earth from alongside. Spirals meet on the 60-foot tangent between 30-degree curves in reverse directions.

The road is operated with direct-connected Baldwin locomotives, 2-6-0, weighing about 100 tons, with a driving wheel base of 13 feet. The traffic is principally logs brought down from the mountains to a saw mill at Alamogordo, though considerable passenger traffic has developed to summer resorts.

The logging cars are about 24 feet long, and passenger cars exceeding 50 feet in length are not used. This road connects with logging roads of standard gauge having 40-degree maximum curves, grades up to 8 per cent, 40-pound rail, and operating 100-ton Shay geared locomotives at a speed of 10 miles per hour.

The primary reason for adoption of standard gauge was to secure the greatest possible stability for the logging equipment. The writer's observation of operation covers the first five years. There were occasional accidents on the logging roads, principally due to careless handling, in several of which was demonstrated the surprising ability of a geared engine to stay on the track and defy the law of acceleration of velocity in falling bodies. On the A. & S. M. proper, accidents were few and unimportant. For a time there were frequent derailments due to shifting of logs in transit. With greater expertness and care in loading and binding these became infrequent. Outer rail elevation was finally limited to 3 inches and gauge was widened 1 inch over 30-degree curves, which helped matters considerably.

The Antofagasta & Bolivia R. R. runs from Oruro, Bolivia, to Antofagasta, Chile, approximately 900 kilometers (550 miles). It is of 75-cm. gauge, with rail of about 20 pounds on wooden ties. A third rail, meter gauge, has been laid from Oruro to Uyuni, about 260 kilometers, permitting joint operation with Bolivia railways. So far as the writer knows, it is the longest mileage of 75-cm. gauge in the world.

The operation of this road, from both a physical and financial standpoint has been very successful. It offers a rather good example of sound judgment in the adaptation of the means to the end. Circumstances, increasing business and the overshadowing importance of its meter gauge connections will no doubt shortly cause its conversion to meter gauge, but by reason of its low capital cost, it is probably now able to write off its original investment.

The 75-cm. gauge is commonly used in the mining regions of Mexico, one of the best examples being the road running from the City of Chihuahua to the Santa Eulalia mines, about 12 miles. The common practice is 20-pound rail laid on wood ties, following the characteristics of the 18-inch gauge mine tracks. Fabricated track of either gauge is unusual, and in fact, undesirable for mining purposes.

Fabricated tracks in 5 m. sections with rails of 8 to 10 kilograms, riveted to pressed steel ties, usually called from its inventor, Decauville track, has found its highest development in France and Belgium for industrial uses, and to a considerable extent for the 75-cm. gauge on the secondary railways. In this country, for industrial use and for contractors' use, both on domestic and foreign work, the 60-cm. gauge has found most favor. Its use has greatly increased during the past two years by reason of the increased activity in highway construction throughout the United States.

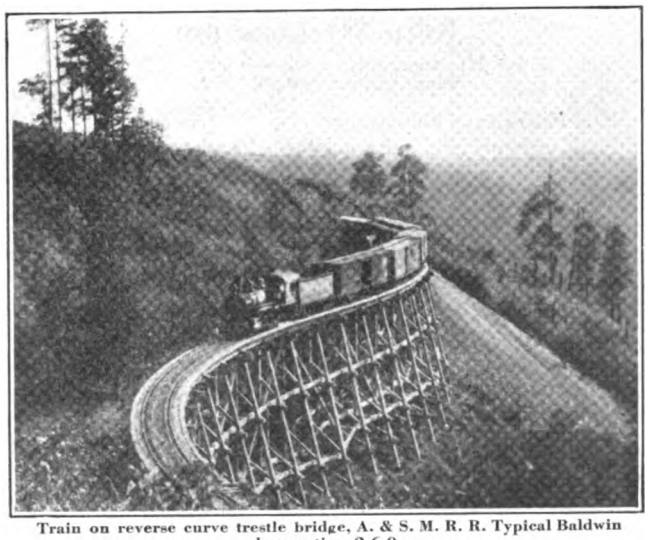
The suggestion of Colonel Kelly to abandon the use of light railway of 60 cm. or 75 cm. gauge for military purposes in favor of a light railway, standard gauge, does not appear entirely feasible, even if we could ourselves select the terrain.

It is, nevertheless, a fact that it is common practice on railroad construction to run material trains at the front over several miles of open track, not only unsurfaced but frequently half-spiked. Naturally these trains proceed at a low speed—about 6 miles per hour. Also, until within a very few years, a diligent search would have revealed a good many miles of 45-pound rail on the main line of one of our foremost western railroads. The writer has operated, with safety, heavy consolidation engines on 40-pound rail, both here and abroad.

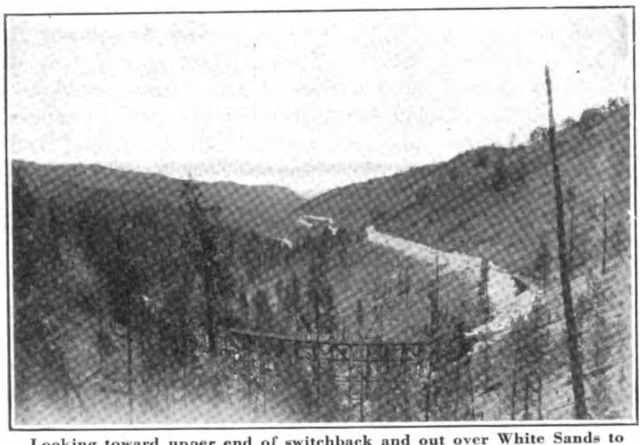
We have to consider, however, not only physical possibilities, but time, weight and cost of material employed, power and space, or equipment used in transporting it to the place of use, and rapidity of getting the railway in operation. All of these factors are against the employment of a standard gauge road using even 40-pound rail and 60,000-pound capacity cars, beyond the point of safety from enemies fire.

Considerations of location also have a bearing on the subject. The standard gauge line picks its own location with reference to further advance and conditions of operation. The location of the light railway is determined by

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Train on reverse curve trestle bridge, A. & S. M. R. R. Typical Baldwin locomotive, 2-6-0



Looking toward upper end of switchback and out over White Sands to San Andreas Mountains

the strategic position of the artillery it serves, which is its real *raison d'etre*.

When it comes to retiring equipment in face of an enemy drive, it would seem that a light third rail laid on the standard gauge for 10 or 15 miles back (a very short job if prepared for) would offer sufficiently effective insurance.

Rehandling is to us in this country a good deal of a bugbear. We acquired a further distaste for it while waiting for cranes to arrive in France, or rather to assemble themselves from the various ports to which parts were consigned. Yet our export business would be greatly benefited if we were to make a serious study of rehandling. As a military duty we should be able, under the worst circumstances, to handle material easily, quickly and systematically and keep track of it from start to destination.

Considering that in war it is essential to dispense with every pound of weight beyond that necessary to serve the purpose, a 60-pound rail would seem to be a reasonable weight for standard gauge lines. For light railways, 60 cm. track in 5 m. sections of 20-pound rail with 10 ties per section might be considered a minimum requirement with 25-pound rail as a maximum.

The adoption of 75-cm. gauge as a standard in face of its diminishing use on civilian work would be a tactical error, and it is doubtful whether the margin of increased stability offered would balance in value the increase in space required in both marine and land transportation.

Hazen L. Hoyt, Jr.,

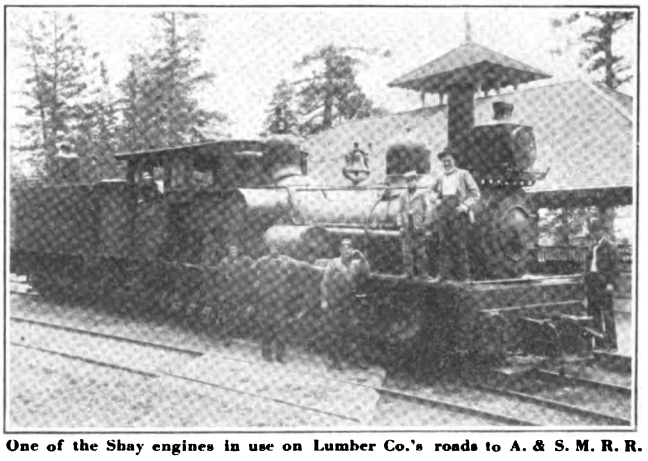
Formerly Captain, 21st Engineers (Light Railway), A. E. F.

I have read with great interest the article by Colonel Kelly entitled "Is the Use of Narrow Gauge Railways Profitable in War?" that appeared in the September-October issue of THE MILITARY ENGINEER and as a sequel to this would it not be well to discuss the question of Road Transportation?

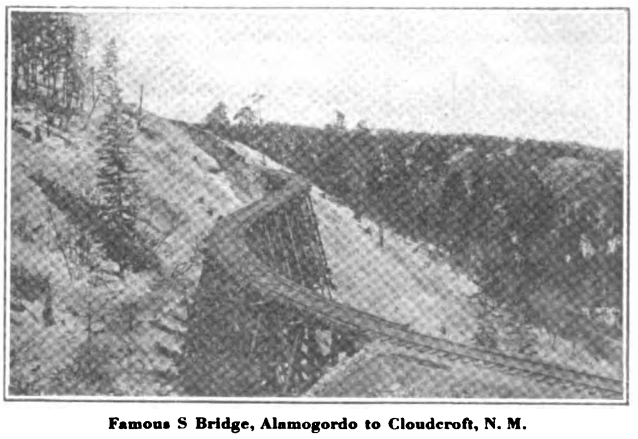
Summing up the discussions on Colonel Kelly's article the writers seem to be of the opinion that the narrow gauge railways served their purpose in France just so long as the line remained stationary, but utterly failed as soon as the line started to advance.

My own observations while serving with the 21st Regiment of Engineers, Light Railway, during the St. Mihiel and Meuse-Argonne Drives, bore out these conclusions, and I am convinced that no change in the design of motive power and cars or the concentration of men and material before hand, can make it possible for the railroads to keep up with even a moderately rapid advance. The narrow gauge railroads may have their place in future wars but so will road transportation, especially gasoline driven vehicles.

An army in the field will probably never be able to dispense with horse-drawn transportation, but gasoline-driven vehicles will take its place more and more as time goes on. At the same time I believe that every one who has had any experience with motor vehicle operations at the front will agree with me when I say that the motor equipment of the A. E. F. left much to be desired. It is only fair to say



One of the Shay engines in use on Lumber Co.'s roads to A. & S. M. R. R.



Famous S Bridge, Alamogordo to Cloudcroft, N. M.

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that the fault did not lie with the Motor Transportation Corps, but was due to the fact that for the first time in the history of the world, motor equipment was used on a scale hitherto undreamed of and under conditions for which the vehicles had never been designed. It speaks well for the automotive engineer that the performance of this equipment was as good as it was.

My experience as M. T. O. of the 21st Regiment of Engineers, Light Railway, during the St. Mihiel and Argonne drives led me to the belief that the motor equipment of a field army should properly be divided into three general classes.

1. Two-wheel drive trucks operating from the broad gauge railheads to the advance dumps. These dumps to be situated as far forward as good road conditions will permit.

2. Four-wheel drive trucks operating from the advance dumps to as far as the road conditions allow, and

3. Caterpillar treaded trucks operating in the extreme forward areas delivering ammunition, etc., to dumps situated off the roads or other places where the condition of the ground will not permit of the operation of wheeled vehicles, and for following up the advance ahead of the road troops.

This division of motor equipment is, in my opinion, advisable as it would require a special type of vehicle of both the four-wheel drive and caterpillar design, for which there is a very limited demand in civilian work and would have to be specially designed and built for the use of the army. It would, of course, be possible to use these types exclusively in the forward areas, but the number required for even a moderate-sized army would be so large that it would be nearly impossible to secure the necessary appropriation for their construction. If, however, these types were used for only the final hauls while standard commercial makes were used for the long hauls in the rear areas the number of special trucks required would be reduced to a minimum.

The question of roads alone is rather a large subject and one which has received considerable thought, but in this connection I might suggest a broadening of the road to include a shoulder from 3 to 4 feet wide outside a line of white-washed posts set at intervals along the entire road to guide the drivers at night, and also as a warning to a driver who gets off the road, as posts of this sort, if not too firmly set in the ground, will not damage the truck in colliding with them, while the 3 to 4-foot shoulder outside these posts will allow the driver to stop his truck before it becomes hopelessly ditched. If thought advisable this shoulder could be widened to include a narrow gauge track, or even roadway for foot troops, while the center of the road would be left free for vehicle traffic.

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228 Scarritt Building

John Wickersham

Formerly Lieutenant Colonel, Engineers; Deputy Engineer Supply Officer, G. H. Q., A. E. F.

The writer is of the opinion that the function of the light railway in war is to relieve the highway as much as possible (in many cases to replace the highway), and that the narrow gauge railway is at no point in competition with the broad gauge railway. He does not believe this point has been made sufficiently clear in Colonel Kelly's paper or in the discussion.

The writer, during the fall of 1917, visited the Second Army, B. E. F., to study engineer supply and equipment for combat troops. Much of the area occupied by this Army was low ground and in consequence, road construction and maintenance was difficult and expensive. The writer's observation was that 60 per cent of the traffic on the roads consisted of engineer material used on road construction (*i. e.*, the roads were very largely worn out by the traffic necessary for their making). This matter was discussed in the Second Army, B. E. F., with the Division Engineer of a British Division, the Corps Engineer of a British Corps, the Chief Engineer of the British Second Army, and the Chief Engineer B. E. F. These officers agreed that the ideal arrangement for the Second Army area would be a single highway in each divisional area for tactical purposes, and a loop of narrow gauge railway for the normal traffic of men and supplies. The highway was to be used only for emergencies.

The writer's experience, civil and military, has not been such as to make him competent to discuss the design or layout of narrow gauge tracks and equipment, and he gladly leaves this discussion to officers more capable of handling this phase of the question. He is of the opinion, however, that the use of narrow gauge railway should not be abandoned in future war plans of the United States Army; and that in these plans the narrow gauge railway should be considered as an alternative to highway construction. If the single narrow gauge track is considered the equivalent of the one-way road, and the double track the equivalent of a two-way road, the military engineer will frequently find he can build and maintain a narrow gauge railway line with greater speed and less expenditure of labor and material than the equivalent highway construction. When this is the case, the narrow gauge railway should be used. The handling of supplies and railhead facilities will be equal for light railway or motor traffic. More salvage is possible from a light railway line than from an abandoned highway.

The enemy used narrow gauge railways to better advantage than we or any of our allies. I would suggest a study of their use by the enemy in his offensive operations in the spring and early summer of 1918. It will prove most instructive.

World's Rainfall—The total annual rainfall of the world amounts to 29,347 cubic miles, quite a shower. Of this only 6,524 cubic miles finds its way through rivers to the sea, carrying with it, however, 2,735,000,000 tons of solid matter in suspension.—*Journal Frank Inst.*

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PERSONALS

The retirement of Col. R. R. RAYMOND, Corps of Engineers, took effect December 21, 1920.

Col. WILLIAM B. LADUE, Corps of Engineers, has been relieved from his duties in Philadelphia, Pa., and assigned to command the 1st Engineers, Camp Dix, N. J.

Col. C. W. OTWELL, Chemical Warfare Service, has been relieved from his duties at Wheeling, W. Va., and assigned to duty at Lakehurst Proving Ground, N. J.

Lt. Col. A. E. WALDRON, Corps of Engineers, has been relieved from duty with the 8th Engineers, Fort Bliss, Tex., and assigned to duty with the 5th Engineers, Camp Funston, Tex.

Lt. Col. ELLIOTT J. DENT, Corps of Engineers, has been relieved from his duties at New Orleans, La., and assigned to duty in the Philippine Islands.

Lt. Cols. F. W. ALBERT, A. F. ALLEN, GLENN S. SMITH, and JAS. E. CASSIDY, Engineers, have been honorably discharged from the service of the Government, their services being no longer required.

Maj. THOMAS M. ROBINS, Corps of Engineers, has been relieved from his duties at Providence, R. I., and assigned to duty in the office of the Chief of Engineers.

Maj. ERNEST GRAVES, Corps of Engineers, has been granted a leave of absence for four months.

Maj. WILLIAM A. JOHNSON, Corps of Engineers, has been relieved from his duties at Montgomery, Ala., and ordered to Honolulu, Hawaii.

Maj. JAMES J. LOVING, Corps of Engineers, has been relieved from his duties at Camp Dix, N. J., and assigned to duty at Montgomery, Ala.

Maj. JAS. G. STEESE, Corps of Engineers, has been ordered to report to the Army Retiring Board, San Francisco, Cal., upon his arrival from Alaska, and then to report to Washington, D. C.

Maj. VIRGIL L. PETERSON, Corps of Engineers, has been relieved from his duties at Boston, Mass., and taken station at Providence, R. I.

Maj. FRANCES C. HARRINGTON, Corps of Engineers, has been relieved from his duties at Camp Humphreys, Va., and ordered to Baltimore, Md., for duty.

Maj. CHAS. J. TAYLOR, Corps of Engineers, has been relieved from duties at Fort Monroe, Va., and assigned to duty at Norfolk, Va.

Maj. CRESWELL GARLINGTON, Corps of Engineers, has been assigned to temporary duty in the office of the Chief of Engineers.

Maj. RICHARD U. NICHOLAS, Corps of Engineers, has been relieved from duty at Wheeling, W. Va., and reported to Fort Benjamin Harrison, Ind., for duty in the Fifth Corps Area.

Maj. ARTHUR P. VON DEESTON, Corps of Engineers, has been relieved from duty in Portland, Ore., and ordered to Galveston, Tex.

Maj. WALTER F. BEYER, Chemical Warfare Service, has been relieved from duty in the U. S. Engineer Office, Wilmington, Del., and ordered to duty at Fort Dupont, Del.

Maj. MALCOLM ELLIOTT, Corps of Engineers, has been relieved from his duties at Florence, Ala., and assigned to duty at Wheeling, W. Va.

Maj. WALLACE W. KIRBY, Corps of Engineers, has assumed charge of the Engineer Reproduction Plant, Washington Barracks, D. C.

Maj. WILLIAM C. LEMON, Corps of Engineers, has been relieved from his duties in New York City, and assigned to duty at Jacksonville, Fla.

Maj. LEON E. LYON, Corps of Engineers, has been relieved from his duties at Norfolk, Va., and assigned to duty at Philadelphia, Pa.

Maj. PAUL REISINGER, Corps of Engineers, has been relieved from his duties with the 2d Engineers, Camp Travis, Tex., and assigned to duty with the 8th Engineers, mounted, Fort Bliss, Tex.

Maj. ELIHU H. ROPES, Corps of Engineers, has been assigned to duty with the 2d Engineers at Camp Travis, Tex.

Majs. CHAS. L. DASHER, WILLIAM J. SHEA, Engineers, and FOSTER VEITENHEIMER, Signal Corps, have been honorably discharged from the service of the Government.

Capt. ALEXANDER B. ACKERMAN, Lieut. GORDON C. DAY, and Lieut. C. W. BALL, Corps of Engineers, have been assigned to the 11th Engineers, Panama.

Capt. LEROY W. CUMMINGS, Corps of Engineers, has been assigned to the 12th Engineers, Camp Grant, Ill.

Capt. EDWARD H. DIGNOWITY, Corps of Engineers, has been assigned to the 2d Engineers, Camp Travis, Tex.

Capt. GEORGE W. GILLETTE, Corps of Engineers, has been relieved from his duties at Wilmington, N. C., and assigned to duty with the 7th Engineers, Camp Jackson, S. C.

Capt. HAROLD S. GILLETTE, Corps of Engineers, has been relieved from his duties at Fort Sill, Okla., and assigned to duty with the 2d Engineers, Camp Travis, Tex.

Capt. EDWARD D. HILL, Engineer, has been honorably discharged from the service of the United States, his services being no longer required.

Capt. KENNETH S. JONES, Corps of Engineers, has been relieved from his duties at Norfolk, Va., and assigned to duty at Florence, Ala.

Capt. WILLIAM V. HILL, Corps of Engineers, has been assigned to duty with the 5th Engineers, Camp Humphreys, Va.

Capt. JOHN E. LANGLEY, Corps of Engineers, has been assigned to duty with the 2d Engineers, Camp Travis, Tex.

Capt. THOMAS H. MESSER, Corps of Engineers, has been relieved from his duties in the office of the Chief of Engineers and assigned to duty with troops in the Hawaiian Department.

Capt. EVERETT D. MURRAY, Corps of Engineers, has been ordered to duty with the 2d Engineers, Camp Travis, Tex.

Capt. HENRY B. POST, Corps of Engineers, has been relieved from his duties at San Francisco, Cal., and ordered to duty with the 2d Engineers, Camp Travis, Tex.

Capts. ROBERT A. RADFORD and HARRY O. TUNIS, Corps of Engineers, have been relieved from their duties in Washington, D. C., and assigned to duty with troops in Germany.

Capt. HARRIS D. W. RILEY, Corps of Engineers, has been assigned to duty with troops at Canal Zone.

Capt. RICHARD L. SMITH, Corps of Engineers, has been ordered to duty with the 2d Engineers, Camp Travis, Tex.

Capt. CHAS. H. SWICK, Corps of Engineers, has been relieved from his duties at Camp Upton, N. Y., and assigned to duty at Florence, Ala.

Capt. ELLIOTT VANDEVANTER, Corps of Engineers, has been assigned to duty at the Eighth Corps Area, Fort Sam Houston, Tex.

Capt. HERBERT C. WHITEHURST, Corps of Engineers, has been relieved from his duties at Camp Lee, Va., and assigned to the Engineer Depot, Army Supply Base, Norfolk, Va.

Capts. WILLIAM F. BARCK, EVERETT S. BEALL, Jr., GUY B. BYAM, ROBERT COE, CHAS. EVANS, ROBERT M. FOX, JOHN H. JONES, EARL R. LEWIS, and ARTHUR G. SPENCER have been honorably discharged from the service of the United States, their services being no longer required.

1st Lt. ROBERT F. GILL, Corps of Engineers, has been assigned to duty at Camp Humphreys, Va.

Lieut. JOHN N. HARMAN, Lieut. FREDERICK W. DECK, and Lieut. CHESTER C. HOUGH, Corps of Engineers, have been assigned to duty with the American Forces in Germany.

1st Lts. FREDERICK A. PLATTE and GEORGE S. WITTERS, Corps of Engineers, have resigned their commissions as officers of the Army.

1st Lt. WALTER D. LUPLOW, Corps of Engineers, has been relieved from his duties in Washington, D. C., and assigned to duty with the American Forces in Germany, Coblenz, Germany.

Lt. EDWARD S. PEGRAM, Corps of Engineers, has been relieved from his duties at Camp Jackson, S. C., and assigned to duty at Coblenz, Germany.

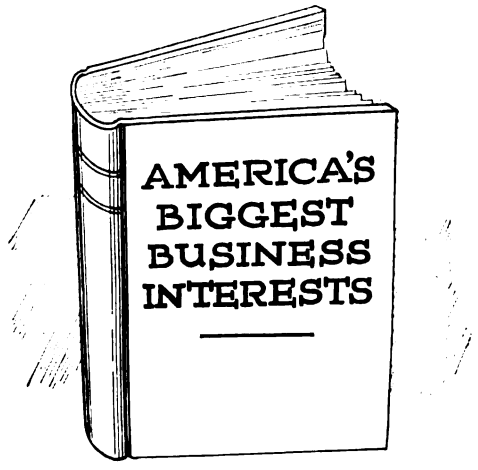
Lieut. EDWARD H. RAYMOND, Corps of Engineers, has been assigned to duty in the Panama Canal Department.

1st Lts. FRENCH W. LAKE, EUGENE NICHOLS, RENO F. RUNCK, and KENNETH R. WOODFORD, 2d Lts. HENRY A. HAENSELER, HUGO A. KEMMAN, and WILLIAM H. MCGRATH, Engineers, have been honorably discharged from the service of the United States.

Lieut. WILSON Y. STAMPER, Jr., Corps of Engineers, has been relieved from duty at Camp Lewis, Wash., and assigned to duty with the 2d Engineers, Camp Travis, Tex.

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The List of Purchasers from War Department Sales Reads Like a Blue Book
America's Biggest Business Interests



NEARLY one hundred thousand individual orders representing sales amounting to nine hundred million dollars is the staggering total of property disposed of through War Department sales to date.

The buying power of America has responded to these sales in a big way, many manufacturers, jobbers, wholesalers, and dealers looking to them as a regular source of supply.

Manufacturers have bought, dealers have bought; the smaller interests have purchased in small lots, the larger business and industrial firms have bought heavily.

Thousands of machines purchased through this channel are in operation. Thousands of motors, generators and other electrical equipment are supplying heat, light and power in every industry. Huge quantities of chemicals have found their way to use through these sales. Thousands of tons of iron and steel from this source have been wrought into every conceivable tool and commodity. Millions of dollars worth of high grade wanted materials, supplies, etc., and equipment of every description has reached the consumer's market through regular re-sale channels.

As long as War Department stocks last, opportunities are many! As a unit of the buying power of America it is to your advantage to follow every War Department offering. Others have benefited. Why not you?

SURPLUS PROPERTY BRANCH

Office of Quartermaster General

Munitions Building **Washington, D. C.**

Additional Items from Machinery and Engineering Materials, List No. 13

To be Sold by Negotiation

Compass Boxes
Ratchet Braces
Lead Covered Cable
Telephone Cable
Calipers
Conveyors

Compass Watches
Cylinders
Steam Engines
Flashlights
T. N. T. Cylindrical
Fuse Dust

Galvanized Bit Plugs
Plain Copper Wire
Crucible Tool Steel
Heavy Wire Screens
Motors for Grinders
Trench Sprayers
Barbed Wire
Weaving Wire
Screw Posts
Strip Steel
Tool Steel
Air Tanks
Motor Fuses
Cement Glue
Litharge

Fuses
Generator Sets
Expansion Joints
Loom Oil
Lard Oil
Signal Plugs
Engine Lathes
Spare Parts, Steam Engines
Buffalo Shears
Tanks, Wood
Storage Tanks
Oil Reclamation Plants
Expanded Metal Sheets
Horseshoe Nails
Warning Signals, Gas

Stocks and Dies
Coupling Poles
Payout Reels
Hand Rip-Saws
Galvanized Rods
Switch Boards
Metal Forming Machines
Oil for Break Switches
Tripods for Heliographs
Differential Cap Pulleys
Galvanized Iron Tanks
Vertical Tubular Boilers
Chief Operator's Desks
Quenching & Tempering Oil
Bar Steel Steel

Malleable Pipe
Sewer Pipe
Rubber Tape
Wrist Watches
Wrought Iron
Angle Posts



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"Surplus Prop

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CHOICE ITEMS FROM THIS LIST

13460
4 PUSH CARTS, No. 12 U. S. Gauge steel, 109" thick, 39" long at top, 21¼" wide at bottom, 20" deep; capacity, 6 cu. ft.
Location—Norfolk, Va.
1084
1275 LBS. DYNAMITE, 40 per cent low freezing.
Location—Norfolk, Va.
19492
450 LBS. DYNAMITE, Dupont Red Cross 40-90 strength, 50 bxs.
Location—New York.
13625
92 HAMMERS, Riveting, steam operating No. 5 "Little David," chipping and parts.
Location—Norfolk, Va.
14200
9 HAMMERS, Riveting No. 90 with ⅞" button head rivet sets; mfd. by Ingersoll Rand Co.
Location—New York.
13631
1 WRIGHT HIGH-SPEED HOIST, 4-ton capacity, with 12' lift.
Location—Norfolk, Va.
E-642
29,875 FT. DISCHARGE HOSE, 2" dia., 4-ply, 25' lgths.; coupling and clamps attached.
Location—Pittsburg, Pa.
E-643
12,500 FT. DISCHARGE HOSE, 2" dia., 4-ply, 25' lgths.; coupling and clamps attached.
Location—Pittsburg, Pa.
13640.
E-644
37,375 FT. DISCHARGE HOSE, 2" dia., 4-ply, 25' lgths.; coupling and clamps attached.
Location—Pittsburg, Pa.
E-645
20,400 FT. DISCHARGE HOSE, 2" dia., 4-ply, 25' lgths.; coupling and clamps attached.
Location—Pittsburg, Pa.

100-FT. AIR HOSE, ¾" wire-bound.
Location—Pittsburg, Pa.
E-640
3840 FT. SUCTION HOSE, 2" dia., 4-ply, 15' lgths.; coupling and clamps attached.
Location—Pittsburg, Pa.
E-614
3,510 FT. SUCTION HOSE, 2" dia., 4-ply, 15' lgths.; coupling and clamp attached.
Location—Pittsburg, Pa.
E-892
1 STEEL STRUCTURAL SHAPE, 48"x7'x4'.
Location—Philadelphia, Pa.
E-891
2 Steel Structural Shapes, 54"—2'x7'—4'.
Location—Philadelphia, Pa.
3510
15,686 "I" BEAMS, 12' lengths, 4" widths; 7¼ lbs. per ft.
Location—New Cumberland, Pa.
E-879
2,360 STRUCTURAL STEEL "I" BEAMS, 5½"x 3"x9' long, 5½" high, 3" wide.
Location—Philadelphia, Pa.
E-890
191 STRUCTURAL STEEL "I" BEAMS, 15' 6" long by 3½".
Location—Philadelphia, Pa.
E-889
27 STRUCTURAL STEEL "I" BEAMS, 2½"x4' 12".
Location—Philadelphia, Pa.
13657
41 SHELTERS, corrugated iron metal arch, 32'x9' x7"x11 gauge, elephant type "E." Complete with parts.
Location—Schenectady, N. Y.
11102
28 BOOKS level 4½x7½.
Location—A. R. D. Columbus, Ohio.
11116
107 BOOKS, handbook of plant construction.
Location—A. R. D. Columbus, Ohio.
3406
5 LOGGING CARTS No. 2. New; wheels 9" high; tires 4"x½"; 8" hickory axle tongue, chains and trap hook, singletrees, evener and neckyoke.
Location—Pullman, Ill.
15692
27 DRAWING BOARDS with trestle. 23"x31".
Location—Columbus, Ohio.
C-57
1 PILE DRIVER, portable compound gas engine and hoist. Class "A."
Location—A. R. D., Columbus, O.
11984
5 WINCHES, hand, single drum 6"x20" bbl. raybestos lined brake with safety strap; double purchase.
Location—A. R. D. Columbus, Ohio.
S. E. 250
1 HOISTING ENGINE, upright, Class "B," 30"x 5' 6".
Location—Oteen, N. C.
S. E. 249
2 CONCRETE MIXERS, Ransom, Class "B."
Location—Oteen, N. C.
S. E. 110
2504 UNIONS SPECIAL. Bet N Class "E"
Location—Atlanta, Ga.
S. E. 101
203 LBS. G. I. WIRE, No. 5, Class "A."
Location—Atlanta, Ga.
S. E. 100
189 LBS. G. I. WIRE No. 7, Class "A"
Location—Atlanta, Ga.

PARTMENT
erty Sales"

Machinery and Engineering Materials

List No. 13

Sold by Negotiation

HOW TO ORDER

All orders and negotiations for materials offered in this list must be addressed to the Depot Quartermaster of the division where material is located. These divisions and the addresses of controlling offices are given below. To obtain a complete list of materials not listed in this advertisement, clip and mail the attached coupon.

LIST OF DIVISIONS AND CONTROLLING OFFICES

Eastern Division
59th St. & 1st Ave.
Brooklyn, N. Y.

Southern Division
Transportation Bldg.
Atlanta, Ga.

Central Division
1819 West 39th St.
Chicago, Ill.

Southwestern Division
San Antonio, Tex.

Northwestern Division
Army Supply Base
Boston, Mass.

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CHIEF, SALES PROMOTION SECTION,
OFFICE OF THE DIRECTOR OF SALES,
ROOM 2515, MUNITIONS BLDG.,
WASHINGTON, D. C.

Kindly send M. & E. M. List No. 13_____

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Firm Name_____

Street Address_____

City_____ State_____

Signed by_____
MILITARY ENGINEER

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Proposals

U. S. ENGINEER OFFICE, WHEELING, W. VA.—Sealed proposals will be received here until 11 a. m. (Eastern time), January 22, 1921, and then opened, for furnishing and delivering forged steel and cast iron wheels for gates and structural steel for gate tracks for Dam No. 11, Ohio River. Information on application.

UNITED STATES ENGINEER OFFICE, BOX 72, LOUISVILLE, KY.—Sealed proposals will be received here until 2 p. m., December 15, 1920, and then opened, for furnishing and delivering gate and valve operating machinery, etc., for Lock No. 48, Ohio River. Further information on application.

PROPOSALS FOR DREDGING.—U. S. Engineer Office, 329 Customhouse Bldg., New Orleans, La.—Sealed proposals for dredging in the Intracoastal Waterway between Mermentau and Calcasieu Rivers, La., will be received here until 11 a. m., January 10, 1921. Further information on application.

PROPOSALS FOR STERN-WHEEL STEEL STEAMBOAT "LUTHER L. GRIFFITH."—Office, Mississippi River Commission, 1st and 2d Districts, Customhouse, Memphis, Tenn.—Sealed proposals will be received here until 11 a. m., January 18, 1921, and then opened, for furnishing the stern-wheel steel steamboat "Luther L. Griffith." Further information on application.

PROPOSALS FOR DREDGING.—U. S. Engineer Office, Philadelphia, Pa.—Sealed proposals will be received here until 12 noon, December 20, 1920, and then opened, for dredging in Delaware River, Phila., Harbor. Further information on application.

PROPOSALS FOR BOILERS.—Office of the Secretary, Mississippi River Commission, 1311 International Life Bldg., St. Louis, Mo.—Sealed proposals will be received here until 12 noon, January 17, 1921, for furnishing six return-flue boilers for steamboat. Further information on application.

PROPOSALS FOR LEVEE WORK.—Office of the Secretary, Mississippi River Commission, 1311 International Life Building, St. Louis, Mo.—Sealed proposals will be received here until 11 a. m., December 22, 1920, for constructing about 1,100,000 cubic yards of earthwork by the hydraulic method in the Sny Island Levee Drainage District, Ill. Further information on application.

U. S. ENGINEER OFFICE, WHEELING, W. VA.—STRUCTURAL STEEL, FORGINGS, STEEL CASTINGS, ETC.—Sealed proposals will be received here until 11 a. m. (Eastern time), January 27, 1921, and then opened, for furnishing and delivering structural steel, forgings, steel castings, etc., for trestles, aprons and horses for Dams on Kanawha River. Information on application.

U. S. ENGINEER OFFICE, P. O. BOX 72, LOUISVILLE, KY.—Sealed proposals for furnishing and delivering two steel dump scows will be received at this office until 2 p. m. (Central time), December 20, 1920, and then opened. Information on application.

PROPOSALS FOR REMOVAL OF WRECK.—U. S. Engineer Office, 329 Customhouse, New Orleans, La.—Sealed proposals will be received here until 11 a. m., November 16, 1920, and then opened, for removing wreck of sunken barge "Detroit" from South Pass, Mississippi River.

PROPOSALS FOR FURNISHING SOUTHERN YELLOW PINE LUMBER, DOORS, WINDOWS, HARDWARE, ETC.—Office, Mississippi River Commission, 1st and 2d Districts, Customhouse, Memphis, Tenn.—Sealed proposals will be received here until 11 a. m., December 22, 1920, and then opened, for furnishing and delivering Southern Yellow Pine Lumber, Doors, Windows, Hardware, etc. Further information on application.

PROPOSALS FOR STEEL DUMP SCOWS.—United States Engineer Office, Philadelphia, Pa. Sealed proposals will be received here until 12 o'clock noon, December 31, 1920, and then opened, for furnishing and delivering five steel dump scows. Further information on application.

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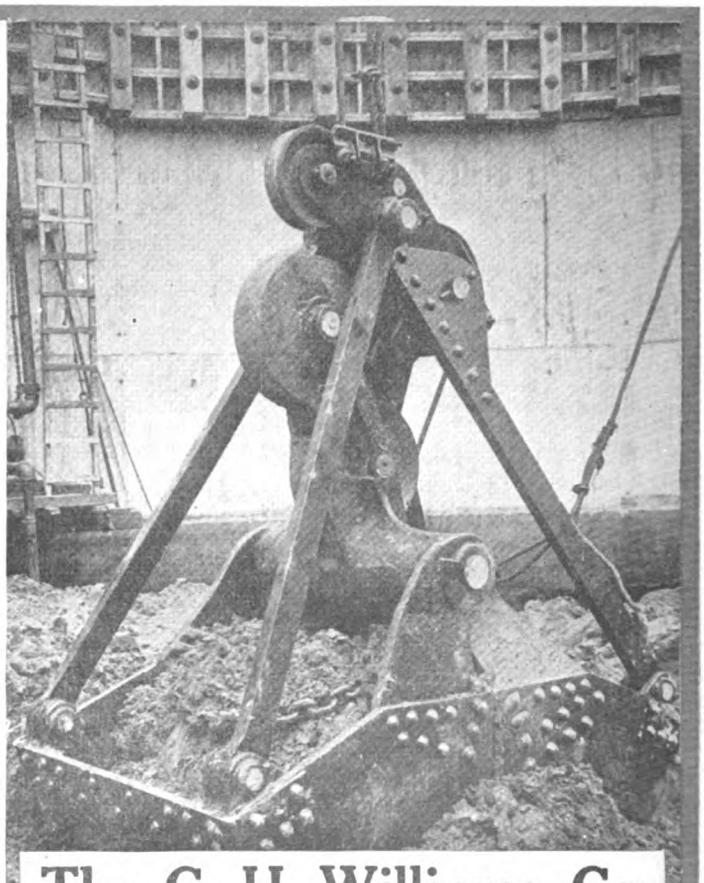
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Additional Roster of Charter Members

Continued from Page 72.

Mershon, Ralph D., 143 Liberty St., New York City, N. Y.
Miles, Capt. George F., 108 Worth St., New York City.
Miller, Lieut. Harry G., 247 14th St., Milwaukee, Wis.
Morrisett, C. T., Edmond, Okla.
Niebling, Geo. F., Jr., Woodbury, N. J.
O'Hara, Maj. G. Dennis, 132 Anza Street, San Francisco, Cal.
Otwell, Col. C. W, C. W. S, Lakehurst, N. J.
Pallin, H. G., Bldg. B., Wilson Dam, E. Florence, Ala.
Palmer, B. H., 712 Ridgley Ave., Fairmont, W. Va.
Palmer, W. C. A., Box 157, Cebu, P. I.
Parker, Willard N., 398 Malboro St., Boston, Mass.
Patterson, G. D., Fort Benton, Mont.
Payton, J. R., U. S. Engineer Office, Jacksonville, Fla.
Perkins, Capt. Alva H., 12th Engineers, Camp Grant, Ill.
Phillips, John C., Fort Worden, Port Townsend, Wash.
Pickworth, John W., 720 W. 180th St., New York City.
Pope, Mark C., Jr., 12 Haigh Ave., Schenectady, N. Y.
Porter, J. H., 611 Telfair St., Augusta, Ga.
Power, Capt. H. M., care Pacific Portland Cement Co., Auburn, Cal.
Prakken, Nicolass, care Pawling & Harnischfeger, Milwaukee, Wis.
Prong, George F., 1226 Niagara St., Buffalo, N. Y.
Renfro, C. H., Western Electric Co., Hawthorne Station, Chicago, Ill.
Richeson, Maj. Austin B., 405 Munsey Building, Washington, D. C.
Rheingans, Lieut. Wm. J., 234 Queen Ann Place, Milwaukee, Wis.
Rice, Lieut. C. R., 635 W. 61st St., Chicago, Ill.
Roberts, J. M., 1206 Negley Ave., Pittsburgh, Pa.
Rockhold, John E., 330 Burckett St., Glendale, Cal.
Ryan, Daniel T., 833 Market St., San Francisco, Cal.
St. Clair, C. L., 313 Wilcox Bldg., Portland, Ore.
Sandy, George E., 201 14th St., Portland, Ore.
Sager, Lt. J. S., Marion, Ark.
Sapper, F. E., Box 758, Rolla, Mo.
Sarter, Maj. R. H., 205 W. 103d St., Apt. 31, New York City.
Schall, Carl A., University of Illinois, Urbana, Ill.
Schmidt, A. E., 891 4th St., Milwaukee, Wis.
Schoder, E. W., 220 Willard Way, Ithaca, N. Y.
Seney, Lieut. Howard I., 176 E. 81st St., New York City.
Seymer, Maj. Ernest P., 1633 Q Street, N. W., Washington, D. C.
Shaw, Eugene J., King City, Monterey County, Cal.
Sherry, Norris, 13 Prospect Terrace, East Orange, N. J.
Simmons, Ray, care Pacific Power & Light Co., Pasco, Wash.
Skinner, Lieut. Wm. E., 376 Cass St., Milwaukee, Wis.
Skinner, Maj. F. S., U. S. Engineer Office, Milwaukee, Wis.
Smith, Harry C., N. Seneca St., Woodsport, N. Y.
Speier, Capt. John J., Foot of Stark St., Portland, Ore.
Sperry, L. N., Boonville, N. Y.
Stafford, Capt. Fred D., 854 W. 181st St., New York City.
Standeven, W. E., 4911 Webster St., Omaha, Nebr.
Sterling, L. P., Tampico, Mexico.
Stewart, James H., 1116 N. 3d Ave., Fort Dodge, Iowa.
Stickney, Maj. H. H., Jr., Lakehurst Prov. Grounds, Lakehurst, N. J.
Stiles, A. A., Reclamation Department, Austin, Tex.
Stonesifer, C. A., U. S. Geological Survey, Sacramento, Cal.
Strong, Capt. John A., Infantry School, Camp Benning, Ga.
Sultan, Maj. D. I., General Staff, Washington, D. C.
Sutherland, Lieut. Hale, care Mass. Inst. of Tech., Cambridge, Mass.
Swasey, Capt. McNeal, 1107 Hibernian Bldg., Los Angeles, Cal.
Swift, Lt. Henry, 422 Prairie St., Rockford, Ill.
Temple, John L., Interstate Commerce Com., Washington, D. C.
Thrall, George A. N., P. O. Box 356, Los Angeles, Cal.
Thompson, L. E., Hawaii Philippines, Silay-O'Negras, P. I.
Thorn Maj. Wray T., 105 S. La Salle St., Chicago, Ill.
Thurber, Capt. H., Const. Quartermaster, Fort Leavenworth, Kans.
Tiernan, L. P., 2213 8th Ave., Altoona, Pa.
Tilden, R. S., 188 Montague St., Brooklyn, N. Y.
Tinsley, Ashton M., Salem, Va.
Toklas, C. Fred, 581 26th Ave., San Francisco, Cal.
Umfug, Rudolf, 1347 29th St., N. W., Washington, D. C.
Vanleer, Blake R., 2218 Durant Ave., Berkeley, Cal.
Vorber, Albert, Jr., 1731 Juniata St., Philadelphia, Pa.
Walker, Capt. Benj. W., S. 312 Cedar St., Spokane, Wash.
Ware, Norton, 514 Mechanics Inst. Bldg., San Francisco, Cal.
Weiskopf, Edward F., 715 W. 172d St., New York City.
Whorley, W. W., 1508 Demonbreun St., Nashville, Tenn.
Willets, Capt. Victor W., 1501 Scott Ave., Los Angeles, Cal.
Williamson, C. B., 1414 Coit Ave., E. Cleveland, Ohio.
Wilson, Henry E., 127 State St., Harrisburg, Pa.
Wilson, Lt. M. H., Company B, 1st Engineers, Coblenz, Germany.
Young, Geo. F., 215 Tuscawilla St., Ocala, Fla.
Zolper, H. W., 1110 S. Kline St., Aberdeen, S. D.

Real Congestion of Traffic

Those who believe that rail traffic in America is unduly congested should read the following report by S. M. Vauclain, President of the Baldwin Locomotive Works, of travel conditions in Rumania:

We hear all sorts of criticisms of the services rendered by the railroads in this country. God forbid that we ever have to undergo transportation difficulties such as I underwent on my way to Bucharest. The bumpers of the cars were crowded; in some inconceivable way men locked themselves to the long buffers with their legs so intertwined that it was impossible to drop on the track. Two men would sit that way, sometimes holding their wives on their laps. The cars were fitted with ladders, and there were resting places for people, and the roof actually afforded seating capacity. After leaving Czernowitz, there were twenty-five people, men, women and children, on the roof of my car, leaving in the dead of night. They had their belongings with them. I counted seven pigs and many chickens, all carried under the owners arms, while waiting for the train to move.

The most interesting feature of it all, says Mr. Vauclain, was that the people seemed to thoroughly enjoy the transportation which they had. There was no grumbling or swearing. In fact, the competition for places was too keen to leave any time for this.

The fact of the matter is that we are far from having reached the ultimate in congestion of traffic. The following story, vouched for as a fact, shows that there is nothing new in these conditions:

During the days of '49 there were two methods of reaching the Eldorado (in the absence of railways.) One was by the "prairie schooner" across the plains, and the other by sailing vessels around "The Horn." Freight ships, which had never been intended for passenger traffic, were packed like sardine boxes, and the rated capacity of passenger vessels was usually multiplied by ten. A small sailing vessel, having an authorized capacity of fifty passengers, started out of an Atlantic port with several hundred aboard. The first week of the passage was exceedingly stormy. The skipper had his troubles, but his passengers were not amongst them. They were in no mood or condition to make any trouble. At the end of a week the weather moderated considerably. One day an inoffensive little man boldly appeared in the Captain's private cabin. "Captain," he said, "I have paid for my transportation on this ship, and you really must find me a place to sleep." "Well," replied the Captain, "Where have you been sleeping for the last week?" "Why," replied the little man, "It's this way; I have been sleeping on top of a big sick man, but he is getting better now and he won't stand for it much longer."

Analysis of Samples of Ancient Armor

The analysis and microscopical examination of about one dozen samples of ancient armor from the Metropolitan Museum of Art, New York, have been practically completed. The analysis indicates that all the samples were made from very pure wrought iron converted into steel by the old cementation process, as would be expected. The carbon determination was made on the entire cross-section as the material of all the pieces was too thin and corroded to obtain samples from different layers.

The microstructure indicates that the process used in the production of the original iron was very similar to our wrought iron process. The metal was then carbonized, probably by a supplementary process, hammered into sheets, differing in hardness (*i. e.*, in the amount of carburization), and those sheets welded together. The whole was then hammered into shape and quenched, thus producing the final hardening effect.—*U. S. Bureau of Standards.*

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Accomplishment

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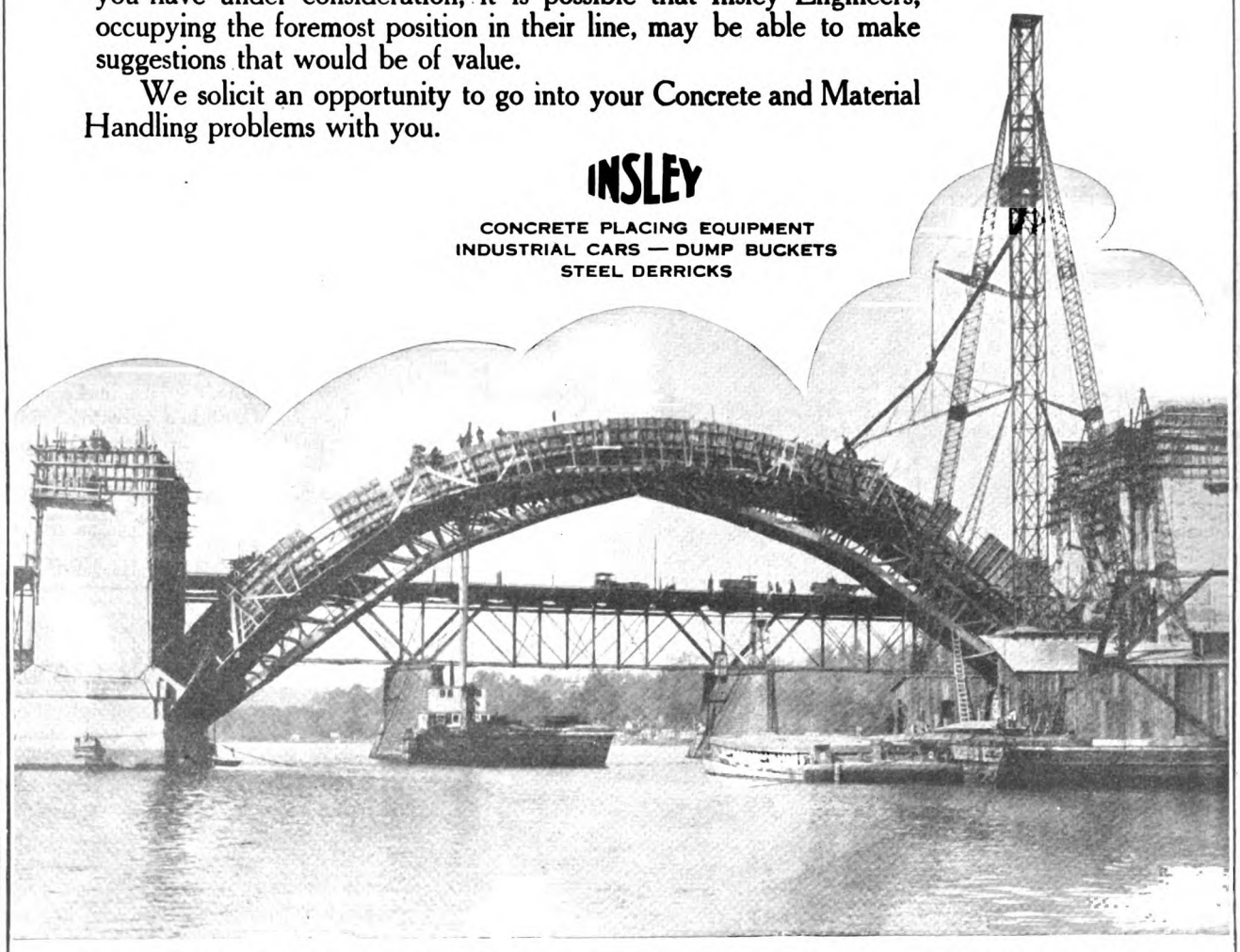
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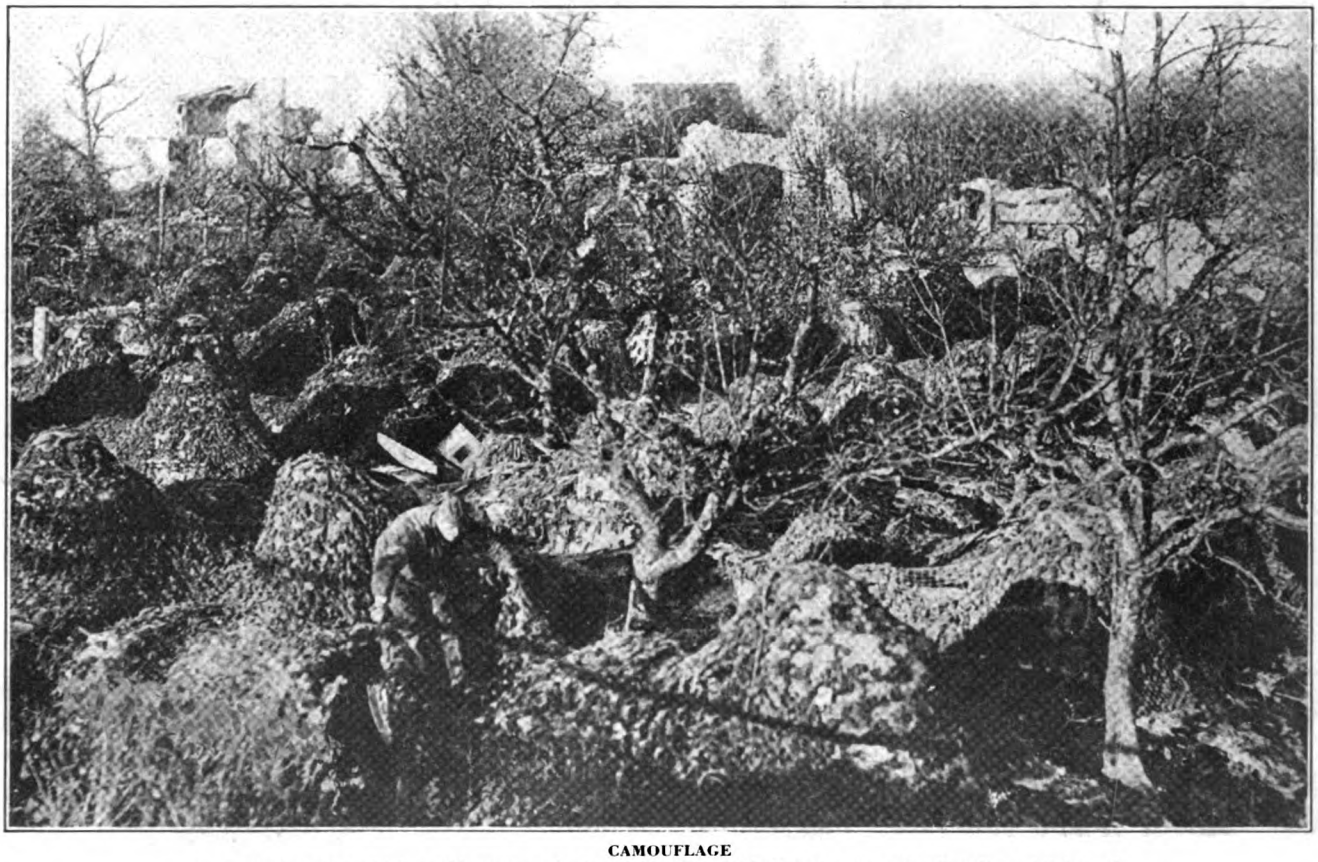
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VOL. XIII MARCH-APRIL, 1921 NO. 68

The Military Engineer



CAMOUFLAGE
This bit of ground, which would appear quite innocent to an aerial observer, conceals a battalion of light tanks

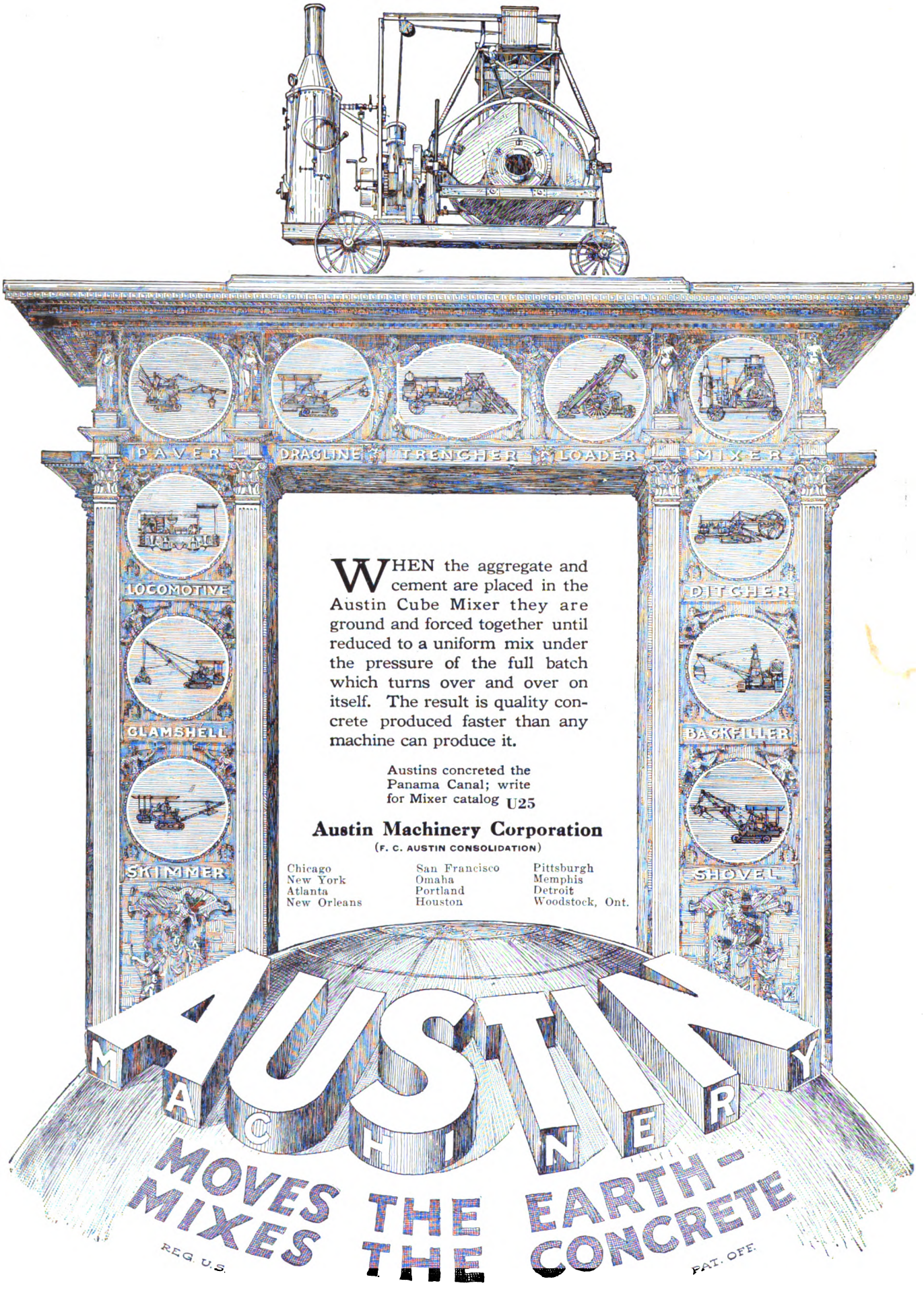
JOURNAL OF

THE SOCIETY OF AMERICAN MILITARY ENGINEERS

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John Wingate Weeks
Secretary of War

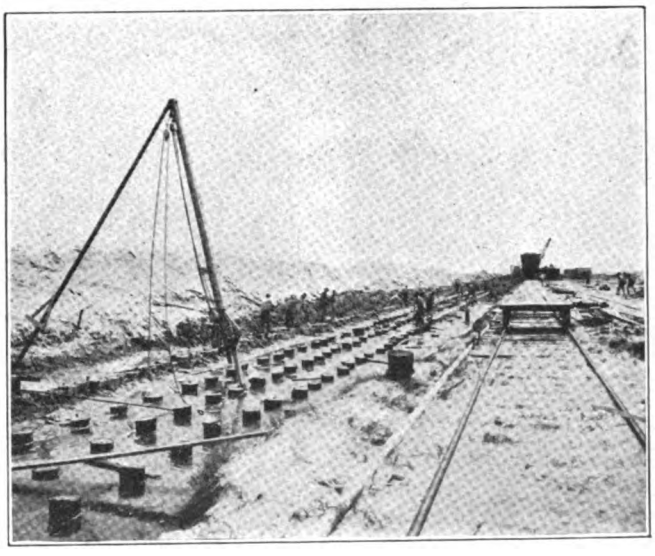
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The Galveston Seawall Extension

By

J. W. Henderson
Assistant Engineer, U. S. Engineer Department

ON September 8, 1900, Galveston Island was visited by a severe hurricane which caused a loss of life of more than 6,000 and damaged property, etc., to the estimated value of seventeen million dollars, the water reaching a height exceeding by far any previous record at Galveston. After this it was decided to adopt protective measures to prevent a recurrence of the disaster, and on November 22, 1901, a board of engineers, consisting of Gen. H. M. Robert, Corps of Engineers, U. S. Army (retired); Alfred Noble, and H. C. Ripley, was appointed to consider and report upon the most efficient way of protecting Galveston against overflow from the sea.



Foundation of seawall, showing wood foundation and concrete sheet piles

The report of this board, dated January 25, 1902, recommended the building of a solid concrete wall, over 3 miles long, connecting with the south jetty near 8th Street; thence to 6th Street and Avenue "D;" thence across the island and down the beach as far as 39th Street; the top of this wall to be 17 feet above mean low water, or 1.3 feet higher than the highest point reached by the water in the storm of 1900, the sea face of the concrete sea wall "to be curved so that its upper portion will be vertical. This will give the wave an upward direction and prevent to a great extent its running up and over the embankment behind the wall. The wall will be founded on piles and protected from undermining by sheet piling and also riprap. It will be located back from the high water line where the ground is about 3 feet above mean low water. Its width at the bottom (1 foot above mean low water) will be 16 feet, and at the top (17 feet above mean low water) 5 feet."

The seawall, as proposed by this board of engineers, was constructed between October, 1902, and July, 1904, and as will be seen on the index map (Plate I), the eastern portion of the island, extending to the south jetty, averaging about 11,000 feet long, and containing about 1,600 acres, was left in an unprotected state, the eastern portion, containing about 600 acres, of this unprotected area being the original Fort San Jacinto Reservation.

The rivers and harbors act approved July 25, 1912, provided for a board of three engineer officers whose duty was to examine and report upon certain harbors and channels in Texas, at or near Galveston. This special board of officers consisting of Col. Edward Burr, Lieut. Col. Lansing H. Beach, and Lieut. Col. C. S. Riche, met at Houston, Tex., on January 6, 1913, and during the course of that week inspected the various portions of the harbor, holding meetings also at the United States Engineer Office at Galveston, Tex. The report of this board is given in House Document No. 1390, 62nd Congress, 3rd session.

The special board, in their report, invited attention to a matter of great concern to the safety of Galveston Harbor, which related to the easterly end of Galveston Island, and especially to the narrow neck just east of the then existing seawall of the city of Galveston and between that and Fort San Jacinto, and stated that—

> The most desirable method, one which would not only protect this narrow part of Galveston Island from being breached by a storm, but also provide suitable communications to and from Fort San Jacinto and protection for its garrison, would consist of an extension of the Galveston seawall from its angle at 6th Street and Broadway to and around the Fort San Jacinto batteries, thence following the south jetty and just inside thereof, to the intersection of said jetty with the present southern boundary of the reservation. Such a sea wall, with a suitable fill behind it, would not only afford all necessary facilities for a garrison at Fort San Jacinto and for its communications, but would render Galveston Harbor safe from obstruction by such a storm as that of 1900. It would also render impossible any flanking of the jetties by the cutting of a channel to the south of them and would permit the erection of wharves along the channel from the eastern end of the present wharves to the boundary line of Fort San Jacinto Reservation.
>
> The work described would be of benefit in part to the harbor and in part to its defenses, and its cost should be shared by the two organizations of the Government concerned. There would also be a benefit accruing to the city of Galveston and to the owners of land between Fort San Jacinto and the present protected portion of the city of Galveston, and the interests thus benefited should bear some equitable portion of the cost.
>
> So far as the protection of the harbor is concerned, it is believed that this can be effected by the extension of the Galveston seawall

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from its angle at 6th Street and Broadway to a point abreast and in front of the nearest battery at Fort San Jacinto, a total distance of 10,300 feet, and its connection with that battery by a wall of heavy riprap which would so unite the end of the wall with the storm protection of the battery as to afford temporary security to the exposed end of the wall until such time as its further extension might be undertaken in the interest of affording protection to the fortifications and their garrison.

This proposed extension of the seawall for 10,300 feet is believed to be that portion of the whole seawall plan above suggested that peculiarly pertains to the protection of the harbor, to the extension of its facilities, and the prevention of its blockade by storm. The wall should be similar to that now in front of Galveston, and it should be backed by enough filling to give a width of 200 feet from the edge of the wall to the rear crest of the fill. Beyond that crest the material should be given such slope as it would naturally assume as a hydraulic deposit—probably 1 on 30. The front part of the fill next to the concrete should be protected by a sidewalk and brick paved roadway as has been done in the Government's similar extension of the seawall to and in front of Fort Crockett, and the top of the fill between this roadway and its rear crest should be protected from the blowing away of its material by suitable soil covering and vegetation.



One-cubic-yard concrete mixer with aggregate hopper on separate car, pouring superstructure forms



Rear of wall, showing concrete base

The board further stated that "any appropriation that the Government might make towards this extension of the seawall should be contingent on a satisfactory cession to the United States, free of cost, of all land east and north of a line originating at the intersection of the center line of the south jetty with the present southern boundary of the Fort San Jacinto Reservation and extending thence approximately south 16° east, to the Gulf of Mexico (this line being made parallel to the numbered streets of the city of Galveston)," the triangular area thus donated to the Government between this line and the extended seawall and the present southern boundary of Fort San Jacinto, being estimated to contain 600 acres. In addition that, 'the Government's appropriation for such extension of the seawall should be contingent upon the quieting of any claims that may be outstanding against the present Fort San Jacinto Reservation." Also that, "the Government's appropriation for such extension of the seawall should furthermore be contingent upon local interests providing for the building of that portion of the extension which lies between the angle of the present seawall at 6th Street and Broadway, and the above new boundary proposed for the Government Reservation. It is estimated that this will require the building of 3,300 feet of wall, with the fill immediately behind it, by the local interests, and 7,000 feet further by the United States."

The recommendation of the board for the seawall extension was as follows:

That, for the protection of the harbor from blockade by storms, and to permit an extension eastward of its wharf facilities, as well as for other reasons, the United States build 7,000 feet of seawall with suitable backing, at an estimated cost of $1,185,000, said work, however, not to be undertaken until the city of Galveston and other local interests first donate certain lands to the Government, quiet all claims to the present San Jacinto Reservation and provide for the construction of 3,300 feet of similar seawall extension.

The river and harbor act of July 27, 1916, contained a preliminary appropriation for this work as follows: "Galveston Channel, Texas: Continuing improvement by construction of seawall extension in accordance with the report submitted in House Document No. 1390, 62d Congress, 3rd session, subject to the conditions therein named, $200,000; Provided, That no part of the amount herein appropriated shall be expended and no contract shall be entered into under this appropriation until the county or city of Galveston and other local interests shall have donated the lands to the United States, as set forth in said Document No. 1390, and shall have quieted all claims to the present San Jacinto Reservation, nor until the said county or city of Galveston shall have obtained a right-of-way and made provision in a manner satisfactory to the Secretary of War for paying the cost of constructing at least 3,300 feet of similar seawall extension in addition to that herein appropriated for; Provided, further, That the entire work of construction shall be done under the direction of the Secretary of War, and the funds appropriated by Congress and those furnished by the county or city of Galveston shall be expended by him."

The estimate made in 1913 for the construction of the wall with fill, etc., and given in House Document No. 1390, due to increased costs of labor and materials, was inadequate for the work in 1918. The county of Galveston having stated that they could only furnish funds for the construction of their portion of the wall alone, without any fill, paving, etc., it was recommended to the Chief of Engineers under date of August 18, 1917, that, if it was considered that the county of Galveston and other local interests had complied with all the requirements of the act of July 27, 1916, appropriating the initial amount of $200,000 for construction, that the construction of the seawall with riprap protection be undertaken, leaving the sand fill behind the

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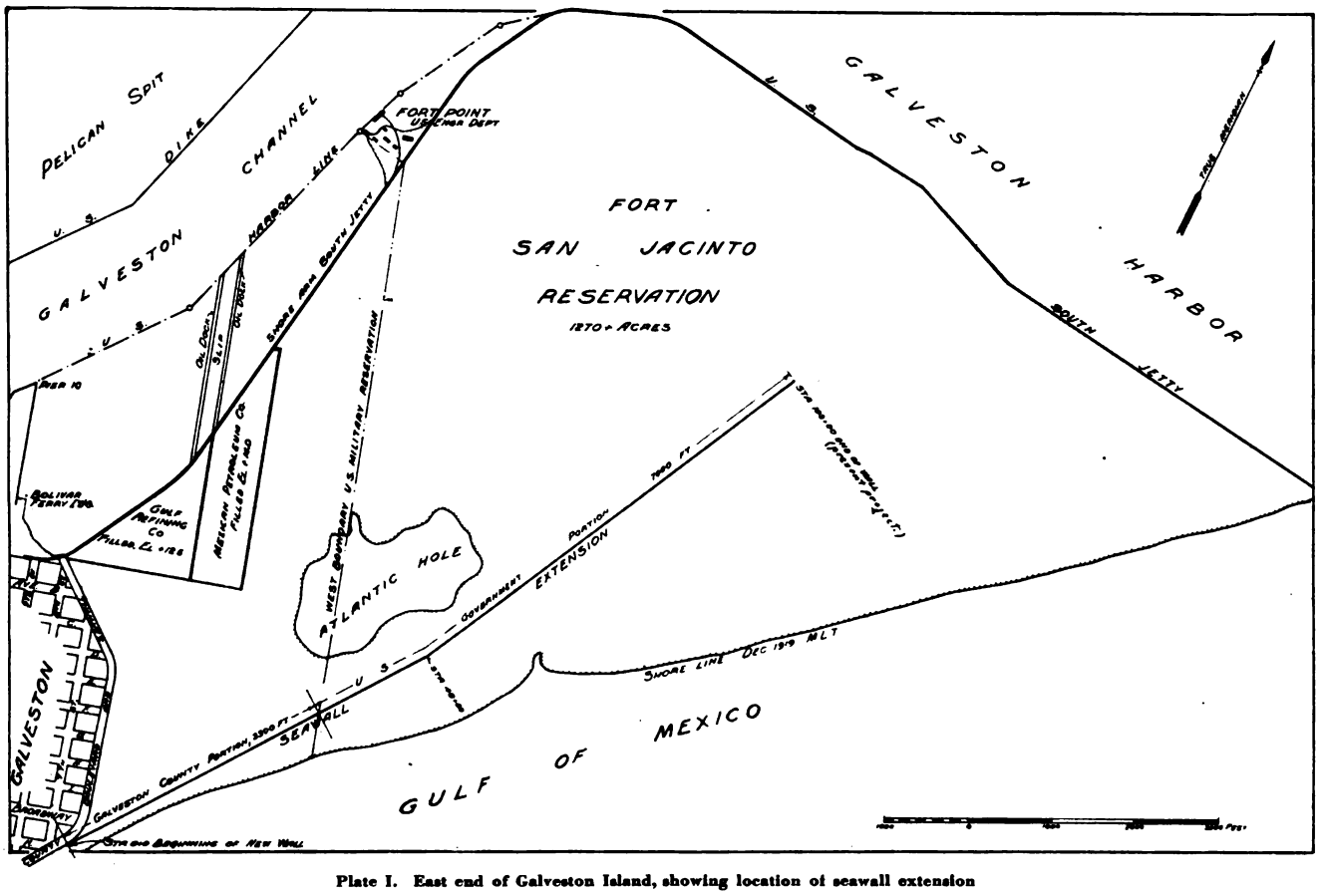


Plate I. East end of Galveston Island, showing location of seawall extension

wall, sidewalk, brick paving, etc., to be provided for at some later date. Authority was received to proceed with the actual construction of the wall, under date of October 20, 1917.

The preliminary work of procuring plant, materials, laying railroad track, etc., was immediately begun, and the first actual construction work of driving foundation piles was started on June 20, 1918.

Description of the Work

As shown on Plate II, the cross section of the seawall approved for the extension, is the same as was adopted by the original board of engineers in 1901, with the exception that the sheet piles are driven in front of all the foundation piles in the present wall, while in the old wall the sheet piles were placed behind the front row of foundation piles, and that the concrete foundation or base is built wider, with overhangs to carry the tracks for the steel traveler which handles the steel concrete forms. The wall proper has a vertical back, the top being 5 feet wide, and the base 16 feet wide, the face being a compound curve joining the top to a vertical portion extending 6 inches above the foundation. The elevation of the top is 17 feet above M. L. T., and that of the base being 1 foot above M. L. T. The wall is supported on four rows of foundation piles 4 feet apart, each round pile sustaining a dead load of 12½ tons, with a line of triple lap sheet piling under the front toe. The foundation and sheet piles are of green pine lumber, the foundation piles being 30 feet long with 9 inch diameter points, and the triple lap piles composed of three 3-inch by 12-inch planks, bolted together, 36 feet long. These triple lap, wooden piles were later changed at Station 56 and 40 to reinforced concrete sheet piles. Twisted reinforcing bars, 1½ inches square and 10 feet long, are imbedded in the concrete 6 inches from the face of the wall.

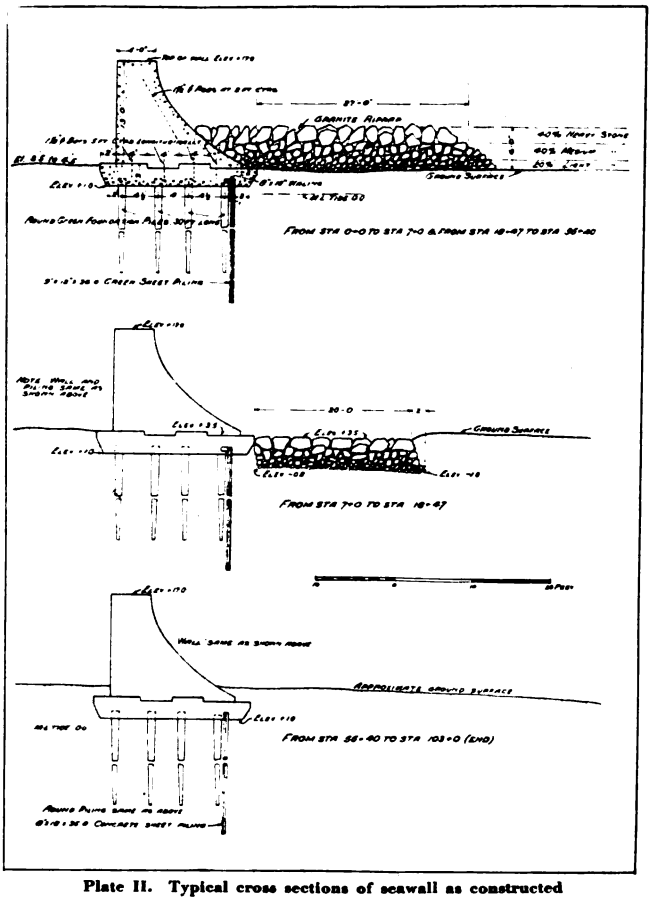


Plate II. Typical cross sections of seawall as constructed

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The riprap protection in front, as originally approved, consisted of heavy riprap 6 feet thick and 27 feet wide, the stones being in the following proportions: 20 per cent of stones weighing from 15 pounds to 200 pounds placed on the bottom, then 40 per cent of stones weighing from 200 pounds to 1,000 pounds, and on top 40 per cent of stones weighing from 1,000 pounds to 5 tons, the rear protection consisting of light riprap placed against the wall in a triangular section 6 feet high and 12 feet wide.

Under date of April 19, 1919, approval was given to a change to be made in the placing of the front, heavy riprap protection, this being the placing of the stone in a trench, the bottom of which is 4 to 4½ feet below the top of the concrete foundation, and 20 to 22 feet wide, the top of the stone being horizontal and on a level with the top of the concrete foundation. It developed during the hurricane of September 13-14, 1919, that riprap protection on the natural beach was superior to that placed in a trench, and the laying of riprap on the natural surface was then authorized by the Chief of Engineers.

Approval was also given under date of May 15, 1919, to the change from wooden sheet piles at Stations 56 and 40, to reinforced concrete sheet piles, of a 1:2:4 mix, the remaining 4,660 feet to be of concrete sheet piles with the front riprap protection omitted, the omission of the riprap being considered justifiable on account of the wide foreshore reducing the violence of wave action on the wall.

Plant and construction methods

The foundation and sheet piles were driven by No. 2 Warrington steam hammers and turntable leads, but on account of difficulty in driving through the fine, packed sand, it was necessary to use 2½-inch jets at 75 pounds pressure to assist in driving them to grade. These turntable drivers work on sills on the previously driven piles. It was found necessary to increase the jets, formerly 2 inch, to 2½ inch in order to drive the large concrete sheet piles more expeditiously.

The concrete in the base and superstructure is of a 1:3:6 mix, or 1.1 barrels of Portland cement, 0.47 cubic yards of sand, and 0.94 cubic yards of broken stone. The sand used is a sharp, freshwater sand with fine gravel, up to 3/16-inch diameter. The broken stone is a limestone from Comal County, Texas, with a specific gravity of 2.68, in pieces ranging from ¼ inch to 2½ inches.

The main construction plant is mounted on standard railway cars. The concreting plant for the wall proper consists of a one-cubic-yard Lakewood mixer and engine, with chuting tower 30 feet high, all mounted on a flatcar and chuting directly into the steel form. A sand and stone hopper to serve this mixer is mounted on another flatcar, this hopper being filled by a locomotive crane from the cars of material. The concreting plant for the base is a ¾-cubic-yard portable Foote mixer mounted on one end of a flatcar, with sand and broken stone hopper on the other end, and chuting directly from the mixer into the base. The cars were rented from the Gulf, Colorado and Santa Fe Railroad.

The heavy riprap stone for front protection was handled direct from the cars by a 15-ton "A"-frame derrick, with 60-foot boom, the base being trussed, and mounted with one side on rollers on top of the completed wall and the other side on cribbing erected on a standard flatcar. This enables the cars to pass under it as they are unloaded. This derrick was used also in excavating the trench for the front riprap stone.

A steel guy derrick, 90-foot mast and 81-foot boom, was used in unloading broken stone and sand from cars to storage piles, when these materials were received faster than they could be used in the construction, and loading cars when there was a shortage of this material being received. It also handled the material for the casting of concrete sheet piling, and the cured piles to storage piles, and on cars.

The wall being of a uniform section throughout, it was considered more economical to use steel forms for the concreting, and a plan was made for the use of six steel forms with a traveler to move the sections, the forms and traveler being constructed by the Blaw-Knox Company, Pittsburgh, Pa. These forms were so designed as to stand alone without outside braces, and when the two sides are swung in the traveler for moving, a form in place can be passed without interference. The toe of the curved side of the form is anchored to the concrete to prevent uplift, by means of threaded bolts anchored in the base, and connected to the form by short ¾-inch rods with long nuts, these latter rods being afterwards withdrawn when the form is removed. When it is desired to move the forms, turnbuckles on the traveler raise the steel sides up and away from the concrete, when one end of all top-connecting channels have been unbolted. These turnbuckles are attached to the form by pins for ease of removal. The wall is built in alternate sections 30 feet long, the steel forms being of such length that the end bulkheads in an isolated form are recessed 6 or 8 inches, and therefore, with the bulkheads removed and angles bolted to the edges, the same sides can be used for the closing sections, plenty of overlap being thus provided. The forms are tied inside with ¾-inch rods, and in the case of the isolated sections have a diagonal wooden brace near the top, which assists as in stabilizing the form and does away with outside bracing. When the concrete reaches the bottom of the brace, the latter is removed.

The steel forms have worked very satisfactorily and have cut the cost of forming more than half, the only improvement necessary being the changing of the top liner angle on the vertical side of the form to an I-beam to stiffen the top of the form, the angle having a little too much flexibility.

The steel form and traveler are shown in Plate III.

On account of the large amount of switching to be done on the work, and the excessive cost per car for having it done by the railroads, it was decided that it would be economical for the Government to procure a locomotive for this work, and a second-hand standard locomotive was purchased, which receives the loaded cars from the railroads, distributes them and does all switching in connection with the construction work.

The construction plant is such as to permit of each branch of the work being carried forward by the machinery assigned to that branch, without interference with the progression of any other part of the work. Excavation for the foundation is done by a locomotive crane operating an orange-peel bucket. Immediately behind that, a piledriver drives the round foundation piles, followed by another piledriver for the sheet piling. Then the ¾-cubic-yard mixer pours the concrete foundation, followed by the 1-cubic yard mixer pouring the superstructure of the wall. Following the wall mixer and completing the wall construction, is the "A"-frame derrick excavating the trench and placing riprap protection.

History of the construction work

The County of Galveston having complied with the requirements of the act of July 27, 1916, making the initial appropriation for this work, the actual construction work

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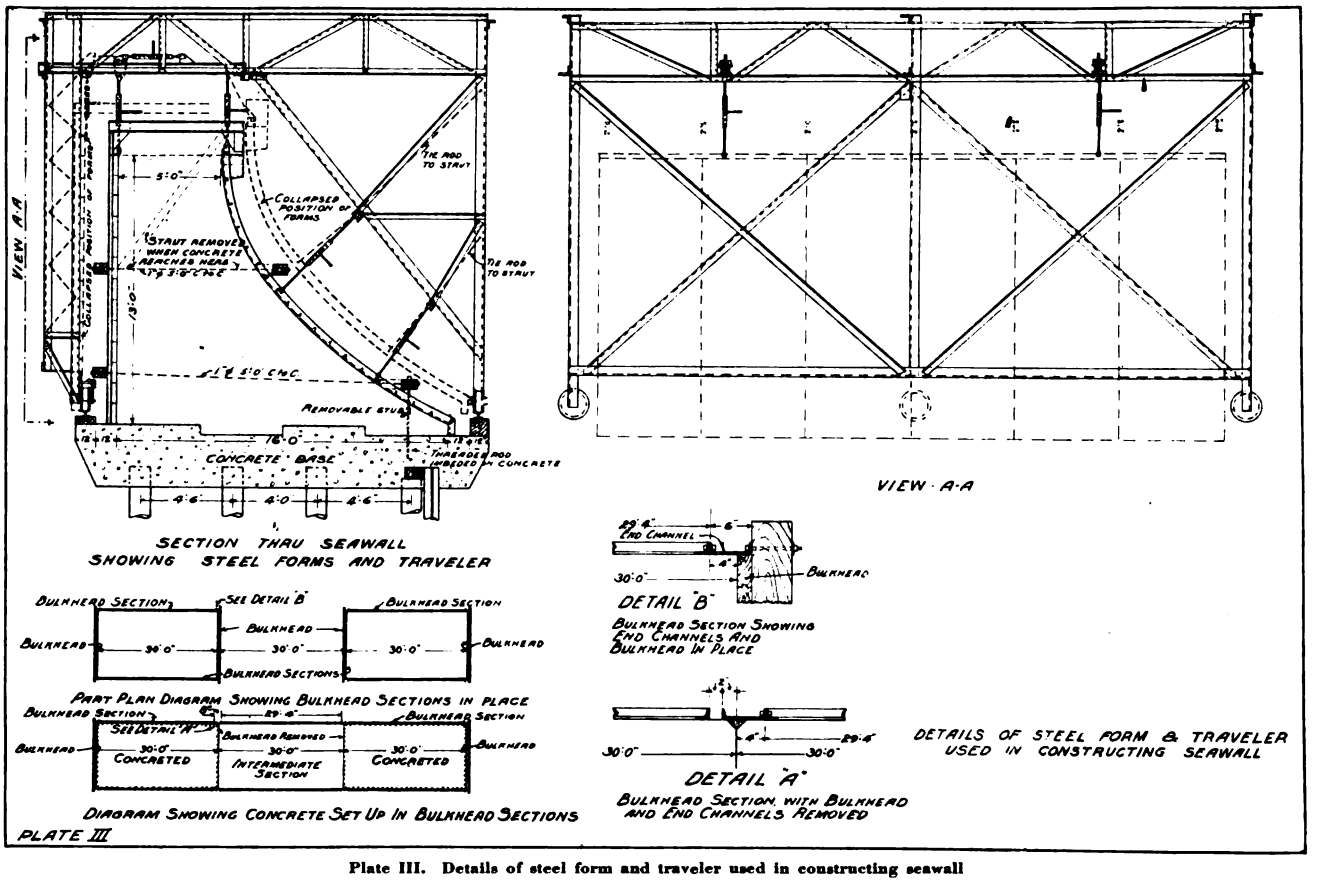
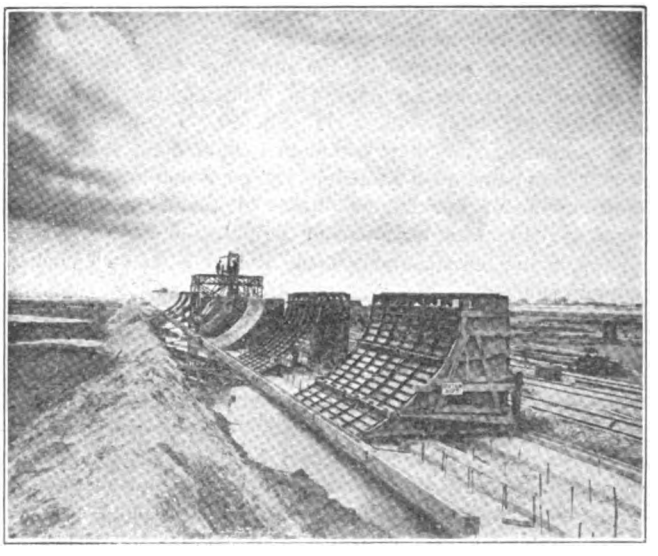


Plate III. Details of steel form and traveler used in constructing seawall

was started in June, 1918, with the county portion of the wall, this being the nearest to the point of connection with the old wall. The new wall being a prolongation of the tangent to the old one, it was decided, in order not to disturb the curve of the old wall, to effect the junction by the construction of a solid concrete ramp, starting with the toe opposite the point of curvature, with a width of 16 feet and extending 147 feet, at which point the line of the new wall was 16 feet from the curve of the old wall, and at this point the regular section of the wall was started. The work was continued from that time, being very much delayed by labor shortage and lack of materials due to the various embargos on cars, etc. When the wall was about 45 per cent completed, and the end of the concrete construction was about opposite the entrance of the Atlantic Hole (a large barrow pit in the flats from which about three million cubic yards of fill for the original Galveston grade raising had been procured), the hurricane of September 13-14, 1919, with a maximum tide of 8.8 feet above M. L. T. occurred, caused a considerable current around the end of the completed wall and scoured a hole about 2,000 feet wide, 924 feet of this hole being at the rear of the foundation and 1,043 feet being the new channel ahead of the wall with varying depths to 19 feet, and an average depth of about 8 feet, where previously the entrance to this hole had been less than 200 feet wide with an average depth of about 2½ feet. This narrow channel had been closed with steel and wood sheet piling and excavation for the wall made, and the work of constructing the wall across the entrance was in progress when the hurricane occurred. In order to continue the wall, approximately 250,000 cubic yards of fill had to be made in this scoured portion. About 19,000 cubic yards were placed with an 8-inch centrifugal pump in the scour at the rear of the completed foundation, and the balance of the fill was placed by the 20-inch hydraulic dredge *Sam Houston*. This latter fill, on account of there being no available material closer, had to be made through a pipe line between 7,000 and 8,000 feet long.

On account of the Atlantic Hole being on one side and the Gulf of Mexico on the other, this fill, the top of which was at elevation 4 feet above M. L. T. would not drain and remained in an unstable condition. It was therefore decided to construct a single-track railroad trestle 981 feet long over the worst part of this fill to take the heavier pieces of construction plant, the other lighter plant to travel over a track laid on a dry, sand embankment placed



Steel superstructure forms with form traveler

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on the original fill. The making of this fill and the difficulty of procuring timber for the trestle, with other drawbacks caused by the hurricane, delayed the construction work for some months.

It may be stated that this hurricane did not do any damage to any part of the completed wall. While it was not as severe as the hurricanes of 1900 and 1915, it was accompanied by heavy seas and a tide of 8.8 feet, and was severe enough to test the new wall to an unusual degree. Despite the severity of the test, the completed portion of the new wall stood without any backing. One of the steel forms had been filled two days previously, and even this green concrete was not damaged, it being protected by the steel form which was still in place. Three isolated forms were in position empty and two of them were badly damaged. One of them had the front curved face smashed in, but stayed anchored to the foundation, though leaning over very materially. The other form was torn loose from its anchorage and carried away into deep water about 80 feet from its original position, being damaged beyond repair.

The riprap protection on the seaward side of the wall settled very generally where it had been placed, an average settlement of 2½ feet occurring in the whole distance over which stone had been placed.

The reinforced concrete sheet piles are of an unusual size, viz., 8 inches thick, 18 inches wide and 35 feet long, with circular tongue and groove, and considerable difficulty was experienced in getting them down to grade and keeping them in line. 2½-inch jets were used in addition to a No. 2 steam hammer. A maximum of 25 of these piles was about all that can be put in place by an 8-hour shift.

Completion of the project

As soon as funds shall have been appropriated for the Government portion of back fill of 7,000 feet, and the County of Galveston has arranged to furnish the money for their portion of back fill of 3,300 feet, it is proposed to complete the balance of the project adopted in the river and harbor act of July 27, 1916, viz., the making of the fill behind the wall, which is to have a crest 200 feet wide and rising on a 2 per cent slope from the wall, the rear slope from the 21-foot elevation to be about 1 on 30. The fill is to be soiled and sodded on all parts not covered by the brick paving, sidewalk, etc. The concrete sidewalk is to be 16 feet wide, and the brick-paved roadway 84 feet wide. At the edge of the brick paving, or 100 feet from the wall, a continuous line of reinforced concrete sheet piles is to be driven to form a cut-off wall, these piles to be 6 inches thick, 18 inches wide, and 14 feet long. The tops of these piles will be incased in a continuous reinforced concrete cap 2 feet wide and 1 foot thick, and anchored to a continuous reinforced concrete deadman. A concrete retaining wall tapering from 1 foot to 2 feet thick, and 6 feet deep, is to be placed at the rear crest of the fill and projecting 1 foot above the crest, or elevation 22 feet above M. L. T., to prevent any possible overpour.

Dredging Tests on Dredge "Raritan"

By

E. J. Dent

Major, Corps of Engineers

The dredge *Raritan* is a sea-going hopper dredge, completed in 1908 for Ambrose Channel, New York. She is equipped with two dredging pumps, direct connected to engines having about 450 indicated horsepower. There are two bins, having a total capacity of 2,884 cubic yards; one bin being forward and one aft of the engine room. As originally equipped, each pump had a 20-inch diameter suction pipe and discharged into a special "Y" from which one 20-inch pipe led to the forward bin and one to the after bin. In other words, the pump had one 20-inch suction and two 20-inch discharge pipes.

The general features of the old pumps on the dredge *Raritan* are shown on page 417, PROFESSIONAL MEMOIRS, July-August, 1916, Vol. VIII, No. 40. On page 407 of the same magazine there are shown the general features of a new pump installed in 1916. On page 430 will be found a discussion of working conditions on the *Raritan* and the reasons for making a change in the pump design.

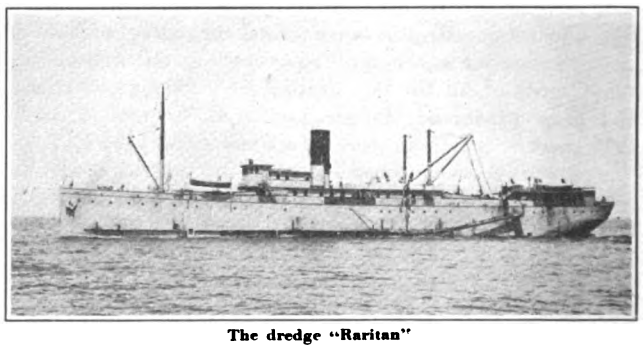
The writer also advocated the use of a 24-inch suction pipe in place of a 20-inch pipe. One such suction pipe was purchased and was used during part of the tests referred to below.

The new pump was installed in February, 1916, and was immediately given an acceptance test while pumping water only. During this test the openings in the drag were reduced in order that the suction head might simulate, as nearly as practicable, the actual working conditions.

As soon as the acceptance test had been completed, an actual dredging test was started. When this test began the following presumptive evidence was available to justify the expectation that the new pump would out-dredge the old pump, under identical conditions, and that the new pump with the 24-inch suction would prove a still more effective unit.

(*a*) With the same expenditure of horsepower the new pump could deliver more mixture than the old pump when both were equipped with the same diameter suction pipes.

(*b*) At the point where the mixture of water and sand enters the drag the new unit, including the larger suction pipe, had a greater available suction than the old unit. Other conditions being equal, the new unit should, therefore,



The dredge "Raritan"

be able to suck in a higher percentage of solids than the old unit.

During March, 1916, seven loads were dredged by the *Raritan* using the new pump only, and seven loads were dredged under as nearly identical conditions as practicable, using the old pump only. The results are shown in the following table:

Tests on Dredge *Raritan*, March, 1916. Loads obtained

(Continued on Page 107)

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The Operation of Motor Trucks in War

Pooling versus Fixed Assignment

By

G. R. Young

Major, Corps of Engineers; formerly Lt. Col., G. S. [G-4], G. H. Q., A. E. F., in charge of motor transportation

With discussions by Maj. Gen. James G. Harbord, Col. M. L. Walker, Brig. Gen. Malin Craig, Col. H. C. Smither, Lt. Col. Geo. P. Tyner, Lt. Col. L. D. Gasser, Lt. Col. J. Edward Cassidy, Maj. Jno. F. Franklin, Maj. Marmion D. Mills

[*Note.*—There was probably no one question which aroused more discussion in the American Expeditionary Forces than that of the relative merits (and demerits) of "pooling" versus "permanent assignment" in the use of motor transport.

The obections to the pooling system were apparently all on a small scale. Nevertheless they were very real, and poignantly felt by those who suffered from them. For example, the division engineer who had to depend on a daily assignment of trucks to carry on his daily work, had real cause for the objections he voiced. He could not depend upon the arrival of trucks which were not under his control; the truck drivers, not being members of his organization, had no particular interest in its work, and were often insubordinate; and motor transport officers exercised, from the engineer's point of view, too great a control over engineering operations.

These very real obections to small-scale pooling are largely removed by the policy of fixed assignment to meet minimum needs, as recommended by Major Young. They are, moreover, relatively unimportant as compared with the great necessity of flexible pools under the control of the higher units.

Major Young, at General Headquarters, had an opportunity to see the problem and its solution, in their larger aspects, as affecting the operations of the army as a whole. There will be few to question the soundness of his opinions. Amongst his commentators there is, except in minor details, not a dissenting voice.

It is believed that this article, and the able discussion following, should settle for all time the proper policy as to the general distribution and control of the motor transport of an army.—ED.]

The two theories

EXCEPT for the supply columns of the Punitive Expedition into Mexico, our first large-scale use of motor trucks in the Army was in the late War. At the beginning of the war, our Tables of Organization were extensively motorized. The method apparently was to compute what horsed transportation would have been needed for the various units, to carry the required supplies, and then convert to motor trucks by the ratio of carrying capacities. Consideration was probably given to the increased radius of action of trucks, in that a division could function farther from its distributing points. Otherwise, it does not seem to have been considered that the old supply system, in or behind the combat zone, would need change.

This is the same as if one had armed Napoleonic infantry with modern rifles, and expected them to fight on Napoleonic tactics, except that they could shoot at a greater range. The substitution of breech-loading repeating rifles for muzzle-loading single-shot smooth-bores did more than increase the killing range of infantry; it utterly changed the theory of infantry tactics. The substitution for animal transport, of vehicles which move three times as fast; which need skilled mechanical repair and operation; which need good roads, and tend therefore always to block those roads, has largely changed the theory of logistics. Much of our Field Service Regulations still needs to be rewritten to conform to the change. But practice precedes the enunciation of theory, and in practice we learned a lot about gas-engine logistics in the war.

The system for handling trucks which was inherited from the days of animal transportation, may be called the theory of fixed or individual assignment. According to this theory there is assigned to every unit of an army, at all times, the number of trucks needed to enable it to function under maximum pressure, or at "peak-load." The opposed theory may be called the theory of pooled transportation. It holds that beyond a certain minimum, trucks should be operated not by tactical units, but by transportation units for the benefit of tactical units; that peak-loads should be met not by a fixed maximum assignment, but by loans for the emergency; that all down the line from high command to division, the commanders should hold out certain truck reserves; and that truck operation implies traffic control. Roughly speaking, the history of the late war showed a drift from the first theory *in the direction* of the second.

In general, this change in technique was forced by the failure of the old system, occurring haphazard and on the individual initiative of unit commanders. There were also two systematic efforts to introduce in a modified form the pooling system during the war.

The theory of the fixed assignment and its breakdown

Previous to the late war, the largest scale on which the American Army ever fought was in the Civil War. In that war an army of 100,000 effectives was a large army. It normally operated over a front of many miles. It fought a war of maneuver, with major engagements occurring perhaps once in a period of months. Its expenditure of artillery ammunition, even in the heaviest battle, was a small thing compared to the expenditure for a large-scale raid, in modern warfare. Outside of railroads, it had not means of moving large bodies of dismounted men on land, at a greater speed than infantry could march. Its transport was animal transport, which could move over almost any kind of road.

When the Tables of Organization of 1917 were framed for the A. E. F., the mental picture of motor transport logistics for the field army was apparently as follows:

a. When the combat trains of a unit were to be motorized, there would be motor trucks attached to that unit with the same carrying capacity as previously assigned animal transport.

b. Where, heretofore, animal transport had been used for food and supplies in a division, there would be a truck train. Its size was computed on the basis of the daily expenditure of food and supplies, and of the average length of haul from rail-head. This was the supply train.

c. Where, heretofore, horse transport had been supplied for ammunition in a division, there would be a truck train. Its size was computed on the basis of the average expenditure of ammunition by a division in action, and of the average length of haul from railhead. This was the ammunition train.

d. Similarly there would be an engineer train, and a motorized section of the sanitary train, consisting of cargo trucks for hauling the field hospitals, size computed in the same way.

e. Similarly there would be trains or artillery parks for hauling ammunition for non-divisional artillery units, and supply trains for the supply of non-divisional units, attached to the Corps and Army.

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All this mass of transportation was to function as per Field Service Regulations. As a division went into action, the divisional trains passed from the jurisdiction of the commander of trains; the division quartermaster, division engineer, and artillery brigade commander sent their respective trains to railhead or refilling point and brought them back. The corps and army staffs handled their particular trains in the same manner. Every unit being motorized to full strength for active combat, every unit would be ready at all times for a major engagement, with the transportation available to supply itself during that engagement period. It was an attractive picture.

I have said that this system broke down. This is not strictly true, but it bent badly. The reasons were:

1. Shortage of vehicles,
2. Unsystematic shipments, resulting in inequitable assignment,
3. Fluctuation of demand,
4. The troop movement problem,
5. The road control problem.

All these factors are interwoven; it is hard to discuss them separately.

1. The A. E. F. was always short of its allowance of motor vehicles. The shortage increased both absolutely and proportionally, up to the Armistice. This shortage is too often passed over, in theoretical discussions, as incidental, one of our war failures due to "unpreparedness," which should not occur again. It deserves, however, more careful consideration. I do not believe it due, to any great extent, to either individual or departmental inefficiency. Our demands were simply greater than the country could meet. They could have been met for a while (assuming sufficient shipping) by shipping any kind of vehicle, regardless of standardization. This would have been satisfactory for a three months' war, while the vehicles were new, but the cumulative difficulty of repairing and maintaining such a diversity of types would rapidly have become an impossible problem. Figuring as it must on an indefinite period of war, the War Department wisely concentrated on a few makes of vehicles. It did its best, with good men and unlimited money. As a result, by the Armistice we were 50 to 60 per cent equipped. We had been fighting seriously for only four months, so that the vehicles were comparatively new; yet thousands were on their last legs, or wheels, needing immediate overhaul. A winter campaign, 1918-1919, would have seen a great increase in percentage shortage.

I believe that the same thing done again on the same scale would produce the same result; that we cannot equip, in a reasonable time, and with reasonably standard equipment, an army of three or four million men with trucks, on the basis of the 1917 tables. And the great demand under those tables was due very largely to the theory of fixed assignment, as will be shown later.

2. Unsystematic shipment of vehicles results from two causes: One was that for several critical months following the offensive opening March 21st, it was very hard to anticipate what troops were coming. The other was that after a certain tonnage for a given month had been allotted for motor transport, and a detailed list of needs sent back, with a tearful cable emphasizing the importance of the shipment being sent as requested, there was but one result which the A. E. F. could anticipate: that neither in quantity nor in kind would the resulting shipment resemble the demand. Reason unknown.

As a result of this shortage, and these uncertainties of supply and demand, equitable assignment was impossible. It was hand-to-mouth work, the only thing which could be considered being immediate shortages and existing stocks. Divisions arriving early when troops were few; and divisions arriving late when a good many trucks had been made available by stripping the S. O. S. were equipped fairly well. There was an intermediate period when they were equipped very scantily.

Fluctuation in demand might have been anticipated. Of course, if you equip a unit for "peak load,' then when the load is not on, some of the equipment is idle. That was anticipated. What seemingly was not anticipated was that "peak load" itself is indefinable. Trucks are to be furnished sufficient to haul the ammunition for a division in combat. To figure how many are needed, you must take, say, the average experience of a hundred divisions in combat. This I believe is how our Tables of Organization are made up—from Allied experience. But when you take the average of a hundred cases, and try to apply it to any one of the hundred cases, any engineer will see the result. No *actual* case is ever an *average* case. The actual need of a unit, for, say, ammunition carrying trucks at a given time, is dependent on many factors—supporting artillery, nature of fire, length of haul, kind of roads, expected development of the attack, etc.; in no two cases are they the same. This sounds elementary. Yet, although recognized in practise immediately, it was not until the very end recognized in theory.

4. Movement of large bodies of troops by truck was a new thing with this war. We had made no systematic preparation for it in our theories or tables of organization. Probably it was assumed that if such a move were made, it was simply a question of mobilizing the trucks, loading and moving as with supplies. But troop movement differs from supply movement in several respects. Troops to be moved are generally camped or billeted over a large area; within this they must be assembled at definite times, at prearranged spots, and not kept waiting a long time. If the move is of any length, special arrangements for feeding and camping are desirable, though not usually essential. If the move is to a point of combat the convoy must be kept together, so that the unit will arrive as a unit. It cannot be echeloned all down the road to arrive piecemeal, as supplies can. Considering the number of trucks needed to move, say, a division, this means the handling *en bloc* of an immense convoy. The consequences of taking a wrong road are more serious than with ordinary supply movements. For these reasons a large troop movement requires a careful time-tabling and dispatching, a centralized operating control, even more than does supply movement. It cannot be done by a dozen separate, hastily summoned trains breezing into camp and picking up men as they find them. As a result, then, of an unavoidable shortage, inequality of assignment, fluctuation in demand, and the peculiar difficulties of troop movement by truck there was throughout the war a *continued shifting of trucks from one command to another and a perpetual improvisation of elastic truck operating organizations.* And because we had no machinery for doing this systematically, it was done hodgepodge.

Early in 1918, there was a division on the Alsace front. Its sector was quiet—hushed. It had many more trucks than it needed. It also had some highly efficient staff officers, who kept a large part of these trucks permanently parked, rotating the companies in use, and thus ensuring continuous repair. For immediate use, it could have dispensed with, probably, half its trucks. Notoriously, neither we nor the enemy were going to start anything serious

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in that sector—probably not at all, surely not on 24 hours' notice. That is, the extra trucks would have been just as useful to that division anywhere in a radius of 150 miles—a 24-hour emergency run.

At the same period, there were several divisions in training areas in the Advance Section, desperately in need of trucks. It was recommended that one or two companies from the Belfort division be loaned to the divisions in training. But this was disapproved. The former was at the front, and under existing theories must be equipped for peak load.

In latter May, 1918, the 3rd Division was rushed to Chateau-Thierry, in trucks, from its training area. Very short notice was given. The trucks were assembled from all over the Advance Section, trickling in individually and in small groups, and were somehow whipped into an improvised organization. They got there; but by "main strength and awkwardness," and through the energy of the Motor Transport Corps officer who engineered the movement, for no system existed to cover such contingencies.

Some time in June, I believe, five divisions, then in training behind the British front, were shifted to the Paris Group and the Alsace-Lorraine fronts. They came suddenly, and needed equipment at once. Again it was a case of raking over the S. O. S., depots, units in training and like miscellaneous sources, to find the needful minimum of trucks, organizing them somehow into provisional companies and hurrying them up. The divisions were equipped, more or less, but again, it was through no existing system, but in spite of its absence.

In later August, on two weeks' notice, the new First Army had to be equipped for the St. Mihiel fight. This time, as I recall, between 1,000 and 1,500 "truck-tons" were sent forward. They were taken from the S. O. S., which was almost stripped for a time, and they were assembled in much the same way. The Motor Transport Corps organization in the S. O. S., where pooling was being developed, helped; but I believe most of the organizations were improvised.

These are important examples from the writer's personal experience at G. H. Q. The same sort of thing was happening all down the line. I give one example which is at hand, from an indorsement by a former chief of staff of the 1st Corps:

"Truck tonnage of the 1st Corps were never completely withdrawn from division and corps troops and assembled in pools, but all truck tonnage, including ammunition, engineer and all other trucks, except special service trucks (meaning repair, equipment, tank, telephone, etc.) was considered subject to call and at the disposition of G-1 of the Corps for use when, where and for whatever purpose needed. * * *

"We consider all trucks as cargo trucks for use where and for any purpose needed, whether originally assigned to an ammunition train or to a supply train. Wherever practicable the Nash Quad (ammunition body) trucks were used to haul ammunition, but road conditions ofttimes limited their use between Army and Corps dumps. It was found necessary to use cargo trucks indiscriminately; sometimes all were used to haul rations and more often all were put on ammunition. * * *

"The trucks of one division were frequently called upon to assist another division. The 'pooling principle' was in force inasmuch as all available transportation was at the disposition of G-1 of the Corps, and if sufficient transportation was not available the most urgent task was given priority."

If space allowed, such examples could be multiplied indefinitely.

5. The last reason mentioned as a cause of the breakdown of the theory of fixed assignment and individual operation is the matter of road control and operation of dense traffic. Our existing theory of combat-zone logistics took little account of traffic congestion, except as an acute occasional condition at critical points like cross-roads, to be handled by a strong-armed M. P. But in modern semi-mobile fighting, with densely packed armies and a huge demand for ammunition, and with a type of transport which must stay on the few good roads, general congestion is the rule. It is impossible to let any one who wishes inject a truck train into or across a main artery. You might as well allow hand-cars to ramble up and down a New York subway—better, for the handcars would meet their deserved fate, while the uncontrolled truck-train lives on and blocks traffic. Conditions on these rocade or axial roads, at such times, approximate to those on a railroad. As on a railroad, there must be a despatching system. The conception of the divisional train, under the absolute command of one of the various officers prescribed in F. S. R., going to and from distributing point on its own breaks down. Control of such trains, at least a limited control of their operation while on main roads, and control of all traffic on such roads, must be centralized; up to division headquarters, up to corps headquarters, sometimes up to army headquarters.

Fortunately, our first experience of an all-American army in a large fight was late in the war, at St. Mihiel. By that time we had learned much regarding centralized truck operation. In the two days following the fight, we learned a lot more, and had experience in untangling some very pretty road blockades. In the Argonne, the 1st Army had developed a workable road control scheme. I am not qualified to describe it. I believe that, roughly, G-1 prescribed traffic control, and G-4 co-ordinated truck movements, with some assistance from borrowed French C. R. A's (see below). But all this was improvised. It was not in the books, and not contemplated by the theory of fixed assignment and independent unit operation.

The above is an outline of how, everywhere, this theory was proven inadequate, and modified in improvised ways. Naturally, the General Staff turned its attention to developing a proper theory and system. It moved, *in general*, toward the French system; which it is accordingly desirable to describe.

French system of truck operation

We recognize a broad division of trucks according to use, into two classes, which may be called "combat transportation" and "supply transportation." (Terms descriptive, not technical.) The former is that directly attached to units of a brigade or less. It has three characteristics: the groups of trucks are small; their loads (combat equipment, etc.) are fixed, and their length of haul is about the same as a march of their units; and they must be with their units to make those units mobile.

The latter class, "supply transportation," includes trains of divisions and larger units. It has the following characteristics: The groups of trucks are large; their loads are widely variable (e. g., an ammunition train in rest-camp, and in a major offensive); also their length of haul, depending as it does on distance to railhead. And while needed for active fighting at "peak load," they are *not* needed in toto to make their units mobile.

The French agree with us that "combat transportation"

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—motorized field trains, technical trucks, etc.—must not be separated from its tactical units. But here the theories diverged. Ours, as stated above, was that the same applied to supply transportation; and we *assigned to divisions, etc., an irreducible amount roughly sufficient for peak-load,* to be operated wholly by such divisions. But the French are realists. They knew that they had not enough trucks to do this. They knew that if they could and did do it, the handing of the trucks under peak-load conditions by divided authority meant hopeless blocking of roads. And if these conditions could be met, the system would still not give the needed elasticity to enable them to handle large troop movements and ammunition for big attacks. So they assigned to divisions, etc., *an irreducible amount roughly sufficient for average load;* and organized the remainder into *operating truck units under G. H. Q., loaned where needed to handle p ak load.*

Such units were, however, loaned not as a man loans a typewriter, but as a railroad loans a freight car. The S. A.* said in effect to a field army: "Your divisions are going into battle. Your field trains and technical trucks are intact. But your divisional trains are adequate only for a quiet sector. You cannot move the necessary supplies and troops in this attack. Therefore we will move them for you. Notify our representative in your area of what you want moved, where it is, where it is to go and when. He has the trucks and will move it. But you must keep your hands off the trucks. Further, our representative is responsible for traffic control on certain critical roads in your sector. If you want to move *your* trucks on or across those roads, you must notify him, so that he can coordinate their movements with those of his trucks."

The "representative" mentioned was a C. R. A. ("Commission Regulatrice Automobile"). It had a headquarters, and a group of platoons or "cantons." When heavy fighting was due, a C. R. A. moved in behind the field army; was assigned a territorial area, and was given a group of the G. H. Q. reserve trucks. It had two functions. First, it received from the army or smaller units, calls for movement of men or supplies which the army with its permanent transportation could not handle, and ordered their movement, when and as requested, by its own trucks. Second, it handled road-control and despatching of *all* traffic, on critical roads (called "routes gardees") through its cantons, which were simply despatcher groups assigned to different parts of the C. R. A. area, with telephone communications. There were nine of these C. R. A. organizations, but they were shifted into different areas as necessary. The C. R. A's reported (through our intermediate channel) to the Director S. A. at G. H. Q. Traffic from one C. R. A. area to another was controlled from above, in a manner that need not be described.

This system as it stood was not applicable to American organization. But it is not true, as sometimes charged, that it failed the French; nor that they tested it only in "fixed" warfare. No defensive test could be severer than that of March, 1918, when the French had to cover and refuse their flank, rush troops from all parts of the line and close the gap behind the broken British Vth Army. On the offensive, the French in October and November had, I believe, about as heavy fighting as we in the Argonne; and being farther from the Allied pivot, they moved as fast, at times, as we ever did. Their truck system met both tests.

The Motor Transport Reserve

The project for an A. E. F. Motor Transport Reserve was an attempt to meet the demonstrated inadequacy of our theories of truck operation, by a system somewhat similar to the French. It was also intended to meet the demands of the Allied High Command, that the truck organization of each army be elastic enough so that trucks could be readily shifted between zones of operation, and so that truck groups of the various Allies could work together. The High Command here had especially in view the expected 1919 campaign, where major attacks in depth, over country without railroads, would make great demands on truck transportation.

Following a meeting of the Military Board of Allied Supply, the writer submitted a report recommending:

a. That divisional, corps and army amunition, supply and transport trains be reorganized into uniform operating units.

b. That they be divorced from rigid assignment to tactical units, and considered on paper as all part of a G. H. Q. Truck Reserve.

c. That a necessary minimum of such truck companies or trains be *attached* to divisions, etc., to handle average load, the remainder to be held behind the lines or loaned out when and as needed.

d. That a traffic-control system approximating the French be introduced.

Absolute control of Reserve trucks loaned for emergency, by C. R. A's or equivalent, was not contemplated.

These recommendations were approved in principle by the Commander-in-Chief. In September and October they were put into a working form, and covered in detail by a proposed order prepared by Lieut Col. L. D. Gasser. This differed from the basic proposal in that, for various reasons the ammunition trains were omitted from the reserve; which was drawn from divisional and other supply trains, but leaving part of the supply trains permanently with the divisions. It was to be organized, as an army reserve, in the 1st and 2d Armies. Traffic control was to be handled by Traffic-Control Officers in those armies, reporting to a similar officer at G. H. Q., along the French lines.

The order was approved, to go into effect November 15th. When the armistice occurred, the whole thing was dropped.

Truck pooling in the S. O. S.

The idea of centralized operation in the S. O. S. did not meet such opposition as in the case of the armies. It was sanctioned in May, 1918. The system developed was in principle that now existing in posts and camps in this country. "Supply transportation" was organized uniformly, and placed, by units, under M. T. C. officers throughout the S. O. S. These units received calls for transportation and handled them, just as a transfer company does for a customer. The M. T. officer had no say as to what was to be moved, where or when, but he had complete operating control of his trucks.

The system was organized simply and well. By insuring skilled mechanical supervision, it caused a great saving in operating and maintenance expense. In the last two months of fighting, when the armies made such demands, it enabled the S. O. S. to function on a surprisingly small allowance of trucks.

Conclusions

I think there is no question that truck pooling in camps and posts, as developed in the S. O. S. and now practiced in this country, is the most satisfactory system. The argument centers around the system in tactical units in war.

Any system of handling trucks in the combat zone must fulfil the following requirements:

(a) Divisions* must be mobile.

* "Service Automobile:" our M. T. C., with a dash of General Staff.

* Read "divisions, corps and army troops, etc."

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(b) Divisions must be capable of feeding and supplying themselves under average conditions (camp, quiet front).

(c) Divisions must be supplied for intensive fighting.

(d) The high command must have facilities for moving large bodies of troops by truck, and meeting emergency calls.

(e) Roads must be kept open.

(a) is met by requiring that motorized combat and technical vehicles and field trains ("combat transportation") be assigned to and operated by their units. This includes the old divisional engineer train, really a regimental combat train, and much of the old sanitary train. (b) is met by assigning permanently a small divisional supply (and ammunition) train. 250 truck tons for the old division of 27,000 men is a fair allowance.

All available trucks beyond this should be organized into uniform units, and carried on paper as a reserve of the high command. This reserve could function in two ways. It could be operated as a reserve, or units could be *attached* to divisions, etc., to be operated by the division or higher commander, just as additional artillery is attached for an emergency. A portion at least should be operated as a reserve, for troop movements (d), and to handle emergency calls.

How to dispose of the remainder to meet requirement (c), depends wholly on the situation, especially on the road conditions (requirement e), and available supply of trucks. To take one extreme, suppose a small army operating in northern Mexico, principally by scattered small units. There would be plenty of trucks in the country to supply it; there would be plenty of room, plenty of roads, all equally bad, and no question of traffic interference. Also, due to the distances, it would take a long time for the high command to reinforce a hard-pressed unit with trucks. Here it would be well to attach to divisions, above their allowance, lots of trucks, all they wanted, say for a division of 27,000, an additional 750 truck tons. The arrangement would work, and the only man to get grey hair would be the M. T. C. in charge of maintenance.

The other extreme is conditions in France. There was a shortage of trucks and always would have been; there were continual emergency calls for troop movement, etc. Excellent roads and a compact zone of operations made possible rapid reinforcement of trucks. And the enormous traffic behind active fronts required good road-control.

The solution here would be to create two or three great reserve parks, say fifty miles behind the line, and to attach to divisions, from these, above their fixed allowance, what the condition required. A division goes into a dead sector; loan it two extra truck companies. A division goes into a doubtful sector; loan it four, and move four more to 20 miles behind it (2 hours' run). A group of divisions is to start an offensive. Loan thirty companies to the army commander, to distribute as he wishes; shift another thirty to behind his front; and tighten up on road control.

A group of divisions, say, in a supposedly quiet sector and with the minimum of trucks, are attacked by surprise and driven back. Much is made, by advocates of the old scheme, of this situation; they point to the British disaster of March, where masses of combat equipment (guns, etc.), demobilized by previous withdrawal of trucks, were lost. But such trucks are *combat* transportation, which must never be detached. A division can pick up its material and run, if it has time, with no supply transport whatever. Extra trucks are needed for a retreat as follows: (1) to supply the artillery when it has fallen back to new positions; (2) perhaps to save infantry; (3) especially, to rush up reinforcements. (1) does not develop at once, in a surprise attack; the first phase is confused infantry fighting and guns firing from their old positions and dumps till they are driven back. It would certainly take eight hours to withdraw a mass of artillery and reorganize it for fire; in which time trains could be sent up from a reserve park fifty miles back. Need (2) does not develop at once, nor at all unless there is a disastrous rout. In such a case, organized trains brought up from the rear, under single command, will do a much better job in picking up masses of beaten men, than a medley of trains under independent command, already caught in the confusion of the retreat. As for need (3), the most important, it simply demands an organized reserve. Indeed, the greatest need for extra trucks in a retreat is not with the attacked troops, but precisely somewhere else.

For traffic control, there should be a transport officer at army or corps headquarters, under the supply and transport general staff (G-4). Under quiet conditions he would have little to do; ordinary divisional regulation and M. P.'s at cross-roads could handle things. When traffic became dense, he would take over critical roads. On them, nothing would run without his permission, and he would despatch and regulate traffic through despatchers strung along the roads.

He would not "own" and farm out truck reserve units attached to the armies. This part of the French system is over-systematized for the American mind. Units loaned from the reserve to armies and divisions would be operated by them, subject to road control. But such units are *simply* loaned for existing conditions; subject to reinforcement or recall as conditions change; permanently a part of a great uniform organization, under G. H. Q., and whose commander is responsible for training, administration and repair.

Such an arrangement, with no loss that I can see, gives an efficient and elastic organization. Under it, one could handle the everlasting necessary shifting of trucks, to meet varying conditions, as one shifts a regiment of infantry; not as one shifts three thousand unorganized men, scrabbled together from all sources. And this I believe to be the great lesson of truck operation given us in the late war. If we did not learn it, we are due for another schooling next time.

(Continued on Page 157)

Wind Maps for Aviators

In olden times, when the commerce of the world (such as there was of it), moved in sailing vessels, the wind was a very important factor. For ages mariners had no guide in the selection of their route of travel, except tradition and personal experience. To-day the winds of the sea are accurately known and charted, and the sailing master may select the most favorable route for travel. But the steamship proceeds direct to its destination, paying little attention to the wind.

With the advent of aerial navigation it became necessary to greatly extend our knowledge of air currents; to cover the land as well as the sea, and the upper strata as well as the surface of the earth. Wind charts, thus far of limited areas, are now being published for the use of aviators. As so great a choice of route is open to the aviator, he being able to detour either horizontally or vertically, these charts are of special value. They might indicate, for example, that it would be advantageous to the aeronaut to make his voyage out at one level, and his return trip at a different level.—*Geographical Review.*

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The Ice Problem in Canada

Extract from an Address by John Murphy, Electrical Engineer, Department of Railways and Canals, Dominion of Canada

With Comments and Explanation
By

Col. Chas. Keller
Corps of Engineers

FOR some twenty years, Mr. Murphy, in co-operation with Prof. Barnes, of McGill University, has been engaged in investigating the causes of ice formation and the possibility of devising practicable remedies to enable us to avoid the difficulties that result therefrom.

The principal part of the matter that follows is from the report of an address by him. It possesses considerable interest for all engineers having to do with power plants, locks or other structures, such as Taintor and other sluice gates in our northerly latitudes. His suggestion that it may be possible to keep a large stream from freezing is at least an interesting one.

The remedy for ice difficulties proposed by Mr. Murphy should be compared with that found to be effective at Keokuk as described in a recent article in this journal by U. S. Civil Engineer M. Meigs. It will be recalled that the leakage of compressed air kept the upper lock gate free from ice, and that this purely accidental result pointed the way to an easy remedy for ice troubles at the Keokuk lock, dam and power plant.

The report of Mr. Murphy's address is reproduced almost without change. It is needless to say that the field it covers is important to canal and river engineers and that the possibilities of remedial measures are worthy of careful study and field observation.

For the sake of clearness, "anchor" and "frazil" ice are defined as follows:

"Anchor" ice forms on the bottom usually at night or in dark, quiet places. It is in long needles. "Frazil" is the same as "slush" ice. It forms in flowing water as small crystals which gradually interlock or combine. These are fairly exact definitions, in discussing which Mr. Murphy writes the following:

The *agitation* of water, at the critical (freezing) temperature, causes it to crystallize—and the introduction into it of an ice-forming nucleus (anything below the freezing point) also starts crystallization. Each newly formed crystal, no matter how minute, also acts as a nucleus, and so the cumulative action in ice formation merrily proceeds when it is once started.

Rocks, on the beds of streams, which have lost their heat by radiation and against or around which water at the critical temperature is tossed (disturbed or agitated) are soon covered with "anchor ice," which remains clinging to those rocks and growing larger and larger in mass in two ways—namely, by self-propagation and by the adhesion to that mass of all floating particles of "frazil" which come within the grasp of it.

Frazil forms most abundantly at the surface, but it will form in any part of a stream when water, at the point or part in question, is at the critical temperature and when it is *agitated*. The agitation of surface water by the wind (or in rapids), the cooling action of the air, the prevention of the formation of sheet ice by such disturbances of the surface (which would, if quiet, soon be covered by sheet ice), and the self propagating faculty of frazil all combine to make the *surface of streams* the place where most frazil is created.

These feathery crystalline spicules are formed as the result of agitation; they *may* all be called "frazil" (and, by the way, they look something like the frazzled end of a rope); and when they have been attached to the beds of streams it is proper to call them "anchor ice." When "anchor ice" rises, after being loosened by heat from the sun, and when it is seen at the surface, it is usually found to be quite dirty in appearance (frazil is beautifully clean), because it has permeated throughout its mass the slime, etc., from the rocks upon which it grew.

Frazil, when floating at the surface, resembles sodden snow and is often called "slush." Until it accumulates into masses it will, however, like a fluffy feather in the air, follow the slightest current up or down in any direction.

Having made the nature of these two kinds of ice fairly clear, we may now proceed understandingly to his principal statements regarding them, which follow:

The ice problems of Canada can be divided into two different classes. The first has reference to the operation of hydraulic apparatus and the necessity of keeping this free from ice. The second is the necessity of preventing the blockading of streams by ice which in this country causes an immense amount of damage by flooding the surrounding country every year.

For a great many years past it has been the objective to discover adequate methods of preventing the shutting down of hydraulic apparatus by frazil ice. We have succeeded in effecting this by the introduction of a small amount of heat so as to keep the machinery one thousandth part of a degree above the freezing point. When this temperature was maintained it was found that frazil ice in the stream would not cling to the machinery, but would pass right through.

We have now stepped into the bold undertaking of discovering a method of keeping great streams, such as the St. Lawrence River, open in the winter time and preventing them from getting choked with ice and causing floods.

Mr. Murphy presents many figures to prove his contention that it is a small matter after all to keep any stream open.

The average flow of the St. Lawrence past a given point is 250,000 cubic feet a second. The winter flow is 200,000 cubic feet a second. In about 50 ice-forming days during the past severe winter only 2 feet of ice had formed in a 3,000-foot stretch across the river. As there are 4,320,000 seconds in 50 days, in the time that 2 feet of ice has been forming over 864,000,000,000 cubic feet of water pass down the stream. Only 6,000 cubic feet of ice had formed, or in other words, only one one-hundred and forty-four millionth part of the water passing down the stream had been frozen. Up to the present time this question had been looked upon as a task of preventing *all the water* in the St. Lawrence River from freezing, whereas the real problem was to keep the small fraction mentioned above from freezing. When looked at in that light, it is found not such an impossible task after all.

It is well known that a stream freezes from the banks out towards the center, but the reasons for this have never been discussed up to the present. The solution of this is that the molecules of water near the edge of the stream are

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continually being rolled about, and in that manner the heat is taken away from them and given up to the shore.

Mr. Murphy showed pictures of dams clogged with frazil ice and racks of power houses, which, because the spaces in them were generally too small, caught the frazil ice and thus became clogged, causing a shut-down, which might have been avoided if the ice had been able to pass through.

Some of the most interesting of the views were diagrams to show the method of introducing the required heat to prevent a power plant from freezing and shutting down. At one particular plant there were sometimes ten shut-downs a year through ice. During these times the load was taken over by an auxiliary steam plant, which used 150 tons of coal a day. The capacity of the plant was 3,000 h. p. The hydraulic engineer, when approached on the prevention of these shut-downs, treated it as a matter of warming all the water passing through, and gave figures to show that energy to the amount of 147,000 h. p. would be required to keep a 3,000 h. p. plant open. Mr. Murphy, however, told him that he was looking at it in the wrong light, as the *machinery* should be kept above the freezing point and *not the water* passing through. In the end he succeeded in getting the machinery heated by steam from a small boiler, using one ton of coal a day, which had the effect of doing the same work that required 150 tons when a shut-down occurred.

Another interesting illustration was a bottle of water just at the freezing point, which was taken into a warm room. Although the outside temperature was warm, it was found the water could be turned to ice quite easily by dropping a nut on the end of a piece of string into it and causing friction. The temperature of the room at the time was 70 degrees. By means of a microscope the small particles of ice were shown in process of formation, and it was clearly demonstrated that the ice formed in the first place on the string and nut, but that once ice had started to form, the action was accelerated by the little particles of ice themselves which rose to the top when detached from the string by friction and became the nucleus of other ice formation. Anchor ice was shown at the bottom of the bottle, where it was firmly lodged.

The final picture was that of a stream where an ice company had harvested its ice supply for years. One year no ice formed on that side of the river, although there was ice to a thickness of 2 feet on the other side. On investigation it was found that a cement mill, which had been built during the summer, poured condensing water into the stream at the rate of 8 cubic feet a second. It was found that this small quantity prevented the water from freezing for a mile and three-quarters down the stream. In litigation, which lasted over five years, the ice company secured heavy damages and an injunction restraining the cement company from ever again preventing the freezing of the stream.

Building the Earth Dams of the Bridgewater Project

The new Bridgewater reservoir for the Western Carolina Power Co. is formed by three dams, called the Catawba, Paddy Creek and Linville dams. Of these the Catawba has a gravity concrete section crossing the river, but the remainder of that dam and all of the other two are earth fills, built by hydraulic sluicing of earth brought in by trains from nearby borrow pits and deposited along the outer edges of the dam from timber trestles.

The three earth fills are of approximately the same design, with a 20-foot top, upstream slopes of 1 on 3, and downstream slopes of 1 on 2½, with a central bottom trench and a downstream low rock fill toe wall. Catawba is 120 feet high and contains about 1,820,000 cubic yards, Paddy Creek 165 feet maximum height with 1,450,000 cubic yards, and Linville 160 feet high with 1,250,000 cubic yards total fill. They were located within 2½ miles of each other, and the material used in building them was of essentially the same nature and composition.

Before the construction of any of the earth dams could be commenced it was necessary to unwater the dam sites, to strip the ground to be covered from all vegetable matter, to excavate a trench along the center line of each dam down to a surface of hard and impervious material and to construct a rock fill toe on the downstream side of the earth fills. While this work was going on suitable borrow pits were located, containing the material used in the construction of the fills, consisting in general of disintegrated gneiss and mica schist, sand and clay intermixed with small stones. The materials from the various borrow-pits were loaded by steam shovels into side-dump cars, made up into trains and transported by locomotives to the timber trestles, the first set of which was built along and inside the upstream and downstream toelines of each dam. From these trestles the materials were dumped, and after the two dykes thus created had reached the required size, the trench excavated along the center of the dam was filled with water.

Two scows equipped with pumping plants capable of delivering 1,000 gallons of water per minute at each 2-inch nozzle of the sluicing monitors, were then floated in the pool formed between the two dikes. After the second set of trestles was built, the inner portion of the fill materials side-dumped from these trestles, was mixed with water and washed down by use of the monitors, the result being that the finer materials settled in the center of the dam. As soon as beaches began to form the surface of the pool was raised by pumping in additional water.

Both dykes of a pair were advanced at the same rate by frequent throwing of the tracks toward the center of the dam; it was, however, not permitted to dump materials which would fall inside the limits of the middle-third zone before being treated with water. In general, trestles of 20-foot height were used, and with the exception of the stringers the trestle timbers were not removed. When the earth fill was above the spillway crest, the hydraulic sluicing was discontinued and the selected material dumped in the small pool between the two dikes. Above the highwater level of the reservoir the pool was discontinued and the dam finished to the specified height, allowing for shrinkage of the earth fill. The grading of the side slopes was done by teams and drag scrapers. Stone riprap was placed on the water slope of the dam, and the downstream slope was planted with grass.—*Eng. News-Record.*

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Air Temperatures in the New York-New Jersey Vehicular Tunnels

By

Harry L. Van Zile
Major, Engineer Reserve Corps

THE vehicular tunnel now being constructed between New York City and Jersey City, New Jersey, presents many new problems, the solution of which will be carefully watched by engineers and all those interested in attempts to increase the traffic facilities for large centers of population.

New York and New Jersey will jointly bear the cost of building and equipping this tunnel, and therefore every effort has been made by the legislatures of these states to have experts on tunnel construction and traffic movement make intensive studies of all of the elements entering into this project.

The Chief Engineer of the New York State Bridge and Tunnel Commission has had available a board of eminent consulting engineers, and it is therefore proper to assume that the pioneer construction of a tunnel for vehicular traffic will not prove to be defective in any important feature.

The Chief Engineer has published a remarkably complete report of his analysis and findings dealing with all of the matters which enter into the location, size and construction of the tunnel. From this report it is learned that there are to be two tubes, each of 29 feet external and 25 feet 6 inches internal diameter, with roadways of a width of 20 feet. The traffic will be in two lines from New York to New Jersey in one tube and two lines in the opposite direction in the other tube.

The total length of this tunnel will be 8,500 feet, and the length between ventilating shafts 3,800 feet. The maximum traffic for one hour in one direction is figured to be 1,900 vehicles if they are all motor driven. On this maximum traffic limit and the average to be reached per day of 24 hours the income from tolls is figured to be sufficient in twenty years to pay the amortized cost of construction after deducting the cost of administration, maintenance and operation.

This result being important to the tax-payers of these two states, much scrutiny has been given to the published report, as anything which would interfere with the amount of traffic obtainable would delay the amortization of the construction cost.

The public will undoubtedly welcome any new traffic route between New York and New Jersey, and thousands of tons of goods will be sent through this tunnel in each direction. One fundamental requirement, however, must be fulfilled, and that is the journey must be safe and not notoriously uncomfortable to the drivers of the trucks.

There will be no question about the safety of the tunnel itself, but the condition of the air must be such that men breathing it, either for short or long periods, will not absorb excessive amounts of noxious or harmful gases or suffer from excessively high temperatures.

Many of the readers of THE MILITARY ENGINEER no doubt recall the discussion some years ago relating to the quality and temperature of the air in the then recently constructed New York City subways.

The public became so insistent in its demands for the remedying of conditions in the subways that the engineers were forced to make an exhaustive examination of the air at various points and even installed some power-driven exhaust fans, which proved to be ineffective. The published report of the subway engineers showed that the quality of the air in the subway was equal to that of the outside air, and that the real trouble was excessive temperature during the summer months.

The report states that during the summer of 1905 the temperature of the subway between 50th and 59th Streets was 5.6° F. above that of the outside air, but that in 1915, with the recently installed ventilating louvres closed, the excess temperature in the subway at the same points was 16.76° F. This increase, the report states, was due to the increase in the number of trains passing through this portion of the tunnel. This is explained by the following statement taken from the engineers' report:

> This energy is transmitted to the subway, is there utilized in moving and lighting the trains, lighting the stations and performing other useful work, the energy thus utilized being reconverted into the form of heat, which must be dissipated by convection of air currents or by conduction through the walls, roof and floor of the subway to the surrounding earth and neighboring subsurface structure. The amount of energy, and, consequently, the amount of heat units, varies directly as the number of trains and as the number of cars per train.

It would seem, therefore, that the examination of the probable condition of the air in the vehicular tunnel during the maximum hourly traffic in the summer months may lead to some interesting conclusions.

This vehicular tunnel will operate under very different conditions than the subway tunnels, as the continuous line of motor vehicles, burning gasoline or other combustible fuels, will be expelling gases that are either non-supporters of life or actually harmful to the health, and further than this, all of the heat from such combustion will be contained in the tunnel except such a comparatively small amount as will be radiated through the concrete sides to the surrounding water.

To determine the temperature condition of the air the following calculations are made:

Length of tunnel between ventilating shafts ft.	3,800
Net cross-section area between roadway and ceiling sq. ft.	318
Net air content between ventilating shafts cu. ft.	1,208,400
Weight of air content at 70° F. lbs.	90,571
Heat necessary to raise this amount of air 1° F. B. T. U.	21,511
Maximum motor vehicles per hour	1,900
Maximum vehicle miles per hour for 3,800 ft. (0.72 mi.)	1,368
Gasoline per hour at 6 miles per gallon lbs.	1,368
Heat units developed at 19,000 B. T. U. per pound	25,992,000

If the air in the tunnel is not changed for one hour, and

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it requires 21,511 B. T. U. to raise its temperature 1° F., the development of 25,992,000 B. T. U. in the tunnel will raise the temperature 1,208° F.

The ventilating system proposed is of sufficient size to fill the tunnel with air thirty-two times per hour, or dividing 1,208 by 32 it is found that such an amount of air will be heated 37¾ degrees above its entering temperature. The changing of the air thirty-two times an hour is believed by the chief engineer to afford sufficient dilution to protect the occupants of the tunnel from any harm due to the carbon monoxide given off from the gasoline-burning vehicles.

It may be thought by some that the heat contained in a pound of gasoline, estimated at 19,000 B. T. U., should not be considered as completely liberated in the tunnel, but unless the gasoline is practically all burned there will be an excess amount of carbon monoxide which would have a disastrous effect on the people in the tube.

The allowance of 6 miles per gallon of gasoline for all makes and kinds of trucks and automobiles may be more or less than the actual distance covered, but it is thought that the assumption is near enough to warrant the conclusion that some further provision must be made for ventilating this tunnel.

Either the maximum traffic expected will not be reached in the warm months of the year or a provision for possibly four times the amount of air delivered will be needed. As this would require 64 times the amount of power provided for at present, such an increase becomes a serious matter.

If the traffic does not approximate the amount figured, the tunnel cannot be paid for in twenty years. If the ventilating system has to be enormously increased, further amounts must be spent for equipment and operating, which will also delay the amortization period. Manifestly the problem is a serious and important one.

Dredging Tests on Dredge "Raritan"

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by using one pump at a time, the pump in use discharging into both bins.

Locality and material.	Cubic yards per minute dredged.
New pump, 24-inch suction.	
Red Hook Channel; mud about 15 per cent sand	3.80
Bay Ridge Channel; fine hard sand about 10 per cent mud	5.82
Ambrose Channel; coarse sand	10.65
Buttermilk Channel; mud and debris	4.92
New pump, 20-inch suction.	
Red Hook Channel; mud about 15 per cent sand	3.06
Bay Ridge Channel; fine hard sand about 10 per cent mud	3.98
Ambrose Channel; coarse sand	9.30
Old pump, 24-inch suction.	
Red Hook Channel; mud about 15 per cent sand	3.58
Bay Ridge Channel; fine hard sand about 10 per cent mud	5.10
Ambrose Channel; coarse sand	9.12
Old pump, 20-inch suction.	
Red Hook Channel; mud about 15 per cent sand	4.14
Bay Ridge Channel; fine hard sand about 10 per cent mud	4.91
Ambrose Channel; coarse sand	9.23
Buttermilk Channel; mud and debris	4.37

During April, 1916, one of the discharge pipes on each pump was closed so that one pump would discharge into the forward bin while the other pump was discharging simultaneously into the after bin. Eleven loads were dredged with this arrangement, three of the loads being obtained while the 24-inch suction pipe was attached to the new pump and eight of the loads while using a 20-inch suction pipe on the new pump and the 24-inch suction pipe on the old pump.

Near the end of April, 1916, all tests were suspended and were not resumed until January, 1920. During the 1920 tests a 20-inch suction pipe was used with each pump. The new pump discharged into the forward bin and the old pump discharged into the after bin. The results of these tests are shown in the following table:

Tests on Dredge *Raritan*, April, 1916, and January, 1920. Loads obtained by discharging entire output of one pump into forward bin while entire output of other pump was simultaneously discharged into after bin.

		Cubic yards per minute dredged.	
April, 1916. (Day)	Locality and materials.	New pump 24-inch suction.	Old pump 20-inch suction.
10	Ambrose Channel; coarse sand	9.54	7.35
10	Bay Ridge Channel; fine hard sand	6.10	5.26
11	Opposite Robins Reef; mud	4.19	3.47
		New pump 20-inch suction.	Old pump 24-inch suction.
17	Ambrose Channel; coarse sand	5 84	7.18
18	----do	6.79	8.33
15	Bay Ridge Channel; fine hard sand	4.67	4.37
17	----do	4.63	4.80
25	----do	4.78	4.94
24	Opposite Robins Reef; mud	4 97	5 19
25	Gedney Channel; coarse sand	12.28	13.02
Jan., 1920. (Day)		New pump 20-inch suction.	Old pump 20-inch suction.
5	Battery to Canal Street—70 per cent ash and cinder, 30 per cent mud, sand, etc	6.05	5.32
12	----do	9.22	4.92
19	----do	8.55	5.40
21	----do	10.85	7.22
6	Edgewater Channel; soft clayey mud	5.47	4.68
15	----do	5.28	2.82
16	----do	6.85	3.82
21	Gedney Channel; coarse sand	14.07	7.75
22	----do	16.90	9.03

During the 1920 tests, the indicated horsepower of the engine driving the new pump was about 7 per cent greater than that of the engine driving the old pump.

The results given above show practically that the use of a higher efficiency pump on the dredges operated by the Engineer Department will ordinarily result in an increase in output. In the case in question, the new pump has been found to be more durable than the old pump, which is a further advantage.

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The Introduction of Mechanical Warfare on Land

And its Possibilities in the Future

Abstract of a Lecture delivered

By

Col. J. F. C. Fuller, D. S. O.

(From The Royal Engineers Journal)

Opposition to the Coach.—In 1565 it is recorded that the first coach constructed in England was built for the Earl of Rutland, but on account of the execrable condition of the roads of this period and the dangers of the highways, it was not until 1669 that systematic journeys were attempted in England and then only between Oxford and London.

Coaching was a novelty and, like every rational and profitable novelty, before or since, its progress met with strong opposition. Early in the seventeenth century a Bill was brought before Parliament 'to prevent the effeminacy of men riding in coaches;" and in 1671, Sir Henry Herbert, M. P., stated that—"if a man were to propose to convey us regularly to Edinburgh in coaches in seven days, and bring us back in seven more, should we not vote him to Bedlam." Nevertheless the coach had come to stay, for its time, and on October 13, 1712, a weekly service was instituted between London and Edinburgh. The journey was made i thirteen days.

Opposition to the Locomotive.—In 1641, that is twenty-eight years before the first coaching service was instituted in England, the Marquis of Worcester, famous as the inventor of an early steam engine, went to see Solomon de Caus in a madhouse in Paris. Marion de Lorme wrote of this visit as follows:

"We were crossing the court, and I, more dead than alive with fright, kept close to my companion's side, when a frightful face appeared behind some immense bars, and a hoarse voice exclaimed: 'I am not mad! I am not mad! I have made a discovery that would enrich the country that adopted it.' 'What has he discovered?' asked our guide. 'Oh!' answered the keeper, shrugging his shoulders, 'something trifling enough; you would never guess it; it is the use of the steam of boiling water.'" Why was Solomon de Caus there? To keep his brain from mischief; he had actually suggested that carriages and ships could be propelled by steam!

In 1769, James Watt invented the first practical steam engine. He also was considered mad, but fortunately for posterity he was not locked up. In 1804 a locomotive guided by rails attained the speed of five miles an hour at Merthyr Tydvil, and ten years later George Stephenson, financed by Lord Ravensworth, to whom was originally applied the adage—"A fool and his money are soon parted," began work on the Killingworth Railway. He met with immediate obstruction, Lord Eldon saying, "I am sorry to find the intelligent people of the North country gone mad on the subject of railways."

Once the locomotive began to crawl, the sluice gates of abuse were opened, and its inventor met with obstruction at every turn. A meeting of Manchester ministers denounced the railway as being "contrary" to the law of God. Lord Derby drove the railway surveyors off his land, and Stephenson had to hire a prizefighter to carry his theodolite in order to prevent it being smashed to pieces. Pamphlets were written and newspapers hired to revile his work. I was declared that the railway would prevent cows grazing, hens laying, and would cause ladies to give premature birth to children at "sight of these things going forward at the rate of four and a half miles an hour."

Parliament supported the reactionaries; birds would be killed by the smoke, foxes would become extinct; horses would be useless and oats and hay unsaleable; country inns would be ruined; boilers would burst and blow passengers sky high, and finally, "the weight of the locomotive would prevent it moving."

The Committee of the House of Commons assembled on March 21, 1825, and the opposing counsel addressed these words to the great inventor:

"Suppose, now, one of these engines to be going along a railroad at the rate of nine or even ten miles an hour, and that a cow was to stray upon the line and get in the way of the engine; would not that, think you," asked the barrister, "be a very awkward circumstance?"

"Yes," replied George Stephenson, with his face in a humorous pucker, "very awkward indeed—*for the coo!*"

In 1914 was the tank conceived; in 1915 was it built; in 1916 was it first made use of; in 1917 did it fight for its existence, and in 1918, I go so far as to say, that without its existence we should not that year have won the war. In 1919, an experimental machine attained a speed of 20 miles an hour; and now, in 1920, is it still struggling against difficulties, for prejudice to things new dies hard and vested interest is a powerful adversary.

Whatever the tank has accomplished, it is still far from perfect, it is still in the Puffing Billy stage of 1822; Puffing Billy, which George Stephenson was wont to drive close by his brother's house and concerning which, when i stuck fast at a curve, he would shout out to his wife, "Hey! Jean, come oot, and gie us a shove around the turn!" Twenty years later we read, "On Saturday last the Leeds Express, formerly called the 'Sleepy Leeds,' which has been on the road upwards of a hundred years, ceased running it being no longer a profitable speculation."

The coach was dead, the railway had come into its own, a new and stupendous world was born, and through mechanicalizing civil movement, by replacing the horse by the steam engine, civilization has advanced more rapidly

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during the last eighty years than she had advanced during the preceding eight thousand.

Here then is the gist of my lecture. What the locomotive has done for civilization will the internal combustion engine do for war. It opens up before us a new world of warfare stupendous in its possibilities. Let us inquire into it, an do not let us fall into a frenzy because possibly rifles and swords, bayonets and lances, horses and limbers may disappear, for even if they do, we may be perfectly sure that things more efficient will replace them.

Opposition to the Rifle.—I will now turn for a few minutes to what I will call the coaching period in the history of war, chiefly in order to obtain a background whereon to throw into relief the future tendencies of mechanical warfare.

In the 15th century gunpowder was considered useful for frightening horses, a century long argument then followed, concerning the bow and the musket, and many arguments were launched for the retention of the bow. The bow has, however, vanished, but not without a struggle, for as late as 1797 a certain Mr. Mason once again proposed to equip British infantry with it.

In 1742, Benjamin Robins in his "New Principles of Gunnery," made a remarkable prophecy as to the eventual adoption of the rifle, which, however, did not take place until a hundred years after his day; he says:

" . . . whatever State shall thoroughly comprehend the nature and advantage of rifled-barrel pieces, and having facilitated and completed their construction, shall introduce into their armies their general use, with a dexterity in the management of them, will by this means acquire a superiority which will almost equal anything that has been done at any time by the particular excellence of any one kind of arms, and will perhaps fall but little short of the wonderful effect which historians relate to have been formerly produced by the first invention of firearms."

1780, Major Patrick Ferguson invented a breech-loading rifle. He paid for its manufacture out of his own pocket and equipped his men with it so that they might meet, on equal terms, the American backwoodsmen. He then, unfortunately, went sick and Lord Cornwallis, the Commander in Chief, had the rifles withdrawn and destroyed.

In 1824 the British Government refused to accept Captain Norton's cylindro-conoidal bullet. It was reproduced by Captain Minie, of the French Army, in 1849. The Minie rifle became the weapon of the day, nevertheless, Sir William Napier strenuously opposed it, as in his opinion, it would destroy the infantry spirit by turning infantry into what he called "long-range assassins."

In 1858, Greener declared the "time and ingenuity spent in planning and constructing breech-loading cannon will always end in disappointment and failure," and again, that "striving to produce perfect breech-loading cannon is like striving to square the circle." Consequently the British Army did not permanently receive such a weapon until 1886. Even as late as 1895, when the *Victoria* went down with Admiral Tryon, some of her guns were still muzzle loaders.

In spite of opposition, the breech-loading rifle and field gun, which I will call the "military coach," for both depended on muscular movement, came into their own.

Phantom Wars.—In August, 1914, the finest muscularly organized body of troops ever raised by Great Britain left her shores. I was fortunate enough to see them all, and I can frankly say that in all my life I have never seen such a perfect force of men and horses as those which sailed for Zeebrugge and Ostend. The Duke of Teck himself told me that he had not a horse in his regiment under the value of 200 guineas. A fortnight later the 7th Division had almost ceased to exist. What had happened?

Many things, amongst which was one, to my mind the most important, which for long remained obscure. The war we had prepared for was a phantom, a will o' the wisp, which literally led us off the highway of progress into a "slough of despond."

What had we failed to realize? We had not realized this—that an Army to prosper must be based on the civil sciences, that an Army must keep pace with the progress of industry, and that an Army which does not do so is but a phantom force for war.

Irresistible Science.—Since 1842, when the "Sleepy Leeds" had run her last journey on the great north road, what had been happening in civil life? A mechanical evolution so rapid that no revolution in the whole world's history can compare to it. Every day brought to birth some new invention, every hour civilization gathered greater speed; epochs crumbled away, epochs sprang up in the night, science was sweeping brute force off the face of the earth, and was replacing muscle by mechanical energy.

In 1885, Gottlieb Daimler designed the first practical internal combustion motor. In 1896 the first motor car in England ran from London to Cambridge preceded by a man carrying a red flag. Parliamentary opposition was revived, humanity could not live with the road car, the roads would become unsafe, children would be run over, dogs and fowls exterminated, and carts overturned. The country gentleman got his back up, but the Rolls-Royce soon got it down.

In 1770 the first patent for a footed wheel was registered; in 1888 an agricultural tractor, almost the future tank, was designed; in 1907 a motor car on tracks attained the speed of 20 miles the hour on firm sand. In 1909, at the first flying machine meeting held at Rheims, General Grierson, an able soldier, watching an aeroplane, turned to General Stone and said: "I say, Stone, do you really think there is anything in it?" and General Stone's comment on this remark is worth recording: "That is only ten years ago, and it is a very striking fact that such a very short time ago as that some of the best brains in the Army thought that anybody who took up flying seriously was a little bit 'gone in the head.' I speak of what I know."

It is indeed easy to be wise after the event, but surely it is better to be thus wise than never to be wise at all. In 1914 the armies of Europe marched forth to fight Worth, Gravelotte, and Sedan over again; forty-four years of scientific progress had been neglected, and the bill—10,000,000 men killed and over £60,000,000,000 expended.

The Nature of the Great War.—Let us turn for a few minutes to the nature of the Great War. One of its most remarkable features was that it resembled the battle of Marathon (B. C. 490), for the greater portion of its duration the battle had no flanks. Why? Because the enormous size of armies enabled battle fronts of upwards of 500 miles to be held in strength, entrenched and wired. What had rendered this possible? The locomotive, the railway, and the steamship, the great mechanical movers of civil life. Soldiers had not considered them very deeply, then, when war was declared, they, like great funnels, poured forth men in cataracts. Immense tracts of country were inundated and for over three years, on the Western Front, armies lay opposite each other in stagnating puddles and slowly evaporated away.

We see a strange sight—millions of men facing each other, millions of men, the subsistence of which, prior to

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battle, depended on every yard of rail and road behind them being utilized to the full. Lorries and locomotives worked day and night to supply this enormous muscular mass, to pile up the military coaches which, from time to time, were launched from their mechanical base into battle areas devoid of railways and all but devoid of roads. What do we then see? We see strings of pack mules and thousands of human carriers wallowing through the mud: in a single day the administrative needs of the Army have increased tenfold and the means of supplying these needs has retrogressed by several thousand years. This brings us to our first main problem in mechanical warfare, the problem of road capacity.

Road Capacity.—In August, 1915, a meter-gauge railway ran from Gezaincourt to Albert, and I suggested to an officer, quite an able man, that if a certain British Corps made use of it considerable economies could be effected. His answer was: "It can't be done, for if we use this railway we shall disorganize the whole of our lorry service!"

In the eighteenth century the squire who brought his wife to London sitting behind him on his cob, objected to the stage coach. In the nineteenth century he had accepted the stage coach and objected to the locomotive. In the twentieth he accepted the locomotive and fell foul of the motor car. And so, in 1915, we find an able officer objecting to the light railway. Why? Because of what I will call congenital prejudice, which can only see the means and not the end, and which, having made a hobby of the means, refuses to see the end.

In 1914 a few score of lorries formed the mechanical equipment of the British Army. In 1917 they had grown in number to about fifty thousand, hundreds of miles of new railways and thousands of miles of tramways covered the British fronts. For three years we had been fighting for road capacity, and behind our front line we had attained it, but in advance of it, it ceased to exist. Armies became like caged animals, they could move about in their own prisons at will and in perfect safety, but to escape from them was next to impossible.

I will take a few examples to illustrate this and will select them out of the events of the last year of the war, during which the bars of the cages had become somewhat more elastic.

(1) In March, 1918, the Germans advanced some 40 miles in 14 days and were then forced to halt. It was apparent that it was not the British Army which caused this halt, but the weakness of the German Army, due to the "Petering out" of its supply system. Road capacity in the Somme area was limited; want of road capacity, which might well have been foreseen, completely wrecked the last chance the Germans had of winning the war.

(2) In May, 1918, the Germans gained another overwhelming victory, this time over the French, the result of which was an advance of 30 miles in 4 days, and the formation of the Chateau Thierry Salient. As long as Soissons remained under gun fire and Rheims held out, road capacity, from the railway point of view, was to all intents and purposes non-existent. To remain in this salient without road capacity was to commit suicide. This is exactly what the Germans did.

(3) In August, 1918, we attacked eastwards of Amiens; behind us was an efficient railway system, in front of us good roads, which, during the battle, were never much damaged; nevertheless, our initial success, which was stupendous, rapidly "Petered out" after the first day's fighting. This was due to several reasons, one being the difficulty of maintaining the energy of the battle by supply, in other words, "road capacity" was insufficient to enable us to continue the advance, and would have been more difficult still had we attempted to force our way across the old Somme battlefield.

The lesson to be learnt from all this fighting, and probably the most important lesson to be learnt from the whole war, is "That the chances of victory or defeat are multiplied directly by any increase or decrease of road capacity in an area of operations, and that unless this road capacity be equal to the supply requirements of the attack, either the attackers must eventually die of starvation or the attack must be abandoned."

This problem may be viewed under two main headings:

(1) Means of cutting down the necessity of supply.
(2) Means of increasing the transportation of supply.

I do not intend to discuss the first beyond saying that the quicker an army can move, the less supplies, in the long run, will it require. As regards the second, it may be viewed under four subsidiary headings:

(*a*) Concentration of traffic.
(*b*) Additional road space.
(*c*) Additional roads.
(*d*) Dispensing with roads.

The first is gained by increasing the tonnage per road mile. The second by constructing vehicles which will move alongside a road over plough and grass land. The third by making use of badly metalled roads or by building new ones. The fourth by cross-country traction which will enable all normal country, plough and grass land, desert and scrub, to be crossed as easily as a lorry today will move along an average road.

Can such a machine be obtained? It can!

The Administrative Link.—What will the cross-country lorry accomplish? It will mechanically link up the strategical base of operation, which consists of a network of railways, with the battlefield itself. No longer will there occur that terrible hiatus between railheads and battle dumps. You won't dump, but you will move. As the battle starts, so will it be continued, there will no longer be an exchange of supply horses in midstream. Right through the Great War this problem remained all but unrealized, and only towards the end was any notice taken of it, and yet on its solution depended the dividend of every attack.

Often was the question asked: "What happens when a penetration has been effected?" The answer is: "Push up supplies"—supplies of men, weapons, munitions, and food; the side which can do this the most quickly is the side which is most likely to win.

The Tactical Link.—Given a mechanical strategical base and a mechanical supply system, logically, the next link to forge is a mechanical tactical striking force. In other words, to cease hauling up to the front innumerable military coaches by means of mechanical power, as the old four-decker sailing ships were towed into position opposite Sebastopol and towed away again after an engagement, but instead to replace the coach by a military motor car and so render the whole army from start to finish a mechanical one.

The necessity of this was realized early in the war by a few farseeing men, and the result was the tank—a cross-country battery which, protected by armour, was enabled to make use of protected mobility for offensive ends.

The idea of protected mobility caused much mirth; one noted officer requested Colonel Swinton to abandon his "flights of imagination and come down to solid facts;" another, when he was informed that his troops were to be led

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by tanks through the Cambrai wire, exclaimed, "fantastic! fantastic!" The press correspondents filled the newspapers with "slimy monsters and Gargantuan toads," but what was worse, a passive and effective barrier of obstructions was raised against all efforts of the Tank Corps to expand.

A bad second to the obstructor was the amateur enthusiast, who, knowing nothing about tanks, expected them to perform miracles.

I am not going to plan for you a mechanical army, nor picture to you some imaginary Armageddon of 40 years hence. In place I am going to glance at our present military problem and point out to you how cross-country traction will help us to solve it.

If I can walk from Chatham to London, a distance of thirty-five miles, in twelve hours and you can motor t London in two hours, when reducing space to terms of time you will find that you have decreased the area to one-sixth of the size it appears to be to me. [The Colonel means one thirty-sixth.—Ed.]

A moment's thought will enable you to realize how cross-country traction can decrease the area of the combat zone.

As regards the machine required, it must be adapted to the nature of the country in which it may be used. The great, lumbering tank, suitable for flat country, must be supplemented by a lighter machine which will serve for the protection of supply columns in hill warfare and which will have the large radius of action necessary in desert warfare. A light, cross-country chassis which can be fitted with either a lorry body, an armoured car body, or a tank body and which, as a lorry, can carry either five tons of supplies or water, or a field gun and 200 rounds, is the type of machine I think we require for this purpose. Its cost complete would probably be well under £3,000.

Co-operation with the Navy.—Some years ago Sir Edward Grey made use of the following pregnant phrase: "The British Army should be a projectile to be fired by the British Navy." If we consider for a moment the meaning of these words we shall realize what an enormous economy could be effected in our small wars if it were literally possible to shoot armies on to coast lines when punitive expeditions become necessary.

There is only one real difficulty in a combined naval and military operation—namely, ships cannot swim out of the sea and walk on land. Because of this inability parties of soldiers have to be landed in lighters, rowing boats, pinnaces, barges, motor boats, and what nots, and in half an hour the beach is like Epsom Downs on a Derby morning.

It is the old difficulty of launching military coaches from a mechanical base, steamships in the present case replacing railways. If now, instead, from these ships floatable tanks and tractors be launched into the sea two miles from the coast line and are able to propel themselves ashore and crawl up the beach and move straight inland, confusion can be replaced by simplicity and surprise. It is so simple that people will not see it, and I have been voted to Bedlam on several occasions for suggesting it, but I am not there yet. In a couple of years from today, I see no reason why such a mechanical force should not operate 1,000 miles from its naval base even in desert land.

Co-operation with the Air Force.—Punitive expeditions may, however, be required at greater distances than 1,000 miles from a naval base, how are we then to proceed? As from our battleships we launched our tanks and tractors, so from these should we now launch our aeroplanes, which should have no difficulty in extending our military influence over another 1,000 miles, that is 2,000 miles in all from the sea coast. The tanks will protect the landing grounds of the aeroplanes and the aeroplanes will carry supplies for the tanks.

Though I do not want once again to be voted to Bedlam or to share the fate of Solomon de Caus, nevertheless, as ships can carry tanks and tractors, I see no insuperable difficulty in aeroplanes doing the same, for machines weighing not more than 6 tons. Recently I have read a prophetic account of the next war written by a Belgian. He suggests carrying half a million men through the air. But why carry men? For at best we shall be depositing but military saddle horses (not even coaches) in our enemy's country. The "Sleepy Leeds" ceased to run because it was "no longer a profitable speculation." Masses of men do not pay, a few efficient machines do. If your strategy is based on mechanical power so must your supply system be and so must your tactics. This brings us to yet one more consideration.

Conclusion.—The soldier of the present must cease thinking purely in terms of land operations, for he must think in terms of sea and air warfare as well. Today, warfare at sea and in the air is purely mechanical, on land it is still nine-tenths muscular. We cannot get unity of action until we have instituted unity of movement, in other words, until our present muscular army has become a mechanical one.

Feasibility of Air Mapping Tested at Washington

To prove further the reliability and the utility of maps made from the air, representatives of the Rand-McNally Co., in co-operation with the Army Air Service, are making detailed maps of the immediate vicinity of Washington. On the success of this venture will depend certain projected larger ventures in map making from the air.—*Eng. News-Record.*

Dredging Tests of the Dredge "Raritan"

Discussion

H. N. Babcock
U. S. Assistant Engineer

Continued from Page 107

The comparative tests of the *Raritan's* two pumps from April 17 to April 25, 1916, are clouded by a suspicion of some obstruction in the suction pipe. During that period, only, the new pump was doing less work with 20-inch suction pipe than the old one had done. Immediately thereafter work was suspended on account of strikes and of the near exhaustion of funds, and the dredge was laid up for general repairs. When dredging was resumed, the new pump was again doing the better work and the nature of the obstruction has not been ascertained.

The 24-inch suction pipe with corresponding drag and with 24 to 20 inch reducing elbow was discontinued after wearing out, because:

(*a*) It cost much more.

(*b*) Unless all of the 20-inch pumps were so equipped, a larger assortment of spare parts would be required.

(*c*) And especially because their weight taxed the capacity of the hoisting engines too far.

The runner of the new (D-W) pump had six vanes, and proved more liable than did the old pump, with five vanes, to choking at the entrance, the result of picking up pieces of piling, fenders, or other small timbers which are common in New York Harbor.

In further pumps of this type for New York Harbor use it is designed to reduce the number of vanes to five.

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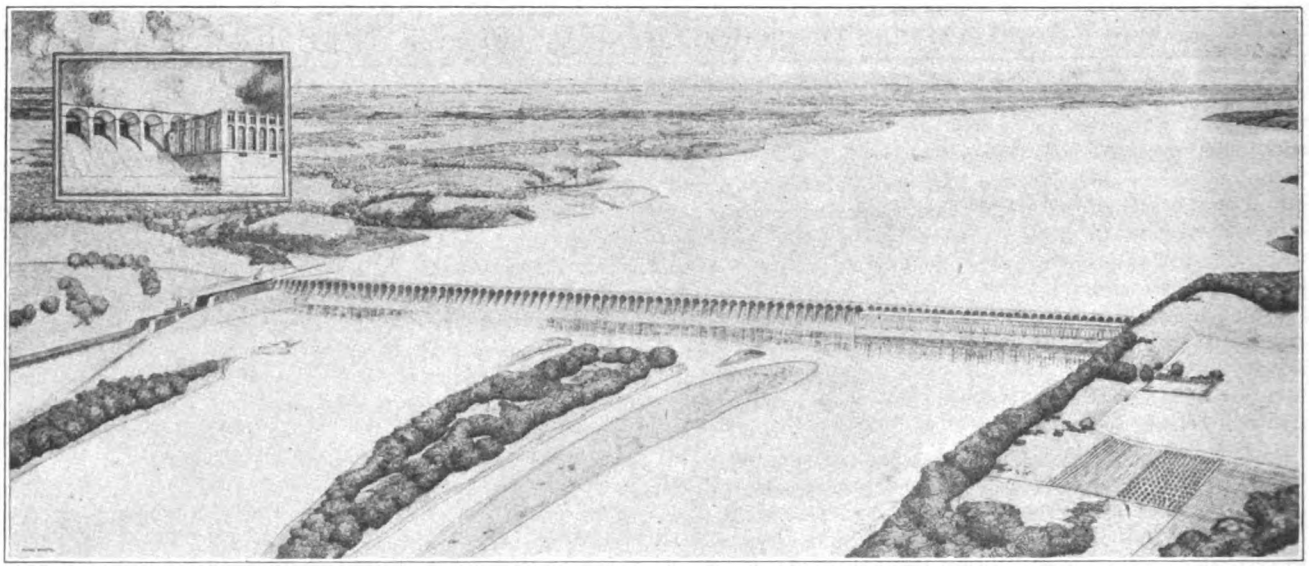


Fig. 1. Sketch showing Wilson Dam as it will appear when completed. Detail of power house and roadway in insert

Notes on the Construction of the Wilson Dam

By

Lt. Col. W. C. Weeks and Maj. S. C. Godfrey

Corps of Engineers

MUSCLE SHOALS. Since the first white settlers came down the Tennessee River, the Muscle Shoals have been recognized as the most formidable obstacle to the navigation of that river. Extending for about thirty-seven miles upstream from Florence, Ala., the resistant strata of flint limestone, which form the bed of the stream, have prevented the river from cutting into the softer strata below, and caused it to spread out into a wide and shallow river, racing swiftly over a series of rocky steps, with low-water depths of only a few inches in places. The total drop in this section is 134 feet; the slope is as great as 15 feet per mile, and velocities exceeding 10 miles per hour have been measured. The river is from one to two miles in width, and contains many islands, for the most part covered with timber. The discharge varies, roughly, between 7,200 and 500,000 cubic feet per second. The banks are generally high and steep, the rocky cliffs towering in many places a hundred feet sheer above the river.

Early Improvements to Navigation. The first effort to surmount this barrier to navigation was undertaken by the State of Alabama, and a canal which paralleled a part of the shoals was completed in 1834. This was unsatisfactory, however, and soon became obsolete. In 1871 a more ambitious project for the improvement of this section was authorized by Congress. This involved the construction of two lateral canals, at the Big Muscle and the Elk River Shoals, with a total of 11 locks, 57 by 275 to 284 feet in size, and a navigable depth of approximately 5 feet. The remaining shoals were to be improved by the contraction of the low-water channel and by rock excavation. This project was completed in 1890, and while it did not provide continuous navigation past the entire Muscle Shoals section, it did place this section in a navigable condition substantially as good as at the principal shoals above and below.

Water-power Projects. The combination of steep slope, high banks and great volume of water at this section of the river make it a favorable location for a large power dam or dams. This fact has long been recognized and numerous examinations and surveys have been made under Congressional authorization with a view to securing development of water power in connection with improvement of navigation through the joint action of private agencies and the Government. An exhaustive report, published in Committee Document No. 20, 63d Congress, 2d Session, contained a favorable recommendation for such an improvement at an estimated cost of $18,701,000, of which approximately $8,575,000 was considered as representing the value of the improvement to navigation, the remainder being chargeable to power development and to be reimbursed to the United States. A report published in H. Doc. No. 1262, 64th Congress, 1st Session, gave the results of a later survey made for the purpose of final selection of sites and the making of detailed estimates of cost. This report increased the estimate of cost to $19,000,000. This report was also favorable, but called attention to the provision contained in Section 124 of the Act to increase the efficiency of the military establishment of the United States, approved June 3, 1916, respecting the establishment of nitrate plants to supply Government needs in the manufacture of explosives for military uses, and in view of this legislation recommended that action on a proposed contract with the Muscle Shoals Hydro-Electric Power Company for undertaking the work be suspended until it had been determined whether the power would be utilized for such a nitrate plant.

The Nitrate Plants. During the war, Nitrate Plant No. 1,

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and later, Nitrate Plant No. 2 were constructed in this vicinity. Plant No. 2, which utilizes the cyanamid process of manufacturing ammonium nitrate, was in successful operation at the time of the armistice. The construction of the Wilson Dam (Dam No. 2 of the complete project) was directed in a letter from the President on February 23, 1918, under authority of the National Defense Act above referred to. The money hitherto allotted for its construction—a total of some $17,385,000 to date—comprises the bulk of the original twenty millions appropriated for a nitrate plant and appurtenances. The Dam is to provide for the generation of electrical power for the production of nitrates or other products needed for munitions of war and useful in the manufacture of fertilizers and other products. It will also insure a minimum navigable depth

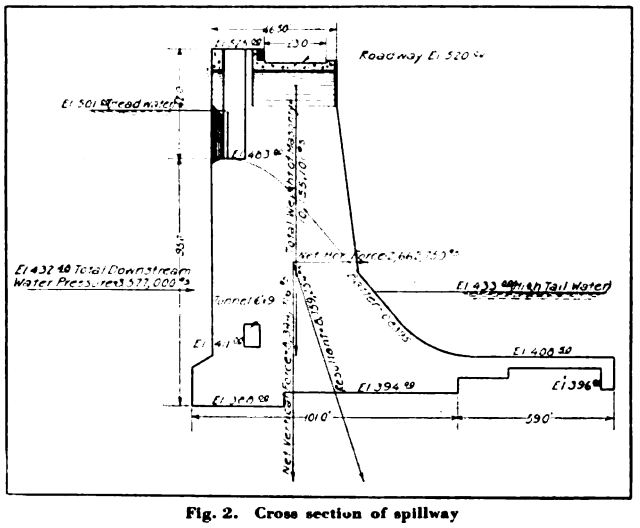


Fig. 2. Cross section of spillway

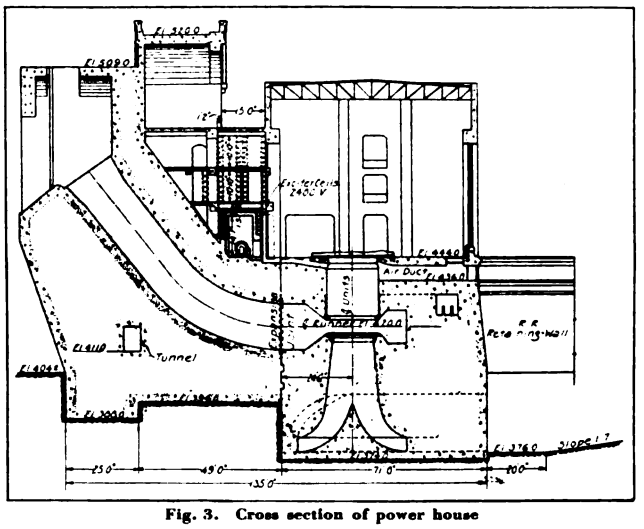


Fig. 3. Cross section of power house

of 9½ feet for a distance of 15 miles upstream—to the proposed site of Dam No. 3, another combined power and navigation dam about 50 feet high. The plans for Dam No. 1, for navigation only, contemplate a small structure across the channel two miles below the Wilson Dam.

The dam may be divided into three typical sections, the lock section on the north or right bank of the river, and the spillway and power-house sections, both founded on the river bed. All three sections support an ornamental mass concrete arch highway bridge having a 23-foot roadway, running without change in grade or alignment from bank to bank of the river at an elevation 19 feet above that of the upper pool.

Fig. 1 shows a general view. The length of the spillway section is 2,890 feet.

The entire structure—lock, spillway and powerhouse—is founded on solid rock, a hard, flinty limestone locally termed Lauderdale chert. The upper layers of the chert are separated by thin mud seams; below these, occasional thin, open seams are encountered, but they are of limited extent and easily closed by grouting. The great number of borings made at and near the dam site gives accurate information as to the character of the foundation two hundred feet below the bed of the river. Rock excavation during construction has disclosed nothing new. All foundations are carried down below any mud seam, and all open seams are grouted to refusal through two rows of closely spaced holes under a pressure 10 per cent less than the weight of the rock above the seal of the grout pipe before any concrete is placed. The rock is hard to drill, but breaks into fragments convenient for loading with steam shovels.

The lock section comprises a cutoff wall running into the north bank from the north lock wall, two locks, and a non-overflow dam, 156 feet long, extending from the south lock wall to the spillway section. The highway crosses the upper lock by means of a bascule bridge, the details of which are not yet complete. The locks are largely in solid rock excavation, and are of the usual design, with chambers 60 feet wide by 350 feet long, and a minimum depth over miter sills of 7½ feet. Both lifts are about 46 feet. The lock gates are the usual miter type, and a double installation is provided for each lift to care for emergencies; in addition, an emergency dam is provided above the upper pair of gates.

The spillway section is 2,890 feet long and is divided by the piers that support the highway bridge into sixty-three 38-foot openings, controlled by vertical sliding steel gates 18 feet high. These gates will pass without appreciable rise of upper pool level a flood 75 per cent greater than the highest ever known. The design of the spillway (Fig. 2) is very substantial, and under the most adverse assumptions, the resultant of pressure passes through the base of the dam at about its middle point. Calculations for stability do not include the apron section. The weight of the masonry is assumed to be 145 pounds per cubic foot. The ratio against the dam sliding on its base is as 1 to 2.29, and against overturning as 1 to 4.16.

The upper pool will be maintained at a constant elevation of 501, and the parabola of the spillway crest is designed to fully support a jet of water issuing beneath a gate under an 18-foot head. The downstream batter, 0.84, merges into the horizontal of the apron by a curve of 40-foot radius. The apron is from 4 to 9 feet thick, 59 feet wide and solidly anchored into the rock by up and down stream trenches. The heel trench is carried down below the base of the dam so as to give a minimum breast wall of 5 feet without any seams. It is 35 feet wide up to the level of the river bed, elevation 404, from which plane it slopes upward to the face of the spillway.

An inspection tunnel, 6 feet by 9 feet, runs straight through the spillway and powerhouse sections. The concrete is brought up to the elevation of the tunnel floor, 411 feet, and 6-inch drill holes at 23-foot centers are sunk through the tunnel floor before the tunnel is formed, to a level 35 feet below the bottom of the heel trench. (See Fig. 7.) These holes are intended to relieve any uplift pressure, and provision is made by a system of valves to

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cut off or to discharge any leakage through pipes concreted in the dam section at tunnel floor level.

The 63 sliding gates on the crest of the spillway, each 18 feet by 38 feet, are counterweighted by steel tanks operating in steel displacement chambers, one counterweight to each end of each gate. The displacement chambers extend from the level of the upstream parapet wall of the bridge to the inspection tunnel floor level. Provision is made to connect the bottoms of the displacement chambers with head and tail water through the system of valves by which the gates will be operated.

The powerhouse section, 1,221 feet long, is shown in Fig. 3 in cross-section. The heel trench is reduced to a width of 25 feet, and the power house occupies the space corresponding to the apron on the spillway section. The present installation in the powerhouse will be 4 vertical, 30,000 H. P. turbines, running 100 r. p. m., direct connected to 25,000 K. V. A. 12-000-volt generators, and one 1,000 H. P. vertical turbine, direct connected exciter, all units spaced 55½ feet on centers, and served by the usual crane arrangement. Ultimately 14 additional units, probably with 36,000 H. P. turbines, will be installed. The head on the turbines varies from 68 to 93 feet.

The roadway over the powerhouse section is identical in line and grade with that over the spillway, but the arch span is increased to 47½ feet to conform to the unit spacing. Beneath the roadway and toward the powerhouse, the space is utilized for the installation of oil switches and other electrical devices; upstream from the roadway, the piers are extended to provide the necessary support for the gates controlling the admission of water to the penstocks. The three heavily reinforced, rectangular penstocks, each 12 feet 4 inches wide by 15 feet 10 inches high, serving each main unit, descend from the rack chamber at an angle of 45 degrees and, curving to the horizontal on a 50-foot radius, merge into the scroll case moulded in the concrete around the speed ring. From the runner the water descends through the draft tube, 14 feet 3 inches diameter, and expands by easy stages over a concrete cone into two horizontal exits, each about 20 feet square, the tops of which are 2½ feet below extreme low water. From the base of these exits the rock of the river bed is excavated horizontally for 20 feet, then on a rising slope of 1 on 7 to the original river bed.

Construction methods

Seven areas along the dam site are enclosed or are to be enclosed by cofferdams. These dams are rock-filled cribs, 14 to 16 feet square, sheeted next the sealing material with scrap lumber and sealed with clay and earth. For the dam, the upstream coffers consist of a single row of cribs with the sealing material dumped on the upstream side. The river arms and downstream cofferdams are built of two rows of 16-foot rock-filled cribs, 16 feet apart, with the sealing material dumped between. The powerhouse cofferdam consists throughout of two rows of 14-foot cribs with a 20-foot puddle wall between. (See Fig. 8.) This construction provides for a minimum of damage when the cofferdams are topped by floods. In most places the original dams have been greatly strengthened by waste rock excavation. The leakage into the enclosed areas, even that of the powerhouse, over 12 acres in extent, is almost negligible.

The salient features of the method of construction are undoubtedly the concrete and steel girder, 4-track, construction bridge and the full circle, 10-ton, traveling cranes. The concrete piers supporting the girders were founded on the bedrock of the river, without unwatering the forms, on the lower portion of the apron of the dam. Where the apron has been built, the rock has been excavated from 3 to 6 feet below the bottom of the concrete piers. The piers and rock footings are enclosed by forms, and when the construction bridge is no longer needed the pier and rock will be removed and the dovetail cavity filled with concrete.

The tracks supported by the construction bridge and elsewhere throughout the work are standard gauge.

The seven traveling cranes for the dam proper run on girders resting on the upstream end of the construction-bridge piers, and on concrete piers so located as to be entirely submerged in the concrete of the dam. (See Fig. 4.) The 75-foot booms of these cranes span all four construction tracks and the base of the dam, and barely reach the floor of the highway bridge. In the powerhouse section, three traveling, full-circle cranes, with 118-foot booms, are installed, two above the line of the spillway and one below the powerhouse. (See Fig. 8.)

Three mixing plants supply concrete. One on the north shore is equipped with two 2-yard Smith mixers; that on the south shore has two 2-yard Lakewood mixers, and that on Jackson Island has two 4-yard Smith mixers. All mixers operate under material bunkers, from which charging is done by gravity. The mixed concrete—approximately 1-2¼-5—is conveyed in 2 and 4 yard buckets on flat cars to the cranes. Large cement sheds at each mixing plant provide ample storage, from which the cement, after testing, is carried to the mixer bunkers by conveying belts.

A rock-crushing plant is located at the Jackson Island mixer, consisting of a 48-inch gyratory breaker and a battery of six 14-inch gyratory crushers, two of which take care of the oversize from the revolving screens. The elevator from the 48-inch crusher passes its product over a grizzley, the rejects from which drop to the 14-inch machines. The product of the small crushers and the grizzley is elevated to revolving screens above the bins by means of an elevator, so arranged that it will also elevate gravel from the storage pile. Sand is placed in the sand bins by means of steam-operated guy derricks.

Gravel and sand are obtained from a dredging plant located at Buck Island, 9 miles below the town of Florence. Two 15-foot hydraulic dredges elevate their output 28 feet to revolving screens mounted on a scow; from the screens the sand and gravel are spouted by gravity to scows moored alongside. These sand and gravel scows hold from 200 to 600 cubic yards, and are towed to the dock at Florence by stern-wheel river boats. The material is unloaded into bunkers by two electrically operated gantry cranes, each having a 4-yard grab bucket. The sand and gravel is drawn off through bottom gates into 20-yard air-dump cars and hauled to the mixing plants at the dam.

The general plan of stream control at Wilson Dam is to enclose an area of the spillway section by a cofferdam and bring the concrete to elevation 411, 7 feet above the river bed. (See Fig. 5.) From this elevation certain sections of the dam, including the arch bridge, are completed. In other sections, corresponding to the river channel, 12-foot piers for sections of the dam, including the arch bridge, are raised above elevation 411, leaving alternate 30 and 38 foot openings, through which the river discharges. When the remainder of the structure is finished, the forty-two openings will be raised by successive 6-foot lifts to the crest of the spillway.

Progress of the work

The first steps toward the actual construction of the Wilson Dam were taken in 1918. During the spring of

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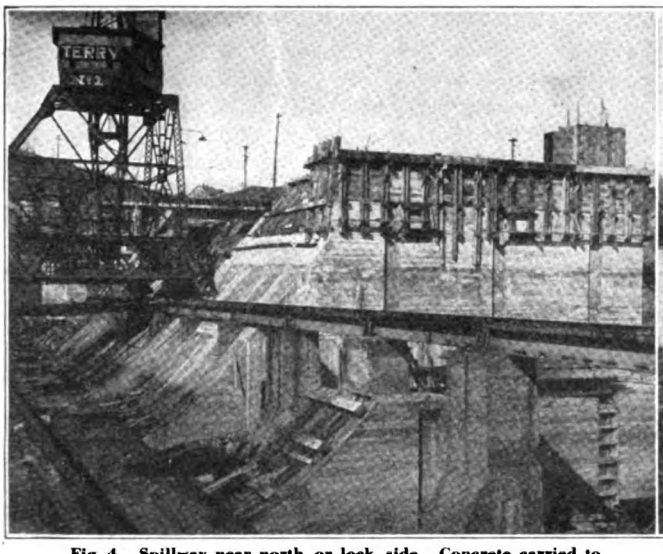


Fig. 4. Spillway near north, or lock, side. Concrete carried to Elevation 446, February 4, 1921

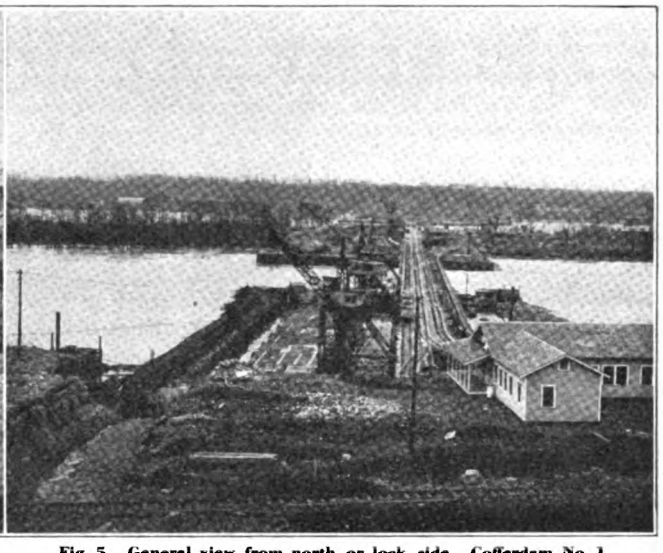


Fig. 5. General view from north, or lock, side. Cofferdam No. 1 carried to Elevation 411, or higher, January 1, 1921

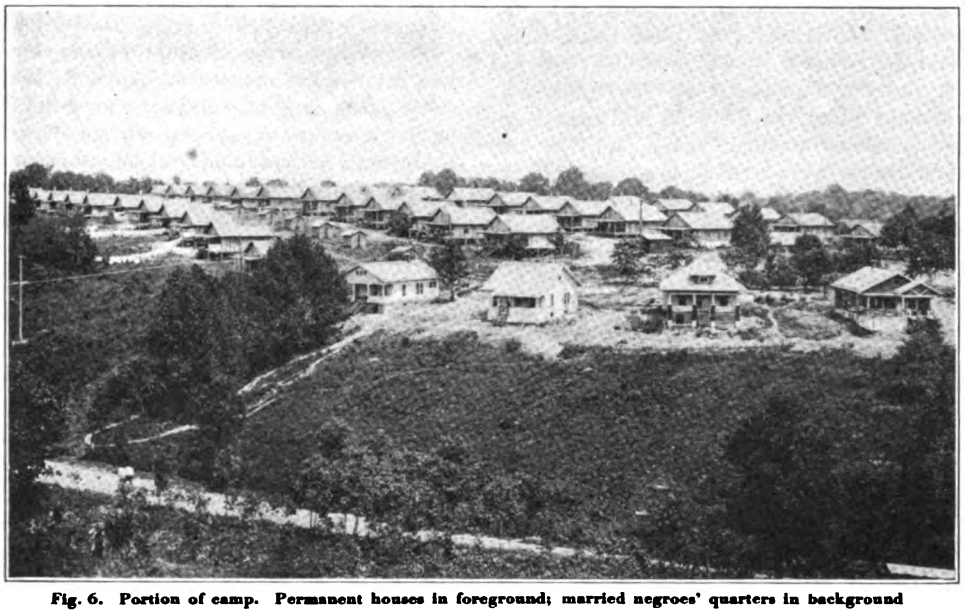


Fig. 6. Portion of camp. Permanent houses in foreground; married negroes' quarters in background

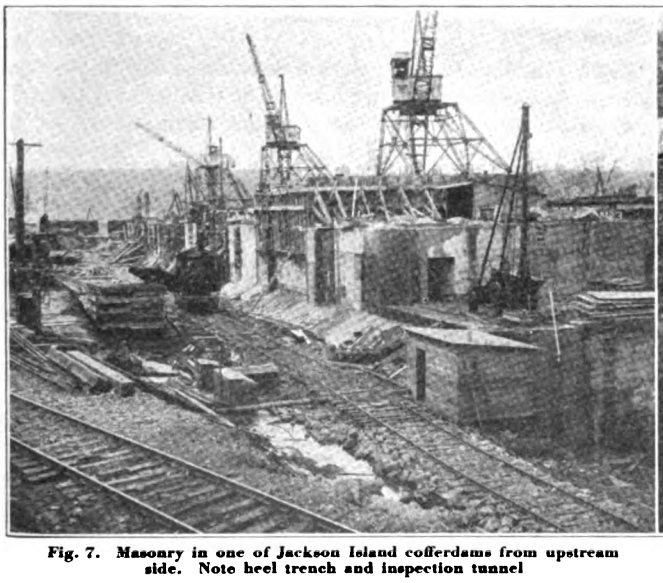


Fig. 7. Masonry in one of Jackson Island cofferdams from upstream side. Note heel trench and inspection tunnel

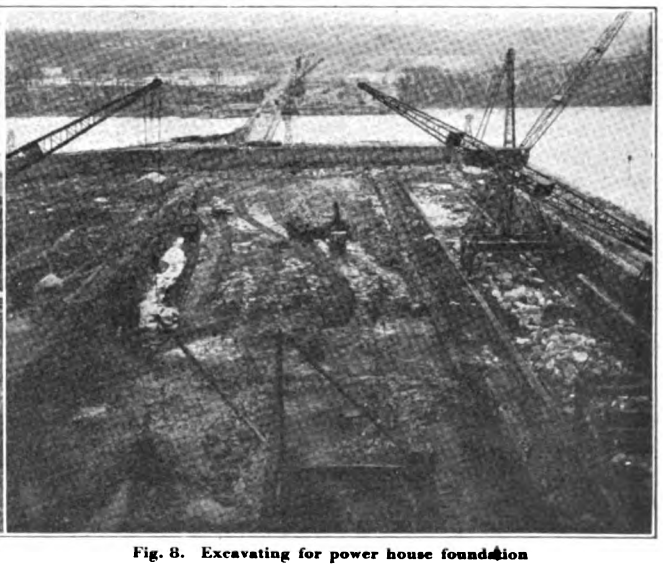


Fig. 8. Excavating for power house foundation

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that year a small force was assembled and the preliminary work of constructing a camp and assembling plant commenced. In the fall of the year, however, all work was suspended on account of the pressure of other war activities, and from August 20, 1918, till the resumption of work on November 9, 1918, nothing was done.

During 1919 more substantial progress was made. A commodious construction camp was erected; the first cofferdam was completed and pumped out (September 1, 1919); the construction bridge was 50 per cent completed; the railroad lines, yards, shops and warehouses largely finished; and the greater part of the plant assembled. Coincident with the commencing of rock excavation in the unwatered cofferdam, preliminary earth excavation was undertaken on Jackson Island, midway along the axis of the Dam. This central section was subsequently inclosed on both flanks by cofferdams 3 and 4. No work was done on the south side of the Tennessee until the fall of 1919, when a separately organized construction division commenced operations on the powerhouse section of the dam.

During the spring of 1920 the work of excavating in the first two coffers and of constructing the powerhouse coffer was pushed vigorously. The construction bridge was put into service, and the ten big travelling tower derricks erected. Meanwhile the plant for the sand and gravel operations had been assembled at Buck Island, and the first dredged concrete materials were available in time for the first permanent concrete poured. On May 7 the first section of the apron of the dam was commenced, inside the Jackson Island cofferdam.

The procurement of cement in adequate quantity became a serious problem at this time. Little or none could be purchased from southern mills, and although cement was available at more distant points, the railroads would not undertake to move it. The problem was finally solved by the purchase of 75 rebuilt box cars, which were devoted exclusively to the cement service between the mills and the dam, and which furnished almost the sole dependence up to the fall of 1920, transporting over 100,000 barrels of cement.

During the summer and early fall the pouring of the apron was continued, while the rock excavation for the main section of the dam was being carried deeper into seamless rock. This concrete was mixed in the north-side mixing plant, with its two 2-yard mixers. Meanwhile the big Jackson Island plant was being completed. The destruction of the latter plant by fire on July 5, together with the adjacent cement shed and crushing plant, threatened to be a serious blow to the progress of the work; its complete rebuilding in three months was a conspicuous achievement, and no material delay was caused.

Modifications in the original design for the dam had necessitated additional rock excavation, postponing until September 29 the pouring of the main sections of the spillway. On that date the preparatory period may fairly be said to have ended. The average daily yardage of concrete poured jumped from about 100 to about 1,300 cubic yards. Operations have gone forward without sensible interruption since that time. Up to February 1, 1921, there had been no stages of the river high enough to interfere seriously with progress. To that date Construction Division No. 1 had placed 148,922 cubic yards of concrete, which is approximately 12 per cent of the total volume of masonry in the entire work.

One section of the powerhouse cofferdam was completed and pumped out in May, 1920, but the entire cofferdam was not unwatered until August. Since that time rapid progress has been made on the great amount of rock excavation necessary for the draft tubes and tail race, and over 100,000 cubic yards, about one-third the total, has been taken out. (See Fig. 8.) The first concrete in the powerhouse section was mixed at the south-side mixing plant and poured on February 1, 1921.

At the locks a large amount of preliminary earth excavation was handled by steam shovel before the side of the upper lock chamber was uncovered. Rock excavation for this chamber is now well advanced.

The Camp. The construction camp at the north end of the dam is a small city of 3,000 inhabitants. The buildings include 107 bunkhouses, 14 mess halls, 230 family residences (30 "permanent" and 200 "temporary"), 2 dormitories, 2 recreation halls, 2 hospitals, and moving-picture shows and poolrooms (run by concessions, together with a store). (See Fig. 6.) Excellent meals are furnished employees at a rate of 75 cents a day, or $20.00 a month. A sewage disposal plant and complete sewer system have been installed, and a refrigerating plant provides for cold storage.

The Wilson Dam Chapter of the American Red Cross was granted its charter on April 3, 1920. It is the officially recognized organization for relief and welfare work on the reservation. Among other activities, it has built and equipped a playground, and maintains a supervisor for it.

The total number of employees is about 4,200, a considerable part of whom live in other smaller camps and in the neighboring towns.

Depletion of timber resources in the United States

The outstanding facts of a recent report from the Forest Service of the Department of Agriculture are that three-fourths of the original timber of the United States is gone, and that we are using timber four times as fast as we are growing it. The forests remaining are so localized as greatly to reduce their national utility. The bulk of the population of manufacturing industries is dependent upon distant supplies of timber as a result of the depletion of the principal forest areas east of the Great Plains. The depletion of timber is not the sole cause of the recent high prices of forest products, but it is an important contributing cause whose effect will increase steadily as depletion continues.

The fundamental problem today, according to the bulletin, is to increase production of timber by stopping forest devastation. At one time the virgin forests of the United States covered 822,000,000 acres. They are now shrunk to one-sixth that area. All classes of forest land now aggregate 463,000,000 acres. Of the land remaining not utilized for farming, approximately 81,000,000 acres have been so severely cut and burned as to become an unproductive waste. New timber remaining in the United States is estimated roughly at 2,215 billion board feet, three-fourths of which is in virgin forest; the rest is second growth of relatively inferior quality. About one-half the timber left is in the three Pacific Coast states, and over 61 per cent is west of the Great Plains. A little over one-fifth of the timber left in this country, or 460 billion board feet, is hard wood. There is now consumed or destroyed annually 56 billion board feet of material of saw timber size. The total yearly consumption of all classes of timber is about 26 billion cubic feet, and the depleted forests are growing less than one-fourth of this amount.

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Pipe Lines of U.S. Dredges "Multnomah" and "Wahkiakum"

Operating on the Columbia River below Portland, Oregon

By

R. E. Hickson

U. S. Assistant Engineer

THE floating pipe lines of the dredges *Multnomah* and *Wahkiakum* average about 1,800 feet in length. They are made up of 60-foot lengths of 24-inch lap-welded steel pipe, supported on wooden pontons and connected with rubber sleeves in the usual manner.

It is the object of this article to discuss the methods of assembling and handling these pipe lines; the apparent advantages of the wooden pontons and rubber sleeves used; and the relative cost of this plant compared with steel equipment.

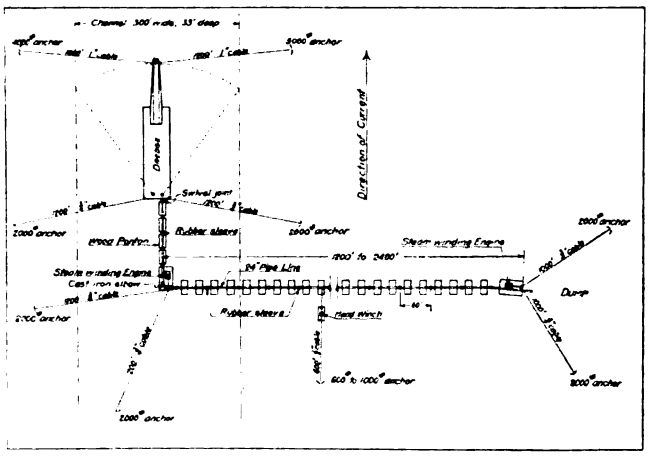
Sixty-foot lengths of pipe are used in order to reduce the number of sleeves, and for the reason that longer lengths supported on two pontons, one at each of the quarter points, make a steadier line without any vertical angles and give much better horizontal alignment, than shorter lengths each supported on a single ponton, as often used In general, the sections of pipe should be as long as practicable consistent with ease in handling and size and number of pontons necessary for their support.

No rivets are used in construction of the pipe, as these, even with countersunk heads, cause excessive wear at some points, and eventually will cause leaks and perhaps scrapping of the pipe before it has served the life possible if the wear were evenly distributed. The pipes are turned through about 120 degrees every four or five months of service in order to distribute the wear. The end bands on the pipe used to hold the sleeves are bored to the outside diameter of the pipe for a depth of one inch. They are slipped over the pipe and spot welded on the outside. The band is three inches wide and accordingly extends two inches beyond the end of the pipe, protecting the end of same until the outer two inches of the band has been worn away. The band is then cut off and a new one placed on the pipe. These ¼-inch pipes will last about six or seven seasons, or about 1,400 to 1,600 working days of 24 hours in the sand encountered in the Columbia River. The elbow used at the angle in the pipe line is made of cast iron with flanged ends, which are bolted to the adjacent sections of pipe, also fitted with flanges. Generally two 45° ells are bolted together to make a 90°, and these are generally taken from the interior of the dredge where they have served their safe life for hull piping. No new elbows are now bought for the ponton pipe line.

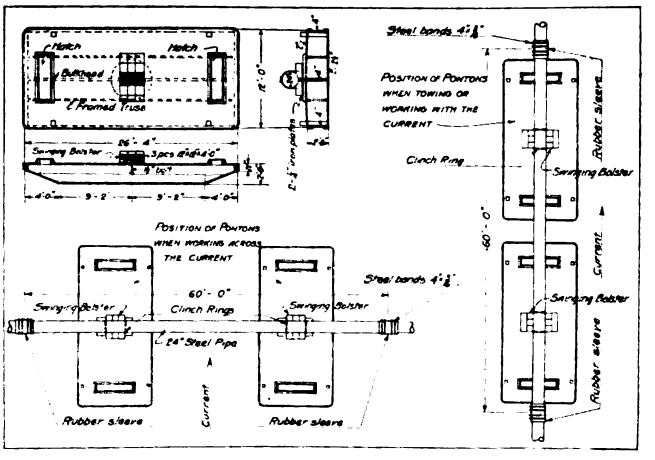
The pontons used to support the pipe are built of Douglas fir lumber. They are little deck barges, 12 by 26 by 2½ feet, as shown in the accompanying picture and drawings. They are submerged about 13 inches with the pipe empty and 17 inches with the pipe full. The gunwale strakes and bulkhead are 4 inches thick, deck 2 inches, and bottom 2½ inches. Hatches are provided at each end to allow air to circulate through the ponton during fine weather, and canvas covers are used over these in stormy weather. In the center of the ponton is a swinging center or bolster, consisting of three pieces of 12 by 12 inch timber, 4 feet long, bolted together, and cut out to a depth of 6 inches in a cylindrical recess to receive the 24-inch pipe. A 1½-inch king pin passes through the center of this bolster and down into the longitudinal bulkhead below deck. A ¼-inch steel plate is fastened on the bottom of the bolster and a similar plate on a raised bed on the deck of the ponton. These plates take the wear and reduce the friction between the swinging bolster and the bed on the deck. The pipe rests only on this bolster, and is fastened to it by means of two sets of curved straps ½ by 2 inches, one set at each end of the bolster, connected and tightened with bolts at the top of the pipe. The ponton itself is free to be swung under the pipe into any position that may be desired. A walk and handline are fastened to the top of the pipe to aid men in walking the line during rough weather.

In operation, these pipe lines are generally set up across the current and the pontons are set at right angles to the pipe line. If it is necessary to lay the pipe at any other angle with the current, the pontons are swung accordingly, and at times it may be necessary, in order to relieve the side pull on the dredge or anchor scow, to "cut" the pontons slightly into the current when they will act like the rudder boards on a shear boom, and thus place the greater strain on the anchor lines at the end of the pipe. When the pipe line is towed any distance, especially up stream, it is absolutely necessary that the pontons be lined up with the pipe as the surface velocities of the Columbia River vary from about 3 to 5 feet per second, and it will be understood how difficult it would be to tow 1,500 to 2,000 feet of pipe line against this current with all the pontons connected rigidly at right angles to the pipe, and if connected longitudinally, as is done with some dredges, it would be impracticable to hold the pipe line across the current when set up for operation. The bolster or swivel type of ponton overcomes these difficulties admirably. The pipe line is held in place when in operation by means of anchors, two of which weighing 2,000 pounds each are placed beyond the end of the pipe line and are connected to a winding engine on a 22 by 56-foot scow supporting the last length of pipe. Dead men on shore are often used instead of the anchors. At the elbow in the pipe line near the dredge two anchors are also connected. These two sets of anchors pulling in nearly opposite directions hold the pipe line in position. One or more smaller anchors are also used, when necessary, with hand winches to hold up the sag in the middle of the line. These winches are mounted on independent pontons, which can be shifted to any point in the line without disturbing the main pipe-line connections. Between the elbow in the pipe line and the dredge two lengths of pipe are generally used.

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General layout of pipe-line and anchors, dredges "Multnomah" and "Wahkiakum"



Plan of ponton and pipe-line assembly, dredges "Multnomah" and "Wahkiakum"

By using the anchors at the elbow in the pipe, nearly all the pull of the floating line is taken off of the dredge and much more satisfactory operation on channel work is possible than when the long pipe line leads directly from the dredge. Steam for the winding engines connected with the anchors is furnished by an upright boiler of 35 horsepower on each of the scows. Slab or block wood is used as fuel for these boilers. The main anchor lines are ¾-inch cables, 1,000 to 1,200 feet in length. The lines to the smaller anchors and hand winches are ½-inch cables about 600 feet in length. As the work progresses the anchor lines are gradually paid out and a tug equipped with a steam winch and derrick is used to shift the anchors. This is generally done once each day. When deep-draft steamers pass, the dredge is swung out to the edge of the cut and the anchor lines crossing the channel are slacked off and drop to the bottom while the steamer is passing. When the vessel has safely passed over the cables, the "donkey man" on the anchor scow hauls in the slack of the cable, and again tightens the pipe line into its proper position. The anchor lines at the end of the pipe line are generally not disturbed during the passing of a steamer, as the end of the pipe may be in shallow water or up against a bank or dump, and cannot be moved any farther away from the channel. The drawing herewith will show the general lay out of the dredge, pipe line and anchors when set up for operation.

It has been observed that dredges are often operated with only small anchors holding the pipe in position, and that the pipe line is often quite slack. This results in excessive wear on rubber sleeves through the bumping or chafing of ends of the various sections of pipe and buckling of the sleeves. A large part of this trouble can be avoided by providing winding engines of sufficient power at the end of the pipe line to keep the slack out of the line. With lines over 1,000 feet in length operating where there is any wind or current, good winding engines and heavy anchors are almost indispensable. In addition to saving rubber sleeves, a tight, straight pipe line offers less resistance to pumping than a slack line with numerous angles and sleeves buckled up to restrict the flow.

Rubber sleeves are used every 60 feet throughout the pipe line. These sleeves are 36 inches long and 25½ inches inside diameter. They are now manufactured under standard specifications of the Engineer Department for Class "A" sleeves. It is believed that for work on the Columbia River ship channel, rubber dredging sleeves are more satisfactory and economical than steel, ball joints or so-called flexible joints. Between the dredge and the elbow in the pipe line, flexible steel joints might be used to advantage, as this part of the line is generally straight and not subject to kinking. Beyond the elbow however, where the pipe line leads across the current, kinking or buckling of the pipe line at some of the joints is at times unavoidable. Angles of 45 degrees or more sometimes occur when the anchor cable stretching the line has to be dropped for a steamer to pass, or if it should be cut, or if the anchor drags slightly when working in very swift water, or heavy wind. A rubber sleeve will allow such a deflection without failure, while 15 to 20 per cent is about the limit of deflection for steel joints. A greater deflection than that for which a steel joint is designed results in a breaking of the joint or crumpling of the pipe. In the matter of cost it is also believed that the rubber sleeves have the advantage, as will be shown. Since 1914, when the dredges *Multnomah* and *Wahkiakum* were placed in commission, the average life of dredging sleeves has been 245 working days of 24 hours. The maximum life has been 739, and minimum 88 days. Some sleeves, broken through wrecks or unusual causes, have been eliminated from the averages. It has been found from the sleeve records of the dredges that the average life of the sleeves has been greater during the last two or three years than in the earlier periods of operation; for while the average life of all sleeves for both dredges has been 245 working days, the sleeves renewed during the last fiscal year had an average life of 272 days on the *Multnomah* and 365 days on the *Wahkiakum*. Two sleeves not included in the above averages were replaced on the *Wahkiakum* during the month of August, after serving 467 and 470 days, respectively. Both sleeves broke during a storm on account of kinks in the pipe line. The added life in the later records may be due to better quality of sleeves, but it is believed should be attributed also to the use of rope "mats" or "jackets," which have in recent years been placed around each sleeve, while in service, to take the strain from excessive pressures and prevent to a great extent the bulging of the sleeves, which often causes a rupture of the inner tube near the points where the pipes end. The "jackets" were installed first on the *Wahkiakum*, which it is believed accounts for the greater average life of the sleeves on that dredge.

These "jackets" are made up of 1-inch manila rope, woven in the form of a mat or net with length of meshes about 12 inches, the meshes being fastened with a seizing of marlin (9 turns) instead of being knotted as in a net. The "jacket" is about 6 feet long, and when placed around the sleeve the two ends are laced together. When the rope stretches, this lacing can be tightened up at any time the

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dredge is not pumping. About 100 feet of rope is required to make a "jacket" for a 24-inch sleeve. The estimated cost is about $8.00 or $9.00 for materials and about 4 hours' time for one man, for which no charge should be made, as it is all in the day's work. It is believed that this device adds 25 to 50 percent to the life of the sleeves, although this would be difficult to prove. Use of the "jackets" is also advantageous in reducing the loss of head in the pipe line caused by enlargement of the pipe section at the joints. The picture shows one of these "jackets" in position. The sleeves purchased recently under the standard specifications of the department have not yet been in service a sufficient length of time to determine their life, but it is expected this will be considerably greater than the average of those previously used on account of the high tensile strength of duck and rubber now called for under the standard specifications.

The proper length of sleeve to use with a given diameter of pipe is a question which has not been definitely settled, but must probably be determined by the conditions to be met and by actual trial. With these dredges working under the conditions on the Columbia River, a 36-inch sleeve has been found most satisfactory, after trial of 30 to 32-inch lengths. The trials were not very exhaustive, however, and the experience of others in this matter would be of interest and value to the writer. The price of 36-inch sleeves for 24-inch pipe has advanced from $50.00 to $55.00 in 1913 to about $115.00 in 1920. Part of this increase is no doubt due to the more rigid specifications.

Recent figures obtained from makers of flexible steel joints were $500.00 each if purchased in lots of 10 or more. To this cost would have to be added for some joints the cost of fitting and installing on the pipe. No figures are available as to the life of these joints in the sharp, clean sand of the Columbia River, but from experience gained with two modified ball joints installed for trial, it is estimated at about 800 to 1,000 working days. It accordingly appears that in addition to the advantage of greater flexibility in the rubber sleeve, so essential when operating on ship channel work before mentioned, they also have the advantage of smaller cost over any steel joints thus far developed.

Cost of the pipe lines of the dredges in 1914 and 1920. and maintenance cost over this period, are shown in the following tables:

First cost of 60 feet of pipe line.

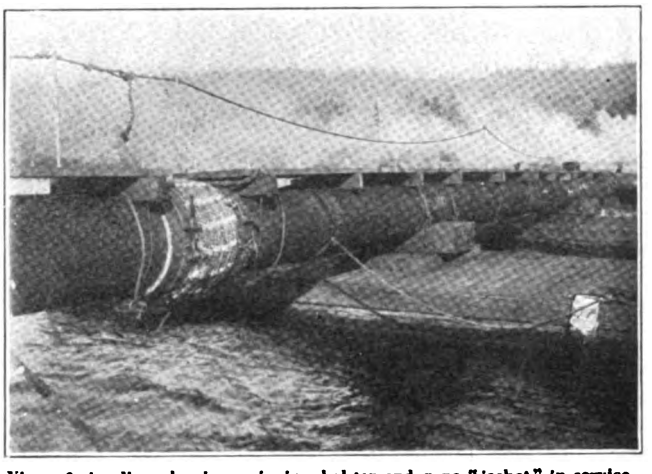
	1914	1920
60 feet 24 by ¼ inch lap-welded pipe	$360.00	$590.00
2 wooden pontons 12 by 26 by 2½ feet	350.00	900.00
1 36-inch rubber sleeve, 25⅛ inches I. D.	55.00	115.00
1 rope jacket	5.00	9.00
60 feet walk handline, etc	9.00	16.00
Total for 60 feet	779.00	1,630.00
Total cost per foot	12.98	27.17

Cost of maintenance.

	Depreciation, per cent	Cost basis 1914	Cost basis 1920
60 feet pipe	100	$360.00	$590.00
2 pontons	75	262.50	675.00
1 rubber sleeve	600	330.00	690.00
Miscellaneous repairs, etc.		100.00	200.00
Total		1,052.50	2,155.00
Maintenance cost per foot for 6 years		17.54	35.91
Maintenance cost per foot per annum		2.92	5.98

With steel pontons of the catamaran type at $1,600.00 per unit, with two units for each 60 feet of pipe, the first cost of pipe line per foot in 1920 would become $65.50, and if steel, flexible joints were also used in place of rubber sleeves, the cost would be about $71.77 per foot of pipe line.

A comparison of the cost of wooden pontons as used



View of pipe line, showing swinging bolster and rope "jacket" in service Dredge "Wahkiakum

here, with those constructed of steel, considering the life of the two plants, shows a decided economic advantage in the wooden plant. Based on a life of 8 years for wooden plant and 40 years for steel, the following comparison of cost of a single ponton unit is drawn:

Estimated first cost of wooden ponton $450.00
Estimated first cost of steel ponton catamaran type 1,600.00

For a period of 8 years:

	Wood	Steel
Interest on first cost @ 5 per cent per annum	$180.00	$640.00
Depreciation for 8 years	450.00	320.00
Repairs, etc.	50.00	20.00
Total	680.00	980.00

Saving in a wooden ponton in 8 years $300.00

The cost of repairs to wooden pontons given above does not include minor repairs made from time to time by the crew while the plant is in operation, as these are made during spare time of the crew, who are necessary in any event for handling the plant, and no extra labor cost is involved. The value of materials used is small. The only real repairs made on these pontons has consisted in lifting them out on a dock with a derrick, setting up the caulking on the rakes and repitching the decks. The cost was less than $50.00 each.

In the above estimates the life of wooden pontons is given as 8 years. It is known, however, that this is practically a minimum, and that with careful selection of seasoned lumber, can be materially increased. Investigations are now being made as to the probable cost of construction, using creosoted lumber, indications being that the life of wooden plant will be thereby increased 50 per cent to 100 per cent, or more, depending on the treatment, at a comparatively small additional cost.

(Continued on Page 130)

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The Military Engineer

Dedicated to the National Defense

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The Secretary of War

JOHN WINGATE WEEKS, newly appointed Secretary of War, whose portrait forms the frontispiece of this issue, was born in Lancaster, N. H., on April 11, 1860. He graduated from the U. S. Naval Academy in 1881, and served in the Navy until 1883, after which he served for ten years in the Massachusetts Naval Brigade. During the Spanish-American War he served in the Volunteer Navy.

In 1900 he was elected alderman, and in 1902 mayor of his home city, Newton, Massachusetts. He was a member of the 59th, 60th, 61st, 62d and 63d Congresses, and was elected to the Senate January 14, 1913, serving until March 3, 1919.

The Army Officer and the Engineer as Salesmen

THE day of the old frontier regular officer is past. His duty was at a one-company or one-troop post. His service was arduous. His mission was one of deeds, not words. He did much. He said nothing. He was a man of hard physique, strong will and unquestioned courage. There grew up in the service a resentment against the talker, and Army officers were proud of their reputation of not being good after-dinner speakers. They prided themselves on their powers of repression of speech. "Silence is golden," was their motto.

These observations have been almost equally true of the engineering profession at large. The engineer, like the soldier, was a man of works, and of silence. Other professions, notably the law, have taken a different attitude. They have cultivated their powers of speech. By reason of the attention attracted by their vocal utterances, lawyers and others have been frequently elected or appointed to public office and other important positions of trust and responsibility, for which, in many cases, engineers were by training better fitted.

Salesmanship, or efficiency in promotion or exploitation, is the slogan in business today. That the Army is a big business concern is now well recognized, both without and within. The Army man must compete with specialized organization of the highest type. It is he, and he alone, who can put his profession and his mission before the public. The Army is an instrument of the American people, and they are entitled to know about it. If they do not know about it, they cannot be expected to support it.

In most army activities of today the regular officer is in a position where his personality, his power to convince others, his personal magnetism and his ability to express ideas all come into prominent play. We have a few outstanding examples of talent in this respect, but for the greater part it seems that the old reputation of the Army, men of deeds, and not of words, is the rule, and the Army suffers accordingly.

Among engineers it has long been recognized that the officer who can win friends to the service is of great value. If he has the community behind him, he can accomplish great things. If he does not have the good will of the public, he is seriously handicapped.

Elsewhere in the Army this need is becoming more and more apparent. In our relationship with the National Guard, now firmly established as the "second line of defense," the personality of the Inspector-Instructor is of paramount importance. The old feeling that the Regular Service is antagonistic to the National Guard, or to the Militia as people used to call it, must be overcome if the regular officer is to succeed with the new National Guard. That the development of the National Guard requires more than the law and the efforts of experienced soldiers, is evident to all who are working with the problem. The only men who can successfully recruit National Guard organizations are National Guard officers. If they are to carry out the policies of the regular establishment, they must work in friendly spirit and full co-operation with the regular personnel. There must be absolutely no feeling of antagonism. There must be friendship. The regular officer must "sell" his service, "sell" the standards of the regular establishment to the National Guard officers, as to the public. His strength is great if it is properly applied. His weakness is fatal.

At the large centers of education where the government has established units of the R. O. T. C., the Regular Army has one or more officers representing the service in the direction of military instruction. Where these officers are capable, and their relations with the faculty and the student body happy, success is assured. Where there is misunderstanding and dissatisfaction, results cannot be expected. The success of the work of developing officer material at these institutions depends chiefly upon the personality of these regular officers, the Professors of Military Science and Tactics.

The newly announced policy of the War Department for the development of the Organized Reserve, shows that certain regular officers will be permanently assigned for duty with units of the Organized Reserve, with one officer to

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each regimental unit, and five for each division headquarters. These officers will have headquarters in the locality assigned for the unit, and must do the great bulk of the work in bringing together former officers of experience, and through them the non-commissioned officers and specialists for the organization. An officer who cannot represent the Army favorably; who cannot convince former service men as to the excellence of his mission; who cannot win to the colors the man whom the Nation needs, such an officer must fail on this assignment. On the other hand, the man of experience and personality, the man with initiative and personal magnetism, can make a splendid record for himself and for the Army in such a position.

Examples might be adduced in great numbers regarding army relationships at home and abroad, in industry, in business, in society. In all national activities the Army officer will be rubbing elbows with the civilian. He will be judged, and the Army which he represents will be judged favorably or unfavorably by comparison. He must therefore be equipped and trained for these activities

It is accordingly apparent that the Army must recognize the need of training its officers in the art of appearing favorably in public, of convincing others, in fact, of salesmanship in its highest form. Far from cultivating habits of bombastic oratory, or indulging in high flown speeches not based on careful thought, the regular officer must be master of his subject, direct and forceful in its presentation, as well as tactful and pleasing. The officer's training as a soldier should guarantee directness and forcefulness—the eloquence of simple truth, simply but clearly expressed. The educational system of the Army must guarantee the other requirements.

Such abilities will be no detriment to the officer in time of war, and will not hamper him in his relationship with other officers of our own army or of allied armies. Most of our successful officers during the recent emergency were men who appeared well in the company of their brother officers, either American or Allied.

Golden silence is well enough in its place, but there are times and occasions when silvery speech is far more effective. The military and engineering professions alike now appear to recognize that in their devotion to "deeds not words" they have been pursuing a will-o'-the-wisp policy.

The new course at West Point recognizes that lucid language is necessary to comprehension, and provides for 217 hours of class-room instruction in English as compared to 94 in the previous course. This course in English has for its aim three objectives, viz, to form habits of clear, concise and correct written expression; to stimulate interest in good reading in the field of contemporary prose, and to give practice in oral expression. It is a hopeful sign of the times that in the leading technical educational institutions of the country, no little time is now devoted to this important subject, with a view to training the engineer in oral and written expression. Clearness and accuracy of expression are essential in the work of the professional man and facility in presentation is of the utmost importance. The Army officer and the practicing engineer are both under the necessity of selling their services not only in their own interest, but in that of the public as well, and it is gratifying to find that the institutions of learning, both military and technical, are now awake to this important truth.

The Congress and the Army

JUST before the close of the last fiscal year, after exhaustive hearings on all phases of national defense, Congress passed a bill which was approved June 4, 1920, amending the National Defense Act of June 3, 1916, These two acts embody in legislative form the military policy of the United States. With the so-called Draft Act, which gave us our armies for the World War, they constitute the most enlightened legislation ever enacted by Congress in the interests of national defense.

In view of these outstanding exhibitions of constructive military statesmanship, those who are most interested in the continuance of a sound military policy have been at a loss to explain the more recent actions in this field on the part of our national legislators.

The casual observer might well conclude that there is a concerted effort to undermine the policy which enabled us to enter the World War and to conduct our share therein to a successful issue. It might appear that a deliberate attempt is being made by the House Committee on Appropriations to hamstring this wise legislation so recently adopted. The action of the Committee, which on January 29th reported out the Army Appropriation Bill for the fiscal year 1922, is best stated in its own words, as follows:

> "The grand total of this bill, combining the sum of $328,861,123 for the support of the Army and the sum of $2,361,489.62 for the support of the Military Academy, is $331,222,612.62. The combined amount of the estimates (submitted by the War Department) for the fiscal year 1922 for the two purposes is $699,275,502.93, and the combined amount of the appropriations for the current fiscal year is $394,700,577.70. The grand total recommended in the bill, therefore, is $63,477,965.08 less than the grand total of the current appropriations and $368,052,890.31 less than the grand total of the estimates.
>
> "The figures of the War Department were based upon an army of the maximum size provided by the Army Reorganization Act of June 4, 1920, an enlisted force of approximately 280,000 men, and 17,000 officers.
>
> "The appropriations in the present bill are based upon an enlisted force of 150,000 men, exclusive of the Philippine Scouts, which number about 6,500 enlisted men, and the Flying Cadets authorized in the law of June 4, 1920, to the number of 2,500. Provision is made to care for 14,000 commissioned officers, which is approximately 1,000 more than are now in the Regular Service."

Since the House Committee made its report, the bill has been passed by the House and has been reviewed by the Senate Committee on Military Affairs, which conducted extensive hearings on its own account. The bill has also been passed by the Senate, which was more liberal than the House in its estimates of the needs of the Organized Reserves and certain training activities conducted by the Regular Army. More recently still, the bill has run the legislative gauntlet "in conference," followed by action in the two branches of Congress on the reports of their respective conferees. The net result has been to increase only slightly the amounts voted by the House for the more important items favored by the Senate. The figures desired by the latter were rarely met in full, even on items of minor consequences.

If it be granted that Congress is in fact a representative body, its action in the matter of appropriations for the army for the fiscal year 1922 leaves small room for doubt that the people of the United States are not disposed at this time to invest funds in the military establishment beyond the most conservative estimate of bare necessities. The pendulum of reaction has swung far indeed, and there appears little to do but to take counsel of patience and await a happier day.

The truth of the matter is that under the methods now in

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force, which make the Committee on Appropriations responsible for the apportionment of all funds, this Committee must of necessity take on the functions of a budget commission; it must balance national outgo against national income. It must cut the garment according to the cloth, and it is obvious that, in the existing state of things, few of the departments of the government can be clothed in voluminous folds of broadcloth and fine linen. All departments will have to practice economy of the most rigorous sort. In time of famine it is well to bear in mind that "a half loaf is better than no bread."

Lack of funds is the determining factor, but this entrains manifestations of a public sensitiveness, a touchiness which finds expression in diatribes against standing armies, militarism, Prussianism and all the other pet bugaboos of an excitable public opinion.

The situation is well described in the following extract from a letter, which we publish with the permission of the writer, the Honorable Frank Lester Greene, of Vermont. Mr. Greene is a member of the Military Affairs Committee of the House, and has taken a leading part in all military legislation enacted by Congress in recent years. With an experience as a member for twelve years of the National Guard of his State, as an officer of volunteers in the war with Spain, as a newspaper reporter and editor and as a Congressman, active in the affairs of the House; possessed of an analytical mind, a profound student of military affairs in their bearing on the national security and welfare, a man of constructive ideas with a pleasing, forceful style of presentation, there are few men in public life today better qualified to express an opinion on the subject matter of his letter. It merits the consideration of every man who has at heart the best interests of the military service. Mr. Greene says:

> "I am by instinct, observation and study heartily in favor of a good-sized, well-balanced, regular or professional military establishment in this country.
>
> "I do not mean by that that I favor what is sometimes called a 'great standing army,' and for that matter I doubt if any sensible person does. But I have seen enough of the story of the world and humankind, since my years of discretion, to convince me that we must have a splendid permanent professional military force for the nucleus of any war army it may ever be necessary to raise in emergency.
>
> "I approach the matter of results of the possibilities in the Army Reorganization Act with a sympathetic interest and with a predisposition to favor any reasonable and practical means of accomplishing the purpose.
>
> "But when I say to you, as I have said to many, that it is a serious mistake for the War Department to hurry the creation of the force made possible by the Army Reorganization Act, or to employ the Army in all the activities possible under that Act, I am saying what I believe to be the most earnest truth in the most earnest interest of the Army itself, as well as the country, whether the Army or its friends believe it or not.
>
> "In my opinion, sincere friends of the Army who understand the situation, will urge the War Department not to begin to pile up enormous bills of costs to be charged up, in popular judgment, against the new Army Reorganization Act. The War Department, if it wants to keep that Act, and the possibilities in it, will do mighty well to make haste slowly. Already there are signs of a reaction against even as large a military establishment as is provided for in that Act; and if we irritate some sensitive opinion at this time by demonstrating that this Act simply means an enormous burden of expense in this tax-ridden, debt-ridden time, we can expect the usual explosion that follows exasperated human nature.
>
> "Moreover, I would counsel the heads of departments in the Army itself to stop whining about some of these things and get to work to do the best they can with the tools they have to work with. They have been given a law that is, in many respects, the greatest Military Act ever put upon our statute books. They have been given resources and opportunities such as never entered the imagination of the average Army officer as a possibility before. The Act is not perfect, but it is a marvelous improvement over former military statutes, and is remarkable in the fact that in so many things it upsets what might be regarded as traditional American policy and points the way to a liberalism that at one time, not long ago, would have been thought an impossibility.
>
> "We have to deal with human nature as it is and not as we may theorize about it. The Congress very readily adopted this law, but the public has not become used to it. The people of this land are struggling with a very intense and even threatening economic situation. Statesmen who are prudent will try to get along with the least possible budget of Government expense, consistent with such savings as do not sacrifice foundations themselves. If they do not, they can expect a storm of public protest and indignation; and any thoughtful man knows that these storms of reaction are often illogical and unreasonable, and do not simply correct the abuses complained of, but destroy institutions themselves sometimes, or so seriously impair them that they result in effects that are worse than the original abuses.
>
> "If our friends of the Army are well advised, they will keep quiet at a time like this. They will make the best they can of what they have at hand and wait for better times gradually to develop the possibilities of that Act to such extent as may be consistent with the demands for national preparedness.
>
> "There are many men who are not only sympathetic with the Army, but who are ambitious for its progress and development along the lines laid out through experience in the great World War. Those men are eager to help in legislation or administration that will serve this purpose, but many of those men are placed where they can see that if some good-intentioned but misdirected spirits in the Army keep up a complaining and irritating criticism of Congress or the Administration for not permitting the utmost freedom in expenditure under the Act at the very start, they stand in danger of being the very ones whose folly will so exasperate the people and the Congress that some of these results gained for the Army after so many years, may be swept away with one short Resolution. Prudent men in the Army now will be content in the ancient philosophy of 'letting well enough alone,' and biding a saner time."

The Military and Non-Military Mind Combined

THERE are so many branches of engineering which find application in the conduct of war that it is manifestly impossible that the military engineer should be an expert, or even that he should have a smattering of practical experience in more than a very few of them. West Point is a school for the inculcation of the

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fundamental principles of the art of war, including its economics, and not for specialized instruction along any line.

The subsequent experience on works of rivers and harbors acquired by officers of the Corps of Engineers is of military value *not* because of the technical knowledge gained, but because of the broadening effects of a training which brings the military engineer in contact with civilians, requires him actually to carry out work involving the use of plant, labor and construction materials, and which, above all, compels him to exercise his practical resourcefulness, meet emergencies, and shoulder responsibilities. The exact nature of the work is not a matter of vital importance, except that it is well that it be in the field of general construction in civil engineering. It is quite probable that practical experience in railroading would be as good, perhaps even better, than the river and harbor work, provided the engineer officers could be placed in positions of *responsibility,* calculated to develop their initiative and resourcefulness. This would not be possible in any railroad corporation where all such positions are already filled by civilians. It is the pioneer stage in civil enterprises which most nearly approximates the service of the military engineer in time of war. Much of the pioneer work in this country was done by graduates of the U. S. Military Academy, because in those early days there were no engineering colleges and the West Pointer was the best technically trained man in the country. But the pioneer days in railroading and other lines are past. There is no enterprise under civilian control in which the military engineer could receive the most essential part of the training he gets on river and harbor work, because he would not be in responsible charge of his work. Such training would be useful, but could not replace the work of rivers and harbors as a military asset.

Railroad construction is so important a matter in war that it is well that there should be a few officers of the regular establishment sufficiently experienced in railroad work to meet the civilian railroad engineer in times of war, "talk his language" and co-operate with him in producing results. In this connection it may be of interest to state that arrangements have already been made and are now being carried out to train regular engineer officers along certain specialized lines of civilian engineering practice at civil educational institutions. This is to be followed by the detail of selected engineer officers for practical training with civil industrial institutions.

A fundamental knowledge of military requirements and military economics, a broad mind resulting from proper training and diversified experience, practical resourcefulness and courage in assuming responsibility—these should be the qualities of the military engineer, rather than highly specialized technical knowledge. It is at the development of such characteristics that the training of the military engineer should aim. If, in addition, a limited amount of specialization is practicable, so much the better. But the narrowing influences of over-specialization the military engineer must carefully avoid.

So important is a broad knowledge of military requirements and military methods, if results are to be attained under war conditions, that it would seem generally unwise to commit an important military construction project to the *sole charge* of a civilian engineer *having no military training.* However skilled he may be in civil construction, more than this is needed to assure success in war.

On the other hand, the military engineer, charged with the supervision of important construction projects with which he is not himself thoroughly familiar as a result of practical experience, will have need and will be wise to avail himself of the advice and assistance of officers with civil experience along the lines of the work in question.

Construction in time of war is the field for the meeting of the "military" mind and the "non-military" mind. If these two minds can be combined in one individual, even to a limited extent, many dangerous mistakes in practice may be avoided. To develop such composite minds for the future service of our country, is the purpose of our present system of engineering training for regular officers, our military training for the Reserve Corps and R. O. T. C. And it is, moreover, a prime function of the Society of American Military Engineers and of this Journal.

Wanted—Suggestions!

The Society of American Military Engineers now has a membership of more than 3,600, covering a wide field of engineering activities. The bulk of the membership is drawn from the Engineer Officers' Reserve Corps.

It is the aim of THE MILITARY ENGINEER to publish articles that will appeal to the membership at large as being well worth reading. It must be borne in mind, however, that the *raison d'etre* of the Society and its journal is PREPAREDNESS, and in the interests of preparedness the most important function of the Society and its journal is the provision of a meeting ground for those engaged in the military service and those now engaged in civil pursuits who will be called into military service in time of emergency. The development on the part of each of these bodies of a knowledge and appreciation of the problems and the point of view of the other, will greatly facilitate their amalgamation in time of emergency into a single body capable of devoting the maximum engineering effort to the common cause.

The military field will furnish material for many articles that would be of great interest to those in the military service, and the civil field will yield data of vital interest to practising engineers; but the purely military field is covered by official publications and Army educational institutions, and the technical press covers all the requirements of the civilian engineer. The aim of THE MILITARY ENGINEER is to provide a connecting link between these two fields, which is obviously a more difficult task than it would be to present merely an assortment of articles, partly military and partly civil in nature.

The Editor is not a mind reader; if he were, securing articles for publication would be comparatively simple. A request to a definite person for an article on a specific subject usually meets with a willing response. When anyone is merely asked to "write an article," he always asks, "What shall I write about?"

In order to answer this frequent and insistent question—"What shall I write about"—it is purposed to publish occasionally in THE MILITARY ENGINEER a list of subjects upon which articles are desired. This list will be compiled from suggestions received from the members of the Society.

It is believed that the publication of such a list, with such additions and revisions as appear from time to time advisable, will serve as an incentive to our readers to contribute by furnishing them a definite starting point, and will also help to insure that articles published are such as will help in the accomplishment of the objects for which the Society and its journal were founded.

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Please write your suggestions on the form on page 196 and send it at once.

The following are some of the subjects that have been suggested:

"Water Supply in Mobile Engineer Operations."

"Construction and Maintenance of Ponton Bridges under Battle Conditions in France."

"Military Railway Transportation."

"Universal Service."

"Effect of Sea Water on Reinforced Concrete."

"Problem requiring the establishment of an Advanced Engineer Depot, showing Organization of Office, Methods of Purchasing from Local Sources, Methods of Storage and Issue of Material."

"*Esprit de corps* among Reserve Officers."

"Developments in Methods of Using Explosives During the War."

"Methods of Administration, Cost Analysis and Progress Reports on Engineer Construction Work."

"Roads and Road Making in Battle Areas."

"Maintaining Interest in Local Posts of the S. A. M. E."

"Proportions of Men Skilled in Advanced Trades Required for a Well-balanced Divisional Engineer Regiment."

The R. O. T. C.

THERE is perhaps no more important item in our present policy of national preparedness for war, nor one more deserving of support, than the Reserve Officers' Training Corps, popularly known as the R. O. T. C. The primary object of the Reserve Officers' Training Corps is to provide systematic military training at civil educational institutions for the purpose of qualifying selected students of such institutions as reserve officers in the military forces of the United States. It is intended to attain this object during the time that students are pursuing their general or professional studies with the least practicable interference with their civil careers, by employing methods designed to fit men physically, mentally and morally for pursuits of peace as well as pursuits of war. There can be no doubt that such military training properly conducted and properly correlated with the primary objects of the institutions concerned will contribute greatly to the development of better citizens.

In a recent statement, President-elect Harding expressed his appreciation of the usefulness and importance of the R. O. T. C. and his belief that it should be improved and extended. Members of Congress have also recognized the value of this movement. In his discussion of the Army Appropriation Bill in the House of Representatives, the chairman of the sub-committee, Mr. Anthony, stated that the bill provides $3,000,000 for the continuation of this work. He stated that his committee proposed to grant sufficient funds to keep up this activity to the fullest extent.

In the event of war our greatest need is for trained officers to supplement our regular force. In the late conflict some 200,000 were employed. It is our present policy to establish a large Officers' Reserve Corps from which a considerable part of the need may be filled. At present the Reserve Corps includes a large number of men who saw service in the World War. But as time goes on, the number of such will become progressively less.

To have even a list of men who are probably eligible to become officers is of some value, to be sure, but such a list does not take the place of a reservoir of really trained officers. To administer practical training to Reserve Corps officers, all busily engaged in their normal vocations, will be a most difficult matter, and since the end of the war nothing of the kind has been practicable. Plans for training are now being prepared by the War Department, but the execution of these plans is contingent upon the appropriation of the necessary funds by Congress. To assemble the men alone will be exceedingly expensive.

Present plans contemplate calling out Reserve Officers for only two weeks' field traiing each year, *provided funds are available.* This is all the time that men in civil pursuits can be expected to devote to active military training, and even this will be an embarrassment in many cases. Yet it is manifestly insufficient time for producing trained officers. Adequate fundamental military training must be provided before the officer enters the Reserve Corps, and his annual two weeks' training periods will then serve to keep him in close touch with military affairs, and to guide his voluntary study of military subjects. The R. O. T. C. is the chief agency for providing the necessary fundamental military training; without it there would be grave danger that the Reserve Corps would eventually become merely a "paper organization."

The R. O. T. C. course includes from three to five hours per week of theoretical and practical instruction during the first two years of college and five hours per week during the last two years. The instruction at the institutions is supplemented by a summer instruction camp of six weeks' duration. The Engineer summer camp has been described by Capt. W. D. Styer, C. E., in a recent issue. The instruction in all institutions is given by selected officers and non-commissioned officers of the regular army, and is closely supervised and directed by the General Staff and the chiefs of the various services.

The present strength of the "senior" (college) branch of the R. O. T. C. is approximately 50,000, and training for all the combatant arms, including engineers, is provided. There are now 3,000 students enrolled in the 19 engineer units in prominent engineering institutions of the country.

The R. O. T. C. has the great advantage that the military training is administered without interference with civil activities, and at a very low cost. Moreover, the advantages derived from the training are not limited to its military application. Enrollment in the R. O. T. C. is primarily a patriotic duty, but the subjects taught and the methods of instruction followed should appeal to the faculty and the student body, not only as a contribution to the national defense, but also as an educational measure of direct utilitarian value in a civil career. The R. O. T. C. enriches the educational resources of colleges and schools by contributing new methods, problems, equipment and applications.

The civil application and value of such courses as Hygiene and Sanitation, Physical Training, Military Law and Administration, Map Reading, Roads, Railroads and Bridges, will be readily apparent. Moreover discipline is just as essential in a construction camp or an industrial or commercial organization as in a military unit, and the fundamental principles of organization apply equally to civil and military service. The basic principles of administration and supply are common to peace and war. The time devoted to a well-balanced course of military training will not be lost, even should the student never be called to do his share in the defense of his country.

From this reservoir of trained young men most of the "recruits" for the Officers' Reserve Corps will in future be drawn. It will be conceded that no more effective and economical plan of providing at least partly trained officers to meet the emergency of war, is possible under the admittedly weak military policy dictated by the temper of the American people.

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Prize Article

THE MILITARY ENGINEER offers a prize of $100.00 for the best article appearing in its columns during 1921.

The article may be on any subject, either civil or military, which will be of interest to the members of the Society of American Military Engineers. The subject need not be taken from the published list of suggestions.

The articles submitted will be judged according to their professional interest and literary merits, but especially by the extent to which they advance the aims and purposes of the Society.

Articles should be not less than four nor more than seven magazine pages (5,000 to 8,500 words) in length. Drawings, if submitted, should be on tracing cloth or white paper, ready for reproduction. (Titles of drawings should not be included in the border, but written in pencil outside).

The articles will be judged by a board consisting of not less than three nor more than seven officers, a majority of whom shall be Reserve Corps or former emergency officers.

The contest is open to all members and associate members of the Society.



The Society Emblem

The membership of the Society of American Military Engineers will be gratified to learn that the Society emblem has now reached the production stage. The illustration above is a cut of a plaster cast of the insignia drawn from a mold under the direction of the sculptor. Due, however, to the medium and to mechanical limitations incidental to reproduction in this form, the cut does justice neither to the design itself nor to the workmanship embodied in the master die. The lines of the emblem when finished in metal will be sharper, cleaner and altogether more virile than can be indicated on the flat surface of this page. The device being built up from rim to center, will have a pronounced relief, will contain a very desirable weight of metal and will avoid the objectionable appearance of stamped tin, so frequently encountered in insignia of this kind. As compared with the drawing published on the front page of the last number of this journal, the lines of the head and wings of the eagle have been improved in the sculptor's model. Minor changes have also been made with a view to enhancing the appearance of the emblem when reproduced in metal.

The symbolism of the emblem has been indicated in previous issues of this journal, and need not be repeated here. Every effort has been made to maintain the correct heraldic significance of the various elements. The number thirteen, symbolic of the original thirteen colonies from which this nation has been derived, is repeated not only in the bars on the shield, but also in the leaves of the olive branch and in the sheaf of arrows grasped by the eagle. It is again repeated in the number of berries on the laurel wreath surrounding the shield. The castle is correct in every detail, having been modeled on the lines of the original drawing, which was made about 1840, when, in its present form, it was first authorized for wear on the uniform of the Corps of Engineers. Incidentally, it may be observed that the chenelles, or embrasures at the tops of the three towers and in the curtain walls between them, also number thirteen. Whatever may have been the origin of the superstition which attaches to this number as one of ill omen, it certainly can have no terrors for the United States—sprung from thirteen independent, weak little settlements on the Atlantic Coast and now welded into a single united nation, the greatest in the world, with potentialities undeveloped.

For the present the Society emblem will be produced in bronze or in gold, according to individual tastes. It will be supplied for wear as a lapel button or as a charm for the watch chain. It can also be furnished with a security brooch-pin if so desired, though this entails a small extra charge. It will be five-eighths of an inch in diameter, or practically the size of the Victory Button and one-third the size of the cut herewith. At some time in the future it may be possible to produce the emblem in miniature form should a demand develop for a smaller size. It will, however, scarcely be practicable to enamel the surface of the shield in red, white and blue as has been sometimes suggested. On account of the superimposition of the castle, it will be difficult to apply the enamel satisfactorily to the small surfaces on the shield available for enamel of each of the three colors.

Orders may now be placed with the Secretary of the Society for emblems in accordance with following prices, viz:

Material	*Button or Charm*	*Brooch-pin*
Bronze	$0.75 each	$1.00 each
10k Solid Gold	5.00 each	5.50 each
14k Solid Gold	6.00 each	6.50 each

In ordering, specify carefully the form of the emblem—that is to say, whether desired as a lapel button, as a watch charm or equipped with security brooch-pin device. Orders will be filled as rapidly as conditions of production permit.

The emblem will also be made up in silver, but not for sale, as it is purposed issuing a silver emblem free of cost to every present member who secures three new members. A letter containing this offer and three application blanks will shortly be sent to all members.

The emblem is handsome and distinctive in appearance and one which can be worn with pride by every member of the Society as the symbol of a rational belief in the wisdom of a foresighted constructive policy of national defense.

Annual Meeting of the Society of American Military Engineers
January 14, 1921—Minutes

1. The Annual Meeting of the Society of American Military Engineers having been called for the fourteenth of January, 1921, in accordance with the provisions of Article VIII, Paragraph 1, of the By-Laws, the meeting was called to order by the temporary President, Gen. Wm. M. Black, at 2.15 P. M., in the Blue Triangle Club House, 20th and B Streets, N. W., Washington, D. C.

2. Seventy-five members of the Society were present.

3. The meeting was conducted in accordance with Article XI of the By-Laws.

(1) The reading of minutes of the preceding meeting was dispensed with, as this was the first annual meeting.

(2) Report of the Board of Directors, by Maj. Gen. W. M. Black, President:

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a. On November 1, 1919, a board of officers was appointed by the Acting Chief of Engineers, U. S. Army, to effect an organization for an Association of Engineers in the Military Service.

b. The first meeting of this Board was held on November 28, 1919. At the meeting the name of the association was fixed as "The Association of American Military Engineers," and the Association was authorized to publish a bi-monthly periodical to be named THE MILITARY ENGINEER, which publication was to take the place of the PROFESSIONAL MEMOIRS, published by an informal association within the Corps of Engineers. A committee was appointed to draft a constitution for the Association.

c. Meetings were held on December 30, 1919, and on January 14, 1920, at which drafts of the constitution were considered. The name of the Association was changed to "The Society of American Military Engineers." On January 14 Major Bond was authorized to solicit membership in the first publication of THE MILITARY ENGINEER.

d. The printing plant and assets of THE PROFESSIONAL MEMOIRS (valued at about $12,000) were turned over to THE MILITARY ENGINEER as a publishing plant and not to the Society. This gave the publication of the Society an excellent start. THE MILITARY ENGINEER set up its printing plant and started to publish the journal.

e. In the spring of 1920 a canvass was taken of the regular and emergency officers serving in the Corps of Engineers to ascertain their attitude toward the new Society. Of those who replied, 226 regular officers were in favor of the Society and 8 were not; and 85 emergency officers were in favor, and 2 were not.

f. On May 28, 1920, a number of members of the Society who, it was thought, would take a live interest and who represented the various classes of members were invited to join the Board of Officers, appointed on November 1, 1919.

g. The first meeting of this new Board was held on June 2, 1920. At this meeting a temporary organization was perfected and temporary officers were elected to carry on the work of the Society until the first annual meeting, when regular elections would be held. A Committee on Development was appointed with Major Bond as chairman, and a Committee on the Design of Emblem or Badge with Colonel Youngberg as chairman.

h. The design for an Emblem for the Society was finally settled, by the temporary Board of Directors, by a letter vote taken in December, 1921. The design appears on the January-February, 1921, issue of THE MILITARY ENGINEER.

i. In September, Colonel Bond recommended to the Executive Committee that because of the expense of operation, the printing plant operated by THE MILITARY ENGINEER be sold, and that the journal be printed by contract. The Executive Committee consented, and, finally, arrangements were made whereby the plant was sold, and a contract was entered into for printing the journal for a period of five years.

With the issue of November-December, 1920, the journal of our Society, THE MILITARY ENGINEER, closes its first successful year. Born under conditions most discouraging and difficult from a financial and other points of view, it has been a worthy organ of our Society, a strong bond of union between our members. Probably more than any other single influence it has contributed to the healthy growth of the organization. Its columns have included handsomely illustrated articles on a wide variety of civil and military subjects, of great interest to all engineers. The contributors to its pages have included many men who won undying fame in the World War, as well as many who have achieved national distinction in civil engineering. But in particular our journal has fulfilled its mission and earned the praise of all who have seen it, because it has truly interpreted and represented the *spirit of service* of the engineer to his country. Its columns have breathed enthusiasm and devotion to duty. No periodical can have a higher aim than this.

That advertisers have appreciated the influence of THE MILITARY ENGINEER is indicated by the growth in the number of its advertising pages from thirteen in its first issue to thirty-five in the issue of November-December, 1920.

All of our members, whose support alone has rendered possible our progress, should feel a just satisfaction and pride in the excellent results thus far achieved and the bright outlook for the future. Less than one year from the time when our Society first took form in the minds of a few men, finds it a strong and flourishing organization of some 3,592 members, supporting and publishing its own journal with local sections established in most of the leading cities, and growing at a rapid and steady rate. Truly this is a most satisfactory result for so short a period. I offer my heartiest congratulations to all our members, and I look confidently forward to greater progress during the coming year.

W. M. BLACK,
Major General, U. S. Army (Retired),
President, Society of American Military Engineers.

(3) Report of the Secretary, Maj. D. L. Weart:

a. Total number of applicants for admission 3,301
This includes 500 applicants who did not remit check with application.
b. Number of applications passed by Membership Committee .. 2,059
This includes 2 life members, 1,962 active members and 95 associate members.
c. Number of applications awaiting action of membership committee 742
d. Number of other paid subscriptions to THE MILITARY ENGINEER 375
e. Total number of subscribers to THE MILITARY ENGINEER .. 3,676
f. Number of copies of THE MILITARY ENGINEER sent to advertisers, exchanges, etc. 137
g. Total circulation of THE MILITARY ENGINEER 3,813
h. Number of organized local posts of the Society 16

Situated at—	Situated at—
Chicago, Ill.	New York, N. Y.
Cleveland, Ohio.	Philadelphia, Pa.
Duluth, Minn.	Pittsburgh, Pa.
Jacksonville, Fla.	Portland, Oreg.
Los Angeles, Calif.	San Francisco, Calif.
Milwaukee, Wis.	St. Louis, Mo.
Montgomery, Ala.	Seattle, Wash.
New Orleans, La.	Wilmington, Del.

REPORT OF THE TREASURER.

Washington, D. C., January 1, 1921.

To the Acting Treasurer,
The Society of American Military Engineers.

Sir: In compliance with the provisions of Article V, By-Laws, I submit herewith my report for the year 1920 as acting Assistant Treasurer of the Society. I have been actively connected with the Society since June 22, 1920, but have incorporated within my report all transactions for the entire year.

The funds of the Society have been kept by and in the name of THE MILITARY ENGINEER at The Washington Loan & Trust Company during the months of January and February and at the Federal National Bank during the balance of the year. Disbursements have been made by myself under the direction of the Managing Editor and by the preceding Business Manager.

Membership dues during the year have been fixed at

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$4.50, but drives have been made which allowed trial subscription to our Journal for $1.00 or $1.50. During four months of the year we maintained and operated a printing plant at 423 G St., N. W., which did our own printing as well as other commercial work, such as printing two numbers of ARMY ORDNANCE.

There follows a list of our assets and liabilities at the close of business December 31, 1920:

ASSETS.

Two Bonds—Chicago City Railway Co., 5 per cent—Nos. 5476-7; Maturing 1927; Interest February and August	$2,000.00
Two Bonds—Maryland Electric Railway Co., 5 per cent—Nos. 4787-8; Maturing 1931; Interest April and October	2,000.00
One Bond—Chattanooga Electric Railway Co., 5 per cent—Matured 1918; Entered for Collection Federal National Bank	1,000.00
Accrued Interest on above Bond	115.00
Five Notes—Frank T. Fuller and Wm. Busey, bearing 4 per cent Interest; Due October 1st of each year beginning 1921	7,500.00
Property and Furniture (approximately)	650.00
Accounts Receivable (approximately)	3,500.00
Cash on Hand, Federal National Bank	1,246.71
Total	$18,011.71

LIABILITIES.

Due D. L. Ward Co., for paper	$746.45
Due E. C. Gramm, for electrical work	361.00
Due Standard Engraving Co., for cuts	199.63
Due Ault and Wiborg, for ink	10.10
Due Acheson Ink Co., for ink	10.00
Outstanding checks	127.85
Total	1,455.03
Balance	16,556.68
Total	$18,011.71

THE MILITARY ENGINEER is at present under a two-year contract, dating from April, 1920, with Messrs. Escaville and Mackay for advertising. They have contracted to get at least 20 pages of advertising for the present and 30 pages starting with the May-June, 1921, issue, at the rate of $40.00 per page net to us, or about $7,200.00 per year. We have from our old advertisers about 6 pages of advertising at $81.00 per page per issue, or $2,916.00 per year. The success of our advertising depends upon our circulation, but it is fair to expect $10,000 per year from it.

Dues are at present fixed at the rate of $4.50 per year, including subscription to the Journal. Applicants for membership, mostly eligible, and members number about 3,500. and with a continuation of the present enthusiasm our number should not fall lower than 3,500 for the year. Their subscriptions expire about as follows:

700 expire with the January-February number.
500 expire with the March-April number.
200 expire with the May-June number.
200 expire with the July-August number.
300 expire with the September-October number.
1,600 expire with the November-December number.

(It is thought that all subscriptions should be made to expire at the end of the year.)

These members would pay as dues a total of $15,750.00 for the year.

On October 1, 1920, we sold to Frank T. Fuller and Wm. Busey our printing plant at 423 G Street, Northwest. They gave us in return $7,500.00 in notes, payable $1,500.00 yearly for five years with 4 per cent interest, and I have recorded with the Recorder of Deeds a chattel mortgage on the property until the final note is paid in October, 1925. Fuller and Busey have also contracted to do our printing of THE MILITARY ENGINEER for the same period of time, the contract price to be adjusted each six monhs. At present the price is $2,161.50 for 3.000 numbers, with 80 pages text and 4 pages cover. Our increased circulation demands about 4,000 copies at present, and our increased advertising warrants about 96 pages text with 4 pages cover. The price of this, including cuts and halftones, should not exceed $18,000.00 per year, or $3,000.00 per issue.

From these figures we have:

Probable income—	
Advertising	$10,000.00
Subscriptions	15,750.00
Note due October 1, 1921	1,500.00
Interest on notes and bonds	260.00
Total	$27,510.00
Probable expenditures—	
Printing journal	$18,000.00
Clerical work	3,000.00
Jobwork, drives	1,500.00
Postage	1,000.00
Rent	300.00
Outstanding indebtedness	1,350.00
Total	$25,150.00

RECEIPTS AND DISBURSEMENTS FOR THE YEAR 1920.

Period Brought Forward	Subscriptions	Advertisers	Jobwork	Miscellaneous	Total receipts	Balance	Disbursements
Balance on hand January 1, 1920						$4,240.36	
January	$580.90	$134.74	$7.00	$2,054.92	$2,777.56	$813.64	$6,204.28
February	389.78	5.00		67.40	462.18	340.65	935.17
March	798.36	195.49		387.26	1,381.11	266.25	1,455.51
April	1,367.24	113.06	2.00	214.79	1,697.09	437.87	1,525.47
May	2,035.91	168.24	250.00	79.14	2,533.29	580.02	2,391.14
June	1,474.64	194.26	94.25	28.95	1,792.10	936.91	1,435.21
July	1,596.43	650.72		39.36	2,286.51	294.88	2,928.54
August	989.30	91.60	2,112.30	58.59	3,251.79	1,857.10	1,689.57
September	1,432.02	738.33	184.88	76.84	2,432.07	1,708.98	2,580.19
October	1,676.11			138.85	1,814.96	1,132.89	2,391.05
November	626.42	879.56		1,659.34	3,165.32	658.23	3,639.98
December	2,588.79	176.44		12.70	2,777.93	1,118.86	2,317.30
Total	$15,555.90	$3,347.44	$2,650.43	$4,818.14	$26,371.91		$29,493.41

January 12, 1921. Audited and found correct

H. R. RICHARDS, *Member,*
Chairman of Auditing Committee.

W. O. TUFTS, *Member.*
FRANK T. FULLER, *Member.*

These are fair estimates for the year 1921, and under the By-Laws of the Society it is the duty of the Treasurer for the year 1921 to acquaint the Board of Directors with any deviation from these figures if they are adopted. Our first year closes with our Society on a firm financial footing and with the best prospects for the future, but the hearty cooperation of the officers, members and editorial staff must be forthcoming to make our body perpetual.

Respectfully submitted,

JOSEPH J. TWITTY,

January 14, 1921. *Acting Asst. Treasurer.*

To the Secretary of the Society
of American Military Engineers.

Approved and transmitted for your information.

W. O. TUFTS,
Acting Treasurer.

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(4) Election of Officers and Directors.

The following election tellers were appointed by the President:

Col. G. B. Pillsbury and Col. A. H. Brooks.

(5-6) Reports of Standing and Special Committees; no reports.

(7) Miscellaneous business; none.

(8) Report of Election Tellers—total votes cast, 958:

For President

Maj. Gen. W. M. Black	954

For First Vice-President

Col. Wm. Barclay Parsons	949

For Second Vice-President

Col. Charles Keller	950

FOR DIRECTORS

Regular Army

Maj. Gen. W. C. Langfitt	949
Col. Mason M. Patrick	950
Col. Wm. V. Judson	950
Col. Harley B. Ferguson	945
Lt. Col. G. A. Youngberg	944
Maj. Richard Park	940

Reserve Corps

Col. Chas. A. McKenny	955
Col. Perley F. Walker	951
Lt. Col. J. H. Finney	951
Col. C. Van Deventer	948
Lt. Col. Harris P. Ralston	947
Maj. Percy E. Barbour	949
Maj. Joseph H. Wheat	949

Membership at Large

Col. C. H. Birdseye	948
Col. F. G. Jonah	950
Col. F. A. Molitor	939
Maj. W. O. Tufts	944
Maj. Geo. O. Totten	946

(9) Announcement of election of new Officers and Directors. The Ballot was elected.

(10) Literary and Social Program.

As the meeting was preceded by a luncheon and an address by the Assistant Secretary of War, Mr. William R. Williams, whose article, "The Council of National Defense and Industrial Preparedness," appears in this issue, no further program was prepared.

(11) The meeting adjourned at 2.45 P. M.

D. L. WEART, *Secretary.*
Major, Corps of Engineers.

MEETING OF BOARD OF DIRECTORS

1. A meeting of the Board of Directors having been called to meet immediately after the Annual Meeting of the Society, the meeting was called to order by the President at 2.50 P. M., at the Blue Triangle Club House, 20th and B Streets, N. W., Washington, D. C.

2. Present:

Gen. William M. Black	Col. Chas. A. McKenney
Col. Charles Keller	Maj. J. H. Wheat
Col. Mason M. Patrick	Col. C. H. Birdseye
Lieut. Col. G. A. Youngberg	Maj. W. O. Tufts

3. Absent:

Col. Wm. Barclay Parsons	Lieut. Col. H. P. Ralston
Gen. W. C. Langfitt	Maj. P. E. Barbour
Col. Wm. V. Judson	Col. F. G. Jonah
Col. Harley B. Ferguson	Col. F. A. Molitor
Maj. Richard Park	Col. C. Van Deventer
Col. P. F. Walker	Maj. G. O. Totten
Lieut. Col. J. H. Finney	

4. The following business was presented to the Board by the President:

(a) Appointment of Secretary for year 1921.

1. In accordance with Article II, Paragraph 5, of the By-Laws, Capt. H. B. Richards was appointed Secretary for the year 1921.

(b) Election of Treasurer.

1. In accordance with Article II, Paragraph 5, of the By-Laws, Maj. W. O. Tufts was elected Treasurer for the pear 1921.

(c) Term of office for members of Board of Directors.

1. In accordance with Article VIII, Paragraph 3, of the By-Laws, Directors were selected by lot to serve for 1, 2 and 3-year terms. Col. Mason M. Patrick was directed to draw the lots. The result of the drawing is as follows:

For Directors

Regular Army

	Years
Maj. Gen. W. C. Langfitt	3
Col. Mason M. Patrick	1
Col. Wm. V. Judson	1
Col. Harley B. Ferguson	3
Lt. Col. G. A. Youngberg	2
Maj. Richard Park	2
Col. Chas. A. McKenny	3

Reserve Corps

	Years
Col. Perley F. Walker	1
Lt. Col. J. H. Finney	2
Lt. Col. Harris P. Ralston	1
Maj. Percy E. Barbour	2
Maj. Joseph H. Wheat	3

Membership at Large

	Years
Col. C. H. Birdseye	3
Col. F. G. Jonah	1
Col. F. A. Molitor	1
Maj. Geo. O. Totten	3
Maj. W. O. Tufts	2
Col. C. Van Deventer	2

(d) Election of members for Executive Committee.

1. In accordance with Article III, Paragraph 2, of the By-Laws, the following members of the Board of Directors were elected to serve on the Executive Committee:

Maj. J. H. Wheat — Col. C. H. Birdseye
Col. Mason M. Patrick

(e) Budget for year 1921.

1. In accordance with Article V, Paragraph 4, of the By-Laws, the budget which is included in the report of the Treasurer, submitted at the Annual Meeting, was tentatively accepted for the year 1921.

(f) Resolution of Chicago Post. "Junior Membership."

Action: A committee consisting of Col. G. A. Youngberg, Col. C. H. Birdseye and Maj. W. O. Tufts was appointed to consider the resolution and report to the Board.

(g) Change in date of the Annual Meeting suggested by Col. F. C. Jonah.

Action: The Secretary was directed to write to Colonel Jonah and inform him that Article XII, Paragraph 2, of the By-Laws, provides for amendments to the By-Laws, and that if he will submit his suggestion in the manner required, the Board will be pleased to consider the proposal.

(h) Resolution of the New York Post, proposing that travel orders be issued by the War Department for Army Officers addressing Posts on subjects of military nature.

Action: It was decided that no formal action could be taken on the Resolution. The Secretary was directed to inform the Posts that if they desired to have Army officers address them on military matters, they should apply to the Secretary, stating the subject which they wished to have covered, and then an effort would be made, in an informal way, to provide a speaker.

5. The Board adjourned at 3.15 P. M., to be reconvened at the call of the President.

D. L. WEART, *Post Secretary,*
Major, Corps of Engineers.

Permeability of concrete

Tests by the Bureau of Standards indicate that concrete is far more impermeable to water than the limestones and sandstones employed for building purposes. Stone slabs from 1¼ to 2½ inches in thickness were penetrated in from 10 seconds to 19 minutes by water at 60-pound pressure. A slab of 1.6 Portland cement mortar, 2 inches thick, resisted penetration for 3½ hours. A slab of 1:1½:2 concrete was penetrated to a depth of ½-inch in 24 hours.

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New York Post Endorses Bill for Retiring Emergency Officers on Regular Basis

The annual meeting of the New York Post of the Society of American Military Engineers was held at a Beefsteak Dinner at Keen's Chop House, in New York, on the night of January 26. There were sixty-five present.

The tellers appointed to canvass the votes on the ticket nominated by the Nominating Committee reported the election of the following officers and directors:

Gen. W. C. Langfitt, President; Col. A. S. Dwight, Vice-President; Maj. Percy Barbour, Secretary; Maj. E. G. Sherwood, Assistant Secretary; Maj. P. B. Fleming, Treasurer; Col. R. D. Black, Col. F. E. Humphrey, Col. T. T. P. Luquer and Col. Geo. A. Johnson, Directors.

The Secretary was instructed, by unanimous vote, to wire Hon. John J. Esch, of the House of Representatives, in support of the bill providing for the retirement of disabled emergency officers on the same basis as Regular Army officers.

The dinner was then given over entirely to social features, including humorous speeches by many of the incoming and outgoing officers, interspersed with music furnished by professional entertainers and songs by the Post.

New York Post, Society of American Military Engineers, Launches Membership Drive

At a recent meeting of the board of directors of the New York Post, Society of American Military Engineers, the membership committee was enlarged as the first step in an intensive campaign to bring into the organization ex-service men and others interested in the national defense. There are now 111 members in the Post, and it is estimated that in New York and vicinity there are from 800 to 1,000 ex-service engineers eligible to membership.

The new membership committee, which still retains as its chairman the chairman of the old committee—Col. T. C. Clarke— is composed of the following men: Cols. O. B. Perry and E. S. Shaughnessy; Lieut. Cols. Philander Betts, J. P. Hogan and Evarts Tracey; Majors J. P. Hallihan, Chandler Davis, E. C. Church, Irving V. A. Huie, W. J. Hammer, A. C. Harper, J. W. Mark and E. E. Sherwood, and Lieut. A. D. Fitzgerald.

Federalization of 22nd Engineers, National Guard, New York

Five former colonels and the New York Post of the Society of American Military Engineers were the guests of honor at the military review of the 22nd Engineers, given at 8.30 P. M., November 15, at the regiment's armory, 168th Street and Fort Washington Avenue, New York City.

The 22d Engineers is the first National Guard engineer unit to become federalized, the completion of its federalization taking place November 5. It was partly in celebration of this event, and partly as an honor to the retiring colonel of the regiment, that the review was held. Col. George D. Snyder, the retiring colonel, acted as reviewing officer. Col. F. E. Humphreys, a graduate of West Point, but who is not now in the Regular Army, is the 22nd's new commanding officer.

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Rope Mat Reinforcement for Dredge Sleeves

By

J. H. Polhemus

General Manager, Port of Portland, Oregon

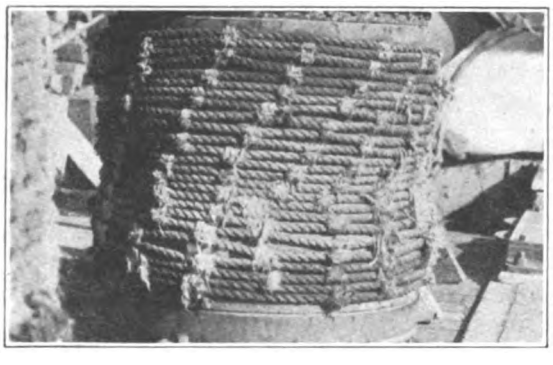
(Continued from Page 119)

For the information of pipe-line, hydraulic dredge operators there is submitted the design and description of a rope mat reinforcement for the rubber sleeves at the flexible joints in the discharge pipe line, or what is generally termed "the floating or ponton pipe line."

The Port of Portland for the past 22 years has been operating, on a large scale, hydraulic pipe-line dredges, and the cost of rubber sleeves has been as always, a very serious question, especially on the very high powered, 30-inch dredges.

Metal flexible joints of several different types for the pipe line have been tried at times, but they were not found satisfactory or suitable for the ponton pipe line.

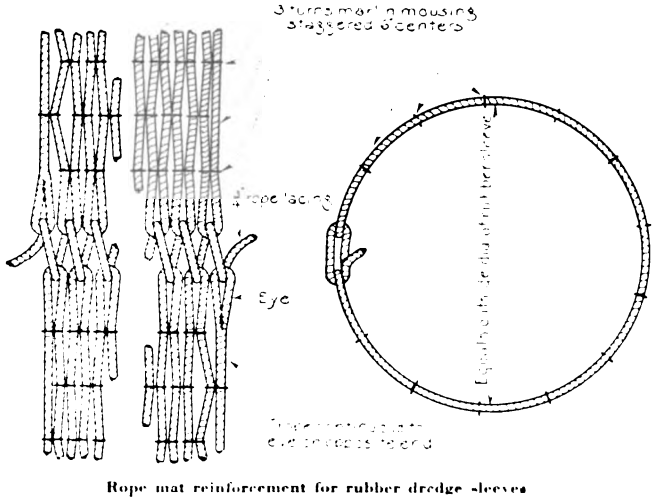
The first reinforcement for the rubber sleeves was tried about ten years ago on our dredges. This was an iron ring clamp around the middle of the sleeve. This, however, cut



the sleeve and also would slip to the end when the pump was stopped. Chains were next used, but with little more success.

The sleeves were later served with rope, but this was not entirely successful, as the rope would not stay in place.

The rope mat as now used very successfully on all of our dredges, and the two 24-inch dredges of the U. S. Engineer Department in this district, was first designed and used by Captain Johnson on The Port of Portland's 30-inch dredge *Tualatin* in 1917.



Rope mat reinforcement for rubber dredge sleeves

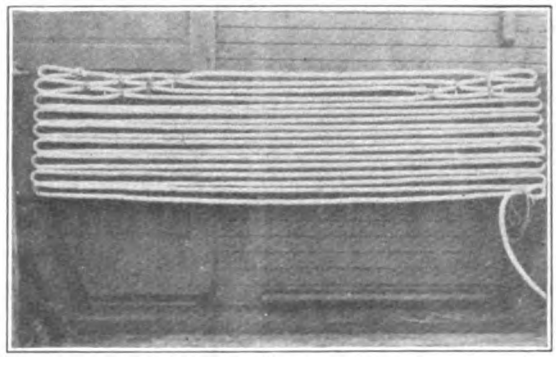
This mat is made of old rope stretched over a rack and tied with rope yarn. The mat is then placed on the rubber sleeve and laced in place. The accompanying drawing clearly shows how the rope mat is made. Old rope makes a better mat than new rope, due to the fact that the stretch has been taken out.

The picture shows one of the spare 30-inch rubber sleeves fitted with a rope mat, and the pegs or templet on which the mat is made.

The material handled by these dredges varies from coarse, heavy, sharp sand to heavy gravel. Some clay is encountered at various locations in the harbor and is awkward to handle. It has been found necessary at times to shut the dredge down as many as fifty times during a 24-hour day to clean the pump but, of course, this is unusual.

The average harbor dredging conditions require a 3,500-foot pipe line and 30-foot lift from water surface to top of fill, the pipe line pressures running as high as 50 pounds per square inch.

The average life of the 10-ply, 30-inch rubber sleeve, such as we have been using, served with rope mats, under average dredging conditions, is 300 working days. The average life of the same sleeve under like service without the mats is 150 working days. Hence we have doubled the life of our



rubber ponton pipe-line sleeves by the use of this simple and inexpensive rope mat. Also the wear and tear is much more severe on the large 30-inch dredges than on the 20-inch dredges, and the sleeves are subject to more accidents, making the rope mat protection the more necessary.

Concrete Construction in the Tropics

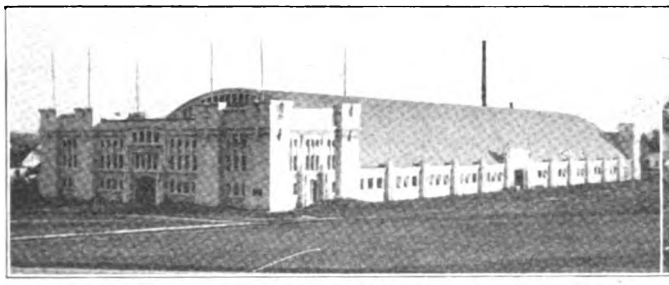
That the tropics, where Jack Frost is conspicuous by his absence, is the ideal place for the use of concrete in building construction, has long been appreciated. Yet American manufacturers have apparently thus far failed to develop the possibilities of this market. We have not advertised our products.

Because of the presence of wood-eating ants no wood construction in the tropics has any great degree of permanence; and wood is at least twice as costly as in the United States. Concrete, on the other hand, is cheaper and more durable in the tropics than in the temperate zone.

Our architects have failed to adapt concrete construction to the needs of the dweller in the tropics. A modified New York house is not suitable for Central America. More window space is needed, and a greater capacity per occupant.

A distinctive design, adapting concrete construction to the characteristic dwelling of the tropics is needed, and the tropics look to America to provide such designs.—*Concrete.*

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The large and handsome armory of the Oregon Agricultural College



The Engineer Battalion pitching shelter tents, Oregon Agricultural College

Engineer Reserve Officers' Training Corps

Instruction at Educational Institutions

By

Patrick H. Tansey
Captain, Corps of Engineers

SO extensive is the scope of activities with which the Corps of Engineers is charged in time of war, that the few officers holding permanent commissions therein must be assisted in the execution of their numerous and studendous tasks when the emergency of war exists. The urgent need for an Engineer Reserve Corps was recognized shortly before the World War, and at the entry of the United States into the conflict there were almost four hundred engineers enrolled in the Engineer Reserve Corps. Among this number there were very, very few who knew anything of military engineering, of the fundamental economic principles of construction in war, and limited opportunities only were afforded them for adding to their scant military education. Shortly after the declaration of war by the United States, Engineer officers' training camps were organized, and even up to Armistice Day Engineer officers were receiving a short, intensive course to fit them for duty either in the field of operations or service of supply in France. Oftentimes engineers with only several weeks' training were ordered away from the camps to active duty along lines of endeavor which they had followed in their civilian pursuits. How well they accomplished their duties history tells; nevertheless in consideration of shortage of officers during the war and the loss of time in training them while the war was raging Congress finally decided that something was radically wrong with our system of national defense.

To provide for well-trained officers in future emergencies the R. O. T. C. has been established. The primary object of the Engineer R. O. T. C. is to provide systematic training in military engineering at civil educational institutions for students actually enrolled in engineering courses at the institution, and to build up a strong and energetic Engineer Reserve Corps in which the members will not be officers merely "by Act of Congress," but also by virtue of the fact that they have been carefully selected as leaders and have been trained in military engineering and the art of war. Fortunately, this training is carried on when the students taking it are in a receptive mood; their minds and bodies are young and undeveloped; their characters are not yet formed; they are filled with intense interest and enthusiasm and the military instructors concerned are not confronted with the proposition of "teaching an old dog new tricks," as were some of the officers on duty as instructors at the Engineer Officers' Training Camps during the war.

In the article, "Summer Camps of Instruction for Engineer R. O. T. C.," Sept.-Oct., 1920, number of THE MILITARY ENGINEER, Captain Steyer stated that "The chief disadvantage of the training (training at college) or the greatest difficulty under which it labors, is that, because of the limited time and facilities available, the instruction with the exception of Infantry drill, is too largely theoretical and too little practical. This is especially true of engineering instruction. The average engineering college has very inadequate facilities for practical instruction in engineering." The above statement no doubt carried to the minds of all the Engineer officers who read that article that the work of Engineer Units at colleges is almost entirely theoretical and very little practical. The spirit of this article is to show what the work at colleges actually comprises in Military Engineering and to demonstrate that the courses are not too largely theoretical. It is contemplated that the following paragraphs shall prove a sequel or rather a supplement to Captain Styer's excellent article on Engineer R. O. T. C. camp training, and that the two articles combined will outline in a comprehensive manner the ideals, purposes, and accomplishments of the Engineer R. O. T. C. All reserve officers, no doubt, are interested to know just how their corps is to be increased and all officers of the Corps of Engineers to find out just what training their fellow reserve officers will have undergone when they join forces to meet the next national emergency.

The course of military engineering requires four college years for its completion, and the final reward for successfully passing through the four years is a commission as second lieutenant, Engineer Reserve Corps. In general this course comprises a thorough ground work in the fundamentals of military science and of engineering art as applied to war; in a word, the instruction given in engineer units at college is calculated to turn out graduates competent to perform the duties of a second lieutenant of Engineers, in garrison or in the field.

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The schedules of training are prescribed within limits by the War Department; however, they are very flexible, so that they may be applied in any college or any clime, and fit in harmoniously with local conditions and local curricula.

To make my point clear, the same schedule could not be applied in Oregon, the land of eternal rain, as might prove a success in California, where the sun is ever smiling; Boston could not follow a course of training adopted in Alabama; colleges in the heart of a city do not offer the same advantages for outdoor practical work as colleges in the country. Wisely has the War Department left to the Engineer officers in charge of Engineer R. O. T. C. units the duty of arranging the schedules of instruction as best to harmonize with local conditions, customs and traditions.

The courses as developed for Engineer units have been made very attractive and interesting, and as such have appealed strongly not only to the students, but to the faculties of our leading colleges and universities; to the students because they feel they are getting some practical good, something of an immediate utilitarian value in their own line of engineering; to the faculty because they see their own courses of engineering amplified and extended with engineering problems of a military nature, and seeing such valuable extension work accomplished, they feel compelled to co-operate with the Department of Military Engineering in every way.

As a freshman an engineering student enrolls in the course in military engineering a private of engineers, his status is distinctly that of a private; his duties and obligations, his rights and privileges within the military sphere of activities are those of a private (the fact that he is a "plebe" or "rook" or what-not, accentuates that fact also). His course of instruction under the military department for the first year is progressive and conducts his education, step by step, through the military fundamentals and such technical knowledge as an intelligent and efficient private of Engineers should have. Normally at the end of the first year of military training the private attends an Engineer basic camp, where the knowledge and training already attained are extended to include practical work. (This attendance is voluntary.) In the fall he returns to college and again registers in the Military Department. During the second year, however, he is appointed either a corporal or a lance corporal and his duties are those of a corporal in all practical work. The theoretical course of instruction during this year is calculated to render him an accomplished soldier—efficient, smart and reasonably qualified to perform the duties exacted of a "non-com" in a company of Engineers. If his work has been satisfactory during the first two years of training and he appears to have the "makings" of a soldier and engineer, he is selected to take the advanced course, which leads to a commission in the Engineer Reserve Corps. Selected as "good timber" for an officer, he enrolls in the advanced course, and during the first year of that course he is trained in the duties which a master sergeant of Engineers would ordinarily be called upon to perform. Between the third and fourth year, he attends the Engineer Advanced Camp, where he actually performs the duties of master sergeant and junior officer in the company, on the drill field, and in the solution of military engineering problems of his own selection, along the lines of his civil education. In the last year of the course he is taught the duties of a junior officer, and at the completion of his four years' course in military engineering he is reasonably qualified to perform the duties of a platoon commander in a company of Engineers. Having been graduated from the college and from the R. O. T. C. and promoted to second lieutenant, Engineer Reserve Corps, he may request to be placed upon active duty as temporary officer in the Engineers.

The object of this period of training with the Regular Army is to acquaint the reserve officer with service in the Regular Army and to enable the Government to ascertain his qualifications for future promotion by thus providing a probationary period of training under the immediate supervision of officers and with units of the Regular Army.*

If a student follows out the entire course as outlined above and in addition has had six months' training as a "shave-tail" in the Regular Army, he certainly is qualified to perform the duties of a second lieutenant of Engineers. His subsequent rank will depend upon his military engineering activities after graduation. During his entire course in the last two years each student is closely observed in all his work and is carefully rated on that work. At the training camps also he is rated upon his proficiency and his personal characteristics. During his voluntary six months' probationary period in the regular service his qualifications for future promotion as an Engineer officer are carefully ascertained by his immediate commanding officer. His record as an R. O. T. C. student and as a temporary lieutenant of Engineers, together with the record of his activities in the engineering world, after graduation, will determine in large part the nature of his duties and his rank in the next war emergency.

Now, if his four years' training at college is too largely theoretical he will be far from a practical engineer when he receives his coveted sheepskin, for after all an engineer manual does not make an engineer "by a long shot." The statement of Captain Styer to the effect "that the instruction, with the exception of Infantry drill is too largely theoretical" was once a sad truth, but that unhappy day is passing. To-day, as far as practicable, our embryo Engineer reserve officers are learning the art of military engineering by *doing*. The theoretical work is becoming more and more harmoniously balanced with the practical work in the field, and in the laboratory or drafting room. In Engineer units Infantry instruction is limited to 17 per cent of the entire four years' course, and that is largely practical; engineering is emphatically stressed. Previous to the year 1920-21, the basic course for Engineers, that is, the first two years, was largely given to infantry instruction, but under the new schedules of training as outlined above the engineer instruction begins as soon as the student enrolls in the Engineer unit at the college, and in that engineer instruction the *practical* is emphasized. The R. O. T. C. officer of the Ninth Corps Area, an Engineer of long and extended practice, demands that engineer instruction be *practical*. Certain features about a college militate against the practical, since most of the courses are largely theoretical; however, that fact alone makes an Engineer unit an interesting attraction on the college campus, if outdoor practical methods are predominant in engineer instruction.

I will show briefly how practical instruction is being effected in certain institutions where Engineer units exist. In the bridge course, bridges are actually constructed to normal scale. Some units have been compelled to construct bridges one-half and one-third size. Such construction is valuable experience to the youthful military engineer, and he actually does something—creates an engineering structure that undergoes stress that he read about in some theoretical treatise. The course in military railways has been vitalized by actual survey and location in

*The number of reserve officers called into active service with the Regular Army will of course depend upon the amount of the appropriation made by Congress for that purpose.—Ed.

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one institution. A combat railway was located under an assumed situation of warfare. This problem in the field was executed after the student was thoroughly conversant with the requirements of a combat railway, its functions and its limitations. Fortification, when practicable, is taught by actually laying out and digging trench systems; putting in the revetments; constructing barbed-wire entanglements, etc. In conjunction with such instruction a certain amount of theoretical study is necessary; however, if the practical method is followed, a student will look up all his duties even though the allotted time for home study is very short. When the student is taught hippology, he is actually brought in contact with live horseflesh, after he has studied the anatomy of the horse from a large chart furnished by the surgeon general, and perused mimeograph sheets issued to him for home study. Some institutions are fortunate enough to have the light ponton equipment; no better instruction in ponton work can be given than actual construction of the bridge on water. Practical instruction in demolitions is given by Engineer units which are blessed with facilities for storage and handling of explosives. The last few sentences show the extensive field open to practical work in Engineer units; however, the course of general construction work affords far more opportunities for practical problems in the field, laboratory and drafting room. The location of a site for a divisional cantonment, its general layout, the design of its water supply, power supply, sewerage system, sewage disposal, preliminary location of roads and railroads, mechanical installations, the design of portable power plants, etc., all these afford a vast source for actual work in the field, that can be executed just about as well at college as at the training camps, and this source is being drawn upon by the Engineer units to the gratification of the Chief of Engineers, to great satisfaction of the engineer college students, and to the growing interest of the college faculties.

The Chief of Engineers is whole-heartedly behind this practical work; the allowance of equipment is almost unlimited, if it can be shown that same can be used efficaciously in engineer instruction. Carpenter, demolition, drafting, map reproduction, photographic, pioneer, reconnaissance, surveying, office, and ponton equipment and supplies are authorized, but the Engineer unit commanders are directed to look upon this equipment as an investment and secure a reasonable return by way of increased efficiency, interest and esprit de corps of the unit. In addition two pounds of explosive are in general allowed every student taking the fortification course, provided, of course, that facilities are available for handling and storage of explosives. Authority is also granted Engineer units to make local purchases of expendable articles for use in drills and practical work in field engineering. Funds are obtained by requisition and may not exceed $300.00 for the first 50 students enrolled and $2.00 for each additional student. The above statements show the stand of the Chief of Engineers upon the Engineer R. O. T. C. training problem. One Corps Area commander of prominence and renown stated recently in an official manner that the most important work under operation in his area was the R. O. T. C. work. No doubt the force of this statement will bring home to the officers of the Corps of Engineers the vast importance of the R. O. T. C. work at colleges.

Notwithstanding the great importance of camp training in the R. O. T. C. instruction schedules, the college work cannot be overestimated. At camps, organization, administration and supply problems are easily solved, while at colleges these present many difficulties never dreamt of in a camp. At camp the atmosphere is purely military; at colleges a military atmosphere must be created. At camps discipline is easy of enforcement; at colleges it is quite a problem. And so the comparison runs down the line with the disadvantages on the college side. The officer on R. O. T. C. duty must ever play the role of the actor, the psychologist, the instructor and the diplomat; and his most difficult problems are by no means his problems of instruction.

In present-day methods of conducting warfare every science and every branch of engineering plays its part. Fundamentally military engineering problems are the same as those of any other branch of engineering, perhaps simpler, yet so extensive is the scope of military engineering that it demands wide range of knowledge in all engineering subjects. All branches of engineering send students to the Engineer units for instruction; it is therefore the duty of the Engineer instructor to show these various students just how their civil education can be put to military use in case of a war emergency, and extend that education by fitting problems of a military nature, where the fundamental principles of war economics must be applied. In addition to the solution of these military problems, the engineer students must also be trained in purely military engineering, which may include all improvisations calculated to accomplish a purpose with the swiftest dispatch. While engineering structures in the field of operations are required to be erected with great speed, and with the labor and materials available, and are in many cases makeshift structures, engineering construction in the zone of communications (the S. O. S.) and mobilization camps, etc., require the same skill and precision demanded in the world of civil engineering. In order to fit engineer students for the attack of such problems the R. O. T. C. Engineer units exist.

The Engineer R. O. T. C. is still in its infancy; modifications take place from year to year, but the policy is set and does not change, and all Engineer officers on this duty are endeavoring to carry out the policy of the War Department in this regard.

The author is of the opinion that the ideal will just about be reached when the basic course for engineer units is largely the Practical Military Engineering course at West Point with all its practical features, in conjunction with training in the military fundamentals; and the advanced course, in which the problems partake of the nature of the problems given at the Engineer School, U. S. Army, in the basic and advanced courses for Engineer officers.

The great success of the Engineer R. O. T. C. cannot be fully realized until its products are actually used in the service. Any officer is valuable inasmuch as he can relieve his immediate superior of responsibilities; in years to come when some of these embryo officers, products of the R. O. T. C., are serving in some future emergency as junior officers under the readers of this article, then can judgment be passed upon the efficiency of the Engineer R. O. T. C. As the years roll on the progress of the R. O. T. C. will continue, and a large and patriotic Engineer Reserve Corps will be established, so that in time of war the Corps of Engineers can turn with pride and confidence to its growing reserve and choose selected experts and proficient Engineer officers to carry out the tasks which war imposes.

The state of Wyoming is contemplating the installation of small beacons along its roads, to warn motorists of railroad crossings and dangerous curves. These beacons will be of the "flashing" type, 8 feet high, with a visibility of 3 miles. There will be distinctive colors for crossings and curves.—*Eng. News-Record.*

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The Council of National Defense and the Mobilization of Industry

A paper read at the informal luncheon preceding the annual meeting of the Society of American Military Engineers, at Washington, D. C., January 14, 1921, by W. R. Williams, Assistant Secretary of War

A STUDY of the history of the activities of the War Industries Board during the World War shows conclusively that not only this organization, but also the allied units of the Food Administration, Fuel Administration, Railroad Administration and War Trade Board, were created to deal with the conditions of confusion in supply existing in the early days of the war. These conditions arose because of our lack of a plan for the supply of the forces we then brought into existence. The various stages of the growth of these bodies, and especially the War Industries Board, furnish impressive evidence in support of the above conclusion.

The Act of Congress creating the Council of National Defense in 1916 was an item of constructive legislation toward national preparedness that stands preeminent in the progress toward national security. However, the Council was created such a short time before the entry of this country into the World War that it was impossible to work out a well-planned organization. It is safe to say that if the Council had been given the power of direction and control it would have evolved sub-divisions of its organization to perform the work of the War Industries Board, the Fuel Administration, the War Trade Board and the other organizations that were created to meet the necessities of war.

No amount of preparation will enable us to dispense with some organizations exercising in war the functions of the War Industries Board, because, despite the most careful plans, contingencies will arise requiring the intervention of such an authority.

In connection with any pre-war plans for the mobilization of industry, a central body acting in the capacity of a national General Staff is indispensable. Without such an organization to initiate, co-ordinate and direct the study made in the several executive departments no definite results can be attained.

While conditions existing during the World War made necessary the formation of the various units referred to above, or at least justified their organization, it is asserted that it will be fundamentally faulty to include in the preparation of plans for another industrial mobilization a body to be brought into existence for the exercise of the functions of the War Industries Board, after the emergency has arisen, or even when it is seen to be imminent. The plans should include the utilization of an existing agency, if there be any such, or, if not, necessary steps must be taken to secure legislation creating a body capable of doing its part in peace-time preparation, and in time of war of executing such of the functions of the War Industries Board and allied organizations as may be then necessary.

Fortunately, there is no necessity for the creation of a new agency. The law creating the Council of National Defense assigns to that body functions that make it peculiarly suitable as the co-ordinating agency in formulating plans for the industrial mobilization of the country for war or other great emergency, and in war of exercising such executive functions as may be necessary. The organization of this body, therefore, should have two objects—first, to perform its part in the work of preparation, and second, to allow for an orderly and immediate expansion to meet the war demands that may be made upon it. With such an organization the only action necessary to enable it to execute its war-time functions will be an executive order. Such order can only be issued pursuant to legislative authority similar to that contained in the so-called Overman Act, but it is assumed that such legislation will be enacted.

A brief consideration of the organic law and its obvious method of application will show the essential part that the Council must take in any plans for industrial mobilization. The Act approved August 29, 1916 (Bulletin 33, War Department, 1916), provides, among other things, as follows:

> That it shall be the duty of the Council of National Defense to supervise and direct investigations and make recommendations to the President and the heads of executive departments as to the location of railroads with reference to the frontier of the United States so as to render possible expeditious concentration of troops and supplies at points of defense; the co-ordination of military, industrial, and commercial purposes in the location of extensive highways and branch lines of railroad; the utilization of waterways; the mobilization of military and naval resources for defense; the increase of domestic production of articles and materials essential to the support of armies and of the people during the interruption of foreign commerce; the development of seagoing transportation; data as to amounts, location, method and means of production, and advisability of military supplies; the giving of information to producers and manufacturers as to the class of supplies needed by the military and other services of the Government, the requirements relating thereto, and the creation of relations which will render possible in time of need the immediate concentration and utilization of the resources of the Nation.

It should be noted that the Council is composed of the heads of six of the Executive Departments. These six departments may be divided into two classes—first, those which represent the great users in war time, the War and Navy Departments, and second, those that represent the productive capacity of the country, Agriculture, Commerce, Interior and Labor. The Council is the great co-ordinating agency in the preparation of plans for industrial mobilization to meet a national emergency. By virtue of its membership, it can assemble statements of requirements, data as to sources of supply, and after a comparison of the former with the latter, reach conclusions as to allocation of facilities to satisfy needs. Such allocations can be made by the Council acting for the President, and will enable the various requiring units to proceed in an orderly manner to make their detailed plans for securing the necessary supplies. In cases where facilities are inadequate to meet requirements, the Council is the proper agency to study the problem, determine the measures necessary to meet the deficiency and intitiate the proper action.

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The Council consists of the Council proper and the Advisory Commission. After the dissolution of the War Industries Board at the end of the war, the Council formed within itself a subordinate organization known as the Interdepartmental Defense Board. This is its real working unit. It consists of a representative of each of the Executive Departments whose heads form the Council proper and is under the chairmanship of the Director of the Council. Under a recently proposed reorganization of the Interdepartmental Defense Board it will have an Executive Committee consisting of the Director, the War Department representative, and the representative of the Navy. The advantages of such a Committee lie in its small personnel and in the fact that it has on it the representatives of the two Executive Departments which are the principal requirers in war and which are, therefore, most concerned with adequate war preparation.

The role assigned by law to the Council of National Defense does not contemplate or require a large organization. For its peace-time activities it can readily accomplish its task with a very limited personnel, relying on existing agencies to furnish the data needed for the development of plans of preparation. The degree of expansion to meet war conditions depends directly upon the completeness with which we solve our supply problems before the emergency arises.

On January 3, 1921, the House of Representatives, in the consideration of the Sundry Civil Bill, eliminated the item covering an appropriation of $75,000 for the next fiscal year for the support of the Council of National Defense. No fair-minded citizen can take exception to the desire of Congress to limit appropriations to essential governmental activities. Now, more than ever before, there is need for rigid economy. There is no economy, however, in eliminating an item for the support of an activity so important to the public welfare as is the Council of National Defense.

Information Concerning Appointments in the Army

Communication from The Adjutant General, U.S.A.

There are more than 4,000 vacancies in the commissioned personnel of the Army. When promotions under the reorganization law are completed, about 1,200 of these vacancies will be in the grade of first lieutenant, the remainder being in the grade of second lieutenant. While it is not proposed to fill all vacancies at present, the necessity for more officers for the Army requires that a portion of the vacancies be filled without delay. An examination for appointment will, therefore, be held April 25, 1921. This examination will be competitive for 2,585 vacancies; the appointments to be distributed among the branches of the Army as follows:

Infantry	812
Cavalry	35
Field Artillery	600
Coast Artillery	268
Engineers	118
Air Service	400
Signal Corps	114
Quartermaster Corps	35
Ordnance Department	86
Chemical Warfare Service	32
Philippine Scouts	85

As a result of this examination no appointments are to be made in branches of the service other than those named above.

The date announced is that of the final examination. Prior to that date applications must be submitted and applicants must undergo a preliminary examination. All applications are to be received and acted upon by corps area commanders, who are also charged with conducting the preliminary and final examinations. Details of information concerning examinations for appointment are contained in regulations now being distributed, and application blanks may be obtained at any military post or station. Applications should be submitted by the applicant at the military post or station nearest his place of residence. Writing to The Adjutant General for information or for blanks will only cause delay.

It is contemplated that successful candidates will be announced and appointed, or nominated for appointment, about two months after the examination. Candidates attending schools or colleges will, therefore, have an opportunity to complete the present school year before being appointed.

All successful candidates will be arranged in their order of merit, as determined by the final examination, and will be appointed in the Army in such order. They will also be placed on the promotion list in such order without regard to the branch of the Army in which appointed. Those candidates who attain the highest marks on examination will, therefore, have priority in advancement to the vacancies existing as first lieutenant. To be informed as to the full details concerning examinations and appointment, it is necessary that candidates consult the regulations which are being sent to all military posts and stations. However, the prospective candidate's attention is directed to the following important points:

1. Eligibility for appointment is fixed by law, and requests for exceptions cannot, therefore, receive consideration by the War Department. The age at the time of appointment must be between 21 and 30 years. At the time of the final examination each candidate must be in one of the following classes:

(a) A warrant officer or enlisted man of the Regular Army having had not less than two years' service as such.

(b) A member of the Officers' Reserve Corps or the enlisted Reserve Corps.

(c) A member of the National Guard.

(d) A graduate of a technical institution approved by the Secretary of War.

Any civilian of the required age who passes the preliminary examination may readily become eligible to take the final examination and to be appointed by entering either Class (b) or (c) above.

2. The preliminary examination consists of an inquiry into the physical, moral and mental qualifications of an applicant to determine whether or not he has the requisite qualifications to justify his proceeding with the final examination. Such a preliminary examination will avoid inconveniences and unnecessary expense to both the applicant and the government in many cases.

3. The final examination is the same for all candidates, and to insure strict justice to all, the examination papers will be marked by central boards convened in the War Department. The scope of the mental examination is such as to insure the Army getting men of the required educational foundation to satisfactorily follow a career as an Army officer. The elementary part of this examination embraces the subjects of history, grammar, geography, arithmetic, algebra, geometry, trigonometry and physics. The advanced part of the examination consists of a large number of subjects, including mathematics, languages,

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literature, electricity, chemistry, law and minor tactics. Examination is required in but three of the subjects of the advanced group to be selected by the candidate.

4. Candidates for appointment in the Air Service, Engineers, Signal Corps and Ordnance Department are required to satisfy certain technical requirements, either by examination or by having graduated from technical schools.

5. The regulations provide liberal exemptions from examination in various subjects according to the education, training and experience that the candidate has had. The granting of exemptions has been placed entirely in the hands of the examining boards, and requests for exemptions cannot, therefore, be considered by the War Department.

6. Each candidate is permitted to express one or two choices of the branch of the service in which he desires to be appointed. In making appointments, however, while the preferences of candidates will be given due consideration, the War Department reserves the right to assign thm to such branches of the service as may be necessary.

In consideration of all of the facts, it is apparent that the present offers an exceptional opportunity for appointment in the Army, and it is anticipated that no difficulty will be experienced in securing the number of good officers for which the examination is held. Should a number of candidates, in excess of those for which the examination is held, receive a passing mark on examination, those making the lowest mark will not be selected for appointment nor will they be placed on an eligible list for future appointment, as the experience of the War Department has been that such eligible lists are unsatisfactory, both to the Government and to the individual.

[*Note.*—See page 165 for further data regarding appointments in the Corps of Engineers, Regular Army.—Ed.]

More About Staff Control

[*Note.*—There is room for extended discussion on the important subject of staff control. Of course, as has been pointed out, "any system will work if good men are on the job." But we must have a system set up in advance which will work with average and often poor men "on the job," because that is what we shall always have in time of war. We accordingly present to our readers two more illuminating discussions on this much-discussed subject.—Ed.]

C. L. Hall
Major, Corps of Engineers

THE two articles in the November number of THE MILITARY ENGINEER on Staff Control approach the General Staff from two standpoints—one from above and one from below. Major Young, writing from the G. H. Q. end, states with the utmost clearness the principles of functional organization which must characterize any complete staff; Major Lee, writing from nearer the enemy's bullets, points out the difficulties of the functional system when the same set of G's are in continuous control of the same individuals. Each writer naturally puts his best foot forward. Each tries to upset the other. Possibly both are right.

To argue by analogy, consider a War Department publication prescribing something or other. It purports to be issued "by order of the Secretary of War," but everyone who receives it knows that official probably never saw it. It was prepared by some individual, or group of individuals, in the War Department who were selected for the job on account of their expertness in that particular line. It was read over and approved by some Assistant Chief of Staff. If the draft was concurred in by the bureau chiefs, and chiefs of combatant arms affected, the overworked Assistant Chief of Staff may not have read it at all. But the man who gets the order never thinks of contesting it. The only people who really knew who wrote the order are (1) the other people in the same General Staff Section, (2) the officers corresponding to the publication writers in the bureau chief's offices, (3) the corresponding G's in the Corps Areas—maybe. If they don't scrap among themselves, the authors of the order will remain anonymous, and the fact that such a coterie, all selected because of their professional reputation, are agreed, indicates that they are most probably right. If this group does quarrel, the dispute will be settled by a general officer of the General Staff, an officer always of long experience, *persona grata* to the Secretary of War, with whom a quarrel is a waste of time.

Take it at the other end—the battalion. Acting on the functional system, the battalion G-3 gets out an order that the company commanders think is bosh. Do the company commanders grin and bear it? They do not—they kick to the major. If the major backs up his G-3, and the captains appeal, does the colonel tell the regimental G-3 to settle it? He does not. He settles the affair on the carpet, between the major and the captains, and somebody goes home with his tail between his legs. There is about as much anonymity in the matter as there is in a murder trial.

Now, somewhere along this line there must be a break where we pass from the large headquarters where the work must be sub-divided functionally, and can be carried on with comparative anonymity, to the smaller office, where the commander can boss the job himself, and use his staff officers, not as referees on complicated matters, but as agents for doing something he has thought of doing himself. This break would seem to occur where the commander is as well acquainted with the powers and limitations of his individual line units as he is with the abilities of his staff officers; that is, where his subordinates and their organizations are reasonably fixed, and go where he goes. And similarly, the commander below is more willing to accept orders which he knows are anonymously prepared, when his organization is not an integral part of the higher commander's unit, but a pawn, to be here to-day and gone tomorrow.

In modern warfare such a break occurs when we pass from the corps to the division. The division commander not only stays with his division, but stays with every regiment, battery, and company of it, until he is relieved or promoted. He knows that Smith's regiment or Johnson's battery is good—at least he does if he's "on the job." Moreover, Smith knows, or thinks he knows, that the old man won't let the G-3 put one over on him. The G-3 knows that Smith knows who is responsible for a decision, and that if Smith doesn't like it, and feels himself in the right, there will be a fuss. But when it comes to the corps, all this is different. The corps and division commanders may be acquaintances of ante-bellum days, but the corps commander doesn't know, and can't know, intimately, how much the 13th Division is worth. It reported on D-2, and pulled out on D-3; and seems to have done fairly well. He may see it again in six months. If it got the proper orders, but did badly, no one will think of holding the corps commander responsible. At least, he will fully clear himself by recommending the division commander's relief. The subordinates who can make and break him are his staff officers. When someone says that the Nth Corps is no good, they don't mean that the organizations are not good; they mean that the staff doesn't function well. When they say the Nth Division is good, they aren't celebrating the virtues of the G's especially—the staff is but one element in

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the estimate. In fact, one could hear in France of good divisions somewhat handicapped by poor staffs. Whoever heard of a good corps with a poor staff?

Another reason for a break from functional to direct control at the division is the relative performance of the headquarters of a corps. Functional staff organization is, in the nature of things, a somewhat intricate game. You have to know one another's telephone numbers to play it, and you have to know the corresponding G in the next higher unit. G-1 of a corps, for instance, is in almost as complete liaison with G-1 of his Army as he is with his own Chief of Staff. He has to be to make the machine work. If he is not able to solve his problems without bothering the corps commander, he loses his job. The corps is quite likely to stay in the same army for a long time. The G-1 gets to know the organization of Army Headquarters, and knows, by name, the fellow to call on the 'phone about every conceivable thing. Moreover, he knows his terrain. So true is this that in some foreign armies a corps didn't take over its job until it had been several days in a new area. Using electrical parlance, it was such a delicate piece of machinery that whenever it was set up in a new place it had to run a few days on no load before the lights could be turned on.

But the division is an altogether different matter. It is a fly-by-night affair; here to-day and gone to-morrow. The division staff officers know no more about the corresponding G's in the next higher unit than they know about the G's back in the S. O. S. They know no more of the terrain than do the line officers of the division. Their usefulness depends, not on the nicety with which functional questions are correlated, but on how much service they are to their own fighting men. They are chief cooks and bottle-washers for their division.

It may be said that a case has been made out for the possibility of a functional staff in the corps and higher units; but that no case has been made out for its necessity. The necessity arises from the huge size of the larger organizations. The bureaus criss-cross at so many points, and on so many different matters, that there is no brain capable of co-ordinating all the joint questions which arise among them. The Chief of Staff has to functionalize to get his work done. Major Young's example of the movement of a division by trucks from a front area to a front area in another sector is very apropos. Imagine that being arranged for, in its ultimate details, at a conference between Generals Pershing, Harbord, Bullard, and Liggett.

The above argument points to a General Staff, functionally arranged, above the division—and a command, with definite lines of personal responsibility, from there down. Undoubtedly, there must be a division Chief of Staff, because the division commander can't deal with the three brigade commanders and all of his bureau chiefs to boot. But the Chief of Staff ought to be the commander of the division staff, and not any particular lobe of the general's brain. And he should not functionally divide his office. If an assistant is necessary, let him be a general assistant, to take the night shift or the rear echelon. The right kind of man as Chief of Staff can co-ordinate his bureau chiefs with his own brain without dividing it into specialized human lobes.

Undoubtedly, there is one G who must be found in every fighting unit that has any kind of staff—namely, the Intelligence Officer. But that is not because the functional decisions with which Intelligence deals are the most ubiquitous, but because functional decisions, in the lower units, form so small a part of its task. It is primarily an operating service, doing things with its own personnel which would not be done without it. It is the least "staff-like" of the staff sections. With this one exception, the writer claims that the G-System, or the General Staff, as a means of controlling the Army functionally, is a necessity in the higher units, but has no place in organizations smaller than a corps.

Breton Somervell
Major, Corps of Engineers

Further discussion of Staff Control being in order, since it has been started by Major Hall, an attempt will be made to arrange some of the ideas which have already been advanced to answer the points he has brought out. The opinions given by officers who have had wide staff experience (I will not say by "highbrows," inasmuch as the latest definition of "highbrow" is "a person educated beyond his understanding") prove that the views expressed by Major Young are fundamentally sound. In addition to this, his exposition of his views is fortunately very clear, and not handicapped by a profusion of ambiguous terms such as co-ordinate, co-operate, etc. He has very clearly stated "in plain words" what the General Staff does, what is the nature and extent of General Staff Control.

Major Lee's main arguments are for direct control and responsibility, which are answered in toto by the statement that the General Staff gives orders and sees to their execution, and by the provision of direct channels for the transmission of these orders. The authority of the General Staff springs from its relation to the general, and not from the ranks of its members. So long as the authority exists and is recognized by all concerned it makes no difference in results.

Major Hall advances the theory that a question, though possible of division into elements when it is a large one, is not thus divisible when it is small. Is a gallon of water more susceptible of resolution into hydrogen and oxygen than a pint? Are not the questions relating to procurement, storage and sale present in a department store also present in a peanut stand? In an army a general must have a staff to handle these questions, whereas in a platoon the platoon leader or boss handles them all himself. Decisions in a division must be made more quickly, and consequently the division commander or his C. of S. should have to consult as few as possible in arriving at a proper settlement of a question. Imagine his consulting eight or ten bureau chiefs as suggested by Major Hall before issuing orders.

Taking up divisions of Major Young's article on Staff Control:

1. What does the General Staff do?

It advises its superiors and gives orders to its chief subordinates. It exists to give service, of course; we all belong to "The Service," no matter what our job is.

2. What is the character of General Staff control?

It is functional, and cannot be anything else.

In this connection, a discussion of the possible "functions" of an army should not be out of place. Due to the fact that some subordinate functions have grown to such large proportions, they are now placed as independent sections of the staff; and consent of the heads of these sections must be obtained by the person who is really charged with the responsibility for results to undertake any course of action. In other words, the tail is wagging the dog.

Any army's mission is to defeat the enemy in battle. To do this the commander must learn where the enemy is,

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what his strength is, etc., and then use his men and weapons to put the enemy out of commission. This is the combat function, and in order that the person charged with drawing up plans for combat may do so intelligently, the intelligence section must be under the orders of the combat or operations officer. In time of peace, of course, there are no field operations, and the duties of this section are reduced to plans and training. The activities of the intelligence section should then be so directed as to enable the operations officer to make sound plans and training programs for possible operations.

In order that the fight may be successful, the army must have personnel, material, and communications. The only other function the army has is to provide itself with these auxiliaries to fighting. In our own Army there are also certain civil functions, but these have nothing to do with the organization of the Army as a fighting machine, and should not be allowed to interfere with its proper organization for the national defense.

The functions of the army as seen by the writer are, therefore, combatant, and administrative or non-combatant. The word "administrative" is badly chosen, but no other is known which explains the situation. This division of functions is not new or original; it is the fundamental organization of the British Staff and of the French. In larger units the French have created a Deputy Chief of Staff to control the 1st and 4th Bureaux and one to control the 2d and 3d Bureaux, as the simplest way of rectifying their previously faulty organization. They have failed, however, to put G-2 under G-3's orders in corps and divisions, as should be done.

All administrative functions except combat can and should be divided into those pertaining to personnel and those pertaining to material, and the sections handling these should have a common chief. Could not this staff organization be used from battalion to army, and would it not be the simplest?

3. What is the extent of General Staff control?

What is helpful interference and what is meddlesome interference?

This is the question which has caused the staff so much trouble, and the one that has made so many faulty organizations. At a time like the present, when the lessons learned in the World War are so fresh in our minds, it would seem that there should be a demand for organization along functional lines, and public sentiment should be such as to tear away the camouflage from specious arguments advanced by individuals and groups of individuals in the interest of personal advancement, and by those who swallow their propaganda—bait, hook, line and sinker. Unfortunately, most of those persons who draw up organization charts regard them not as a delimitation of functions, but as orders assigning themselves to special duties. Generally, if they are ambitious, they will wish to get as much power as possible, even at the expense of not making the organization a smooth working machine with all its gears in mesh.

The most bitter attacks on the General Staff, those mentioned by Major Young, come from the administrative corps and not from the line branches. Any system of bureaucracy based on the idea that all officers in the bureau are Class AA+1 is wrong. Whereas enough officers are not available to outfit the army with exceptionally good men in every job, enough are available to put such men on the General Staff. If such men are put on the General Staff, complaints as to "trash," "bull," "bunk," etc., circulated by the General Staff will not be well taken, inasmuch as the authors of General Staff writings will be the best, or as good as we have.

Considering the bureaus from the functional viewpoint, the Adjutant General's Department should be eliminated, as suggested by Gen. Fox Conner, and the others should be delimited so that no two will have the same duties, *i. e.*, reduce the twilight zone between bureaus to a geometrical line without breadth. No two should, for example, have construction. No one bureau charged with procurement and issue of supplies should control the operation of a utility, such as transportation, which is vital to the success of all the others as well as to itself.

Following the functional idea, all services except the combatant services would fall under the immediate jurisdiction of the non-combatant G, and there should be no doubt in any one's mind that such is the case. Many Engineer officers have had their feelings hurt because they were "put under a G" or "received orders" from a G, when their position on the staff entitled them to access to the Chief of Staff or the commanding general. Their position was badly taken because they were in exactly the same position as the Chief of Artillery and should have governed themselves accordingly.

The General Staff control extends to the same degree that any other direct control extends. If the superintendent on a project gives a foreman a job, he gives general instructions so that the foreman's work will fit in with the rest of the project, and only interferes when the latter falls down on the job. He then helps him with advice, if he can, or removes him.

Most engineers get into the wrong frame of mind by imagining themselves staff officers, when they are, in fact, line officers called on for advice, in much the same way as the Chief of Artillery is called on when their work affects the entire plan of the commander. An engineer is not always right, and should understand that the rest of the Army is his client. If he undertakes to produce something for his client, the latter will want results and not be interested in methods. The case is much the same as in civil life. A company wishes a bridge built to meet certain conditions. It is up to the engineer to meet the conditions and not tell the head of the firm that he does not want the bridge. On the other hand, unless the plan is fundamentally wrong he should do his best to make his plans to fit the general scheme.

In conclusion, the preponderance of opinion seems to be with Major Young, but there is in addition to his ideas, which are admittedly sound, a conviction that the staff corps should be reorganized to conform to the functional system, undue overlapping and duplication of effort being eliminated.

The World's Greatest Gas Engine. A giant gas engine made in Liege, Belgium, was in process of erection when the Germans captured the city in 1914. The Germans permitted the installation to continue, and as soon as assured of the success of the experiment they removed the engine to Derisburg, where it was in operation at the close of the war. It was then returned to its owners. This monstrous machine has four cylinders of 1.3 meters in diameter by 1.5 meters stroke, and develops 8,000 horsepower at 94 r. p. m.—*Journal Frank Inst.*

News Item from Palestine—The motor car is replacing the camel as a means of transportation.

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Army Engineers Need Railroad Training

By

L. A. Jenny

Formerly Major, Transportation Corps

THE writer read with a great deal of interest the article written by Col. G. A. Youngberg, which appeared in the January-February number of THE MILITARY ENGINEER.*

Colonel Youngberg explains at length the civil experience of the Army engineer who has had an opportunity to be connected with River and Harbor work. There is no doubt that many of these engineer officers are excellent executives and good engineers.

There are, however, many branches of engineering in which the Army engineer has no practical training; it would seem highly important that more attention should be given to some of these branches, and the writer wishes to refer particularly to railroad engineering and operation.

Although the writer may be considered the pioneer of the Transportation Corps, having been the first railroad engineer officially assigned to the A. E. F. and having sailed for France with General Pershing in the first expedition, he does not claim to be the originator of this Corps. This honor goes to Col. W. J. Wilgus, who was a member of the special commission which was sent to France ahead of General Pershing and who was assigned to the Chief Engineer, A. E. F., about a week after we had opened our headquarters at 149 Boulevard Hausman in Paris. Colonel Wilgus was appointed Director of Railways in August, 1917, and worked out the first comprehensive organization chart comprising engineering, construction and operating personnel for this Corps.

The writer therefore having been connected with this work from its infancy and having been designing engineer for the Transportation Corps throughout the war, charged with the preparation of all plans for railroad connections, railroad terminals, depots and port facilities, has had an opportunity to come in contact with many Army engineer officers of all ranks, and it is his opinion that comparatively few of these officers had any conception of railroad requirements.

Under railroad requirements the writer means railroad engineering in a broad sense, the proper co-ordination of railroad facilities, correct planning of yard layouts so as to facilitate yard movements, locomotive repair and coaling facilities, water stations, etc., all of which are highly important, may prove a serious menace during an engagement if not properly planned, and may result in the defeat of an army if supplies cannot be forwarded in sufficient quantities.

It would seem that future officers of the Corps should receive some instruction in this important branch of engineering from a practical railroad engineer, while at West Point. After graduation these officers should receive practical training in the engineering department or operating department of some modern railroad, or, if possible, receive some training in both of these departments.

It is not expected that the Army engineer should be an expert railroad engineer or operating official, but he should have a fundamental knowledge of this new branch of the service and, above all, he should have a clear conception of railroad requirements.

Discussion

Elbert A. Gibbs

Formerly Colonel, 15th Engineers (Ry.)

Major Jenny's contention that officers of the Corps should receive more instruction in railroad engineering and operation is believed to be met as far as practicable by the provision for sending officers to engineering schools and industrial organizations to complete their training.

Only fundamentals of railroad engineering can be taught, even in a purely technical school and could be included in the course of study at West Point only at the expense of other fundamentals more necessary in the training of an officer.

It should be kept in mind that we have an organized reserve which includes men especially experienced not only in railroad but in many other branches of engineering, who are available when needed. This is one reason for having an Engineer Reserve Corps. However, in order to be of the greatest service, the reserve officer should have a clear conception of the requirements of military engineering, and it is the writer's opinion, based on his own experience with the A. E. F., that the Reserve Officer has as much to learn as the regular engineer officer to make his more special knowledge of real value.

The military engineer in time of war can scarcely ever construct as the best engineering practice dictates, because, even assuming that he has the necessary material, the need would pass before he finishes his work. If he builds too poorly, his structure will break down under the strain. Men are generally more plentiful than material, and time, the all important consideration, is fixed by the plans of operation and cannot be altered without impairing their success. Therefore, the best military engineer is the officer who can sense just how little in labor and material can be made to answer the basic requirements of the situation and be ready to function when needed. Some Reserve Officers had this faculty developed more highly than others, which was likewise true of the regular officers, and in both classes their success was proportionate to this quality.

If the facility is to be used over an extended period, the same principle applies, but the layout should provide for expansion when needed. If the A. E. F. had provided all the construction that certain services, including the Transportation Corps, demanded as the minimum before they could begin to function, the war would have lasted at least a year longer. By building so that the particular facility would operate with the minimum amount of construction and provide for such future extension as might become nec-

*"The Civil Activities of the Corps of Engineers," page 73.

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essary, the always inadequate supply of material and labor was made to answer all reasonable demands of the situation in its constantly changing phases.

It is believed that the question of experts was rather overdone during the war. We sent many special engineering units to France that would far better have been pioneer engineer units with a properly balanced personnel. These special units either found little work of their kind to do or were obliged to work under such crude conditions that their special training was more of a handicap than otherwise. Considering the class of men that will be obtained from civilian life, both for the commissioned and enlisted personnel, for engineer regiments in war time, the prime necessity is to give them sufficient military training to teach them what military engineering is and how to apply their knowledge to military operations. They already know more of their profession or trade than they will probably ever have opportunity to use.

C. W. Sturtevant

Colonel, E. O. R. C.; formerly Colonel, 15th Engineers (Ry.) M. Am. Soc. C. E.

Major Jenny's views on railway methods in France during the war have been read with much interest.

I am neither a military engineer nor a railway engineer, although I had charge of railway construction and some railway operation during my service in France as a member of the first railway regiment to arrive overseas. I do not understand why the commander of a railway regiment should be expected to be familiar with all the details of railway engineering any more than he should be able to direct the regimental surgeon how to perform an operation for appendicitis.

All of the railway regiments were organized and commanded at the outset by regular army engineer officers assisted by adjutants from the regular army, as they should have been, for the reason that there were few, if any, railway or civil engineers who were familiar with military organization and regulations or with military supply methods. The other officers were of the best that could be obtained from the engineering profession at large. These regiments were prepared to do any kind of engineering work except military field engineering.

In all of these regiments, after the field officers became familiar with military organization, the regular army officers were transferred to other duties, leaving the officers from civil life in command. The latter were in charge, as a rule, of the railway management, design and operation, while the strategic questions, such as the location of railroads, the amount and routing of the tonnage required to be moved were usually determined by regular army officers.

In time of war it is of course impossible, on account of scarcity of labor and materials, to build such luxuries as balloon tracks and four-way connections between yards and main lines. It seems to me that the French and some of the American railway officers from civil life did not understand "temporary" military railway construction in emergencies. It is very easy to sit in an office and design a complicated, elaborate railroad yard, but altogether a different proposition to build it in war time with the men and materials that may be available at the time. The failure of officers from civil life to appreciate the military emergency was unusual, but did sometimes occur. I remember one occasion when the railway operation department refused to take charge of two railroad yards that were already in operation, until coaling platforms and inspection pits were built. On another occasion they refused to operate 32 miles of repaired French railway destroyed by the Germans until the Signal Corps had installed telephones or telegraph lines. The construction engineer, however, handled all the freight offered by simply dividing the line into two 16-mile sections and placing one locomotive on each section with double crews, with orders not to leave that section under any circumstances. There were no collisions.

The suggestion that regular army officers failed in general to understand the scope or the requirements of military railways is evidently taken from some standpoint that I do not understand.

If some of the engineer officers, after leaving West Point, could take a 4-years' course in any of the civil, mining, mechanical or electrical engineering institutions, it would no doubt be valuable, but even then they would secure little or no actual experience.- In the same way civilian engineers can secure valuable military training by joining the Reserve Corps, but they will not attain actual experience unless there is a war.

The officers from civil life often felt hampered by military red tape, but when they broke through it and got results the regular officer was the first to condone it. I knew a regular army officer who placed all communications in his wastebasket that had passed beyond the tenth indorsement. Have you ever been out in a camp at night when all was still and heard the typewriters pounding away like machine guns in the distance? An army would now be impossible without typewriters, and there is much more office work than in the time of the Spanish-American War.

I think that everyone recognizes that engineer officers from civil life played an indispensable part in the great work of the American Army. The regular army officers have always given us credit for what we did, even if we did not speak the language, hold the salute, speak to our superior officers in the third person, and wear spurs while riding in automobiles. All of us, both regular and volunteer, took part in a great work, each as he saw his duty, and we can and will do it again whenever necessary. "Let's go!"

F. W. Green

Formerly Lieutenant Colonel, Transportation Service, A. E. F.; M. Am. Soc. C. E.; Vice-President St. Louis Southwestern Ry. (Cotton Belt)

Major Jenny's views, as expressed in his letter, reflect the ideas quite commonly held by engineers of civil experience as to the lack of technical perfection upon the part of army engineers of the regular establishment. It is quite natural that conclusions of this character should sometimes be reached. Most of us minister in one form or another to our *amour propre*. In comparing ourselves with our fellowmen, it is quite natural to compare their weaknesses with our own strong points rather than conversely.

The writer has had abundant opportunity to observe and compare the regular army engineer with the civilian engineer in military service, and in an honest effort to do exact justice to all has reached the following conclusions:

(1) That the training of the civilian engineer, coupled with his experience, undoubtedly enables him, in his own particular specialty, to function more efficiently than the regular army engineers. This is attributed entirely to the fact that with application and experience comes facility.

(2) That as military engineers the men with civilian experience are distinctly inferior to officers of corresponding rank in the regular service. This is attributed to the inability of the civil engineers to properly evaluate their

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problem in military terms. They deliberate upon and consider the relative economies, efficiencies, etc., of the various types of fire-fighting apparatus, while, figuratively speaking, Rome burns. The military engineer dismisses all such considerations from his thought, impresses the first 200 or 300 men he comes across into service, improvises a bucket brigade and puts out the fire. This illustration is perhaps overdrawn; it is intended to present in rather sharp contrast the differences in mental attitude, and is not intended to be in any way unkind.

The training of the military engineer in matters of organization and administration is generally superior to that of the civilian engineer. This was repeatedly impressed upon the writer whenever a new project was to be organized. The military engineers apparently had been trained to estimate new situations and reach decisions, make dispositions, etc. The writer further noticed that as between civilian engineers of the rolling stone type and those who had maintained one employment throughout their experience, the former were about a mean proportional between the military engineers and the latter. In his own command the writer found it necessary to undertake the training of his officers to a proper appreciation of these fundamental requirements. This stressed the following points:

(a) What is the mission?
(b) How much time is there for its accomplishment?
(c) What personnel and matériel are available for the execution of the work within the time allowed?
(d) If there are two or more alternatives, select the one which will be most certain to provide the best means for obtaining the objective with the least expenditure, bearing in mind always the imperative necessity for winning the objective first, and counting the cost afterwards, and assuming that the authority naming the objective has duly weighed the benefits against the costs, and that the tactical responsibility in that respect attaches to such authority and not to the officer who is given the mission to perform.

As to the criticism that army engineer officers of all ranks have an inadequate conception of railroad requirements in connection with the design of railroad facilities, it may be said that they could hardly be expected to be expert railroad designers in view of the fact that their entire training has doubtless been to consider railroad facilities as a means to an end, and not something to be considered wholly by itself. Railroad engineering is a rather broad field, and it would hardly be within the scope of any average man to qualify as an expert in this and all other branches of engineering. The writer does not believe it would be practicable to train all army engineers as railroad engineers, but believes that a better plan would be that suggested by him about two years ago, when the army reorganization bill was in process of formulation. At that time he recommended that a certain number of officers of the Regular Army be detailed in peace time to duty with railroads, manufacturing establishments, etc., to study and observe the methods and practices followed, to the end that in case of war such officers could be assigned to duty appropriate to the respective specialties in which they had had experience during such peace-time training. At the same time he stated that railroads and manufacturing concerns would no doubt receive considerable benefit from such an arrangement, as the army officers would no doubt be able to discover and point out errors and defects in organization which their military training should enable them to do, and which would become apparent to them because of their entering into the situation with fresh and eager minds, untrammeled by precedent and unfettered by tradition. It is with some sense of gratification, therefore, that the writer notes that the present army organization bill has recognized the value of this recommendation and has provided means for its realization.

In closing, the writer feels that it is only just to state that his contact and association with engineer officers of the Regular Army has been of great value to him in contributing to his realization of the importance of things that are fundamental, as distinguished from things that are supplemental. In fact, the military service of many thousands of civilian officers during the late war has undoubtedly contributed to a material change in their habits of thought and action, and with much advantage to them upon their return to their civilian pursuits.

Personals

Col. FRANCIS A. POPE, Corps of Engineers, has been relieved from his present assignment at Duluth, Minn., and ordered to report to the Commanding General, Philippine Department, for duty with the 14th Engineers.

Col. MASON M. PATRICK, Corps of Engineers, has been relieved from his duties at Washington, D. C., and assigned to temporary duty at Camp Pike, Ark., in connection with the training and instruction of Engineer troops.

Col. CHARLES S. RICHE, Corps of Engineers, has been retired from active service upon his own application, after more than thirty-eight years' service.

The leave of absence previously granted to Lieut. Col. CLARENCE O. SHERRILL, Corps of Engineers, has been extended fifteen days.

Maj. MAX C. TYLER, Corps of Engineers, has been granted leave of absence for two months, effective on or about February 1, 1921, with permission to leave the continental limits of the United States.

Maj. JAMES G. STEESE, Corps of Engineers, whose retirement from active service had been ordered on account of disability incident thereto, has been placed on active military duty as President of the Board of Road Commissioners for Alaska. Major Steese has been ordered to report to the Chief of Engineers for temporary duty, upon the completion of which he will return to his proper station at Juneau, Alaska.

Maj. EDWIN H. MARKS, Corps of Engineers, has been relieved from his duties at Washington, D. C., and ordered to Duluth, Minn., for duty.

Maj. CRESWELL GARLINGTON, Corps of Engineers, has been assigned to duty and station in Washington, D. C.

The leave of absence granted Maj. OSCAR N. SOLBERT, Corps of Engineers, has been extended ten days.

Maj. JOHN E. HARRIS, Corps of Engineers, has been relieved from further observation and treatment at Walter Reed General Hospital, Takoma Park, D. C., and ordered to report to the Chief of Engineers for duty in his office.

Maj. WILLIAM F. TOMPKINS, Corps of Engineers, has been appointed an Acting Quartermaster for the purpose of issuing bills of lading in the office of the Chief of Engineers.

Maj. ARTHUR P. VON DEESTEN, Corps of Engineers, has been granted five days' leave of absence.

Maj. ERNEST GRAVES, Corps of Engineers, has been retired from active service on account of disability incident thereto.

The leave of absence on account of sickness granted Maj. ARTHUR R. EHRENBECK, Corps of Engineers, has been extended one month.

Maj. WILLIAM A. JOHNSON, Corps of Engineers, has been relieved from duty as Assistant to the Department Engineer, Hawaiian Department, but will retain station at Honolulu in connection with his duties pertaining to the District Engineer Office.

Maj. DANIEL DEE PULLEN, Corps of Engineers, in addition to his other duties, has been ordered to report to the Commanding General, Panama Canal Department, for assignment to duty with the 11th Engineers.

Maj. ALLEN P. COWGILL, Corps of Engineers, has been retired from active service on account of disability incident thereto.

Maj. HARRISON V. PITTMAN, Engneers, U. S. A., has been honorably dischargd from the service of the United States for the convenience of the Government.

Maj. LEON E. LYON, Corps of Engineers, in addition to his other duties, has been detailed to superintend the construction or repair of

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any aid to navigation authorized by Congress in the fourth lighthouse district, relieving Col. WILLIAM B. LADUE, Corps of Engineers.

Maj. JAMES W. BAGLEY, Corps of Engineers, has been relieved from his duties in Washington, D. C., and ordered to McCook Field, Dayton, Ohio, for duty as representative of the Corps of Engineers in experimental work connected with the adaptation of aerial photography to mapping.

Maj. WILLIAM B. HARRISON, Corps of Engineers, has been relieved from his duties in Washington, D. C., and ordered to report to the Commanding General, Panama Canal Department, for duty with the 11th Engineers.

Maj. HENRY H. STICKNEY, JR., Chemical Warfare Service, has been ordered to Wilmington, Del., for duty.

Capt. SAMUEL R. IRWIN, Corps of Engineers, was granted leave of absence for ten days, effective February 19, 1921, upon the expiration of which his resignation as an officer of the Army was accepted by the President.

Capt. WALTER E. LORENCE, Corps of Engineers, has been relieved from his duties at the Engineer School, Camp A. A. Humphreys, Virginia, and detailed as Assistant Professor of Military Science and Tactics, Colorado School of Mines, Golden, Colorado.

Capt. PIER L. FOCARDI, Corps of Engineers, in addition to his other duties, has been assigned to duty as Assistant to the Engineer, First Corps Area.

Capt. CLIFFORD E. BLACK, Infantry, has been relieved from his duties at Nogales, Ariz., and ordered to report to Fort Bliss, Texas, for assignment to duty with the Eighth Engineers.

Capt. JAMES D. CLEARY, Quartermaster Corps, has been assigned to duty in the office of the Engineer of the Ninth Corps Area.

Capt. DAVID L. NEUMAN, Corps of Engineers, has been ordered transferred from the Panama Canal Zone and will report by letter to the Chief of Engineers upon his arrival in New York City for instructions.

Capt. EUGENE F. GAEBLER, Corps of Engineers, has been relieved from his duties at Fort Sheridan, Ill., and ordered to report to the Commanding General, Hawaiian Department, for duty with the Third Endineers.

Capt. RALPH E. CRUSE, Corps of Engineers, upon his arrival in the United States, has been ordered to report to Chicago, Ill., for duty.

Capt. HORACE H. BRAUN, Corps of Engineers, has been relieved from his duties at Camp Lewis, Wash., and ordered to report to the Commanding General, Philippine Department, for duty with the 14th Engineers.

Capt. HUGH P. ORAM, Corps of Engineers, has been relieved from his duties at Fort Bliss, Texas, and ordered to report to the Commanding General, Hawaiian Department, for assignment to duty with the Third Engineers.

Capt. ROLAND H. STOCK, Corps of Engineers, has been relieved from his duties at Camp Grant, Ill., and ordered to report to the Commanding General, Hawaiian Department, for duty with the Third Engineers.

Capt. EDWARD EVERETT HALL, Engineers, U. S. A., has been honorably discharged from the service of the United States for the convenience of the Government.

Capt. WILLIAM HENRY WARNECKE, Engineers, U. S. A., has been honorably discharged from the service for the convenience of the Government.

First Lieuts. FREDERICK H. MCDONALD and WILLIAM GASTON MARTIN, Engineers, have been honorably discharged from the service of the United States, their services being no longer required.

First Lieut. WILLIAM A. CALLAWAY, Corps of Engineers, has been ordered from Camp Grant, Illinois, to Camp Meade, Maryland, for duty with the 56th Infantry.

First Lieut. CHARLES W. BURLIN, Corps of Engineers, has been transferred from Norfolk, Va., to Washington, D. C.

First Lieut. FREDERICK W. CONANT, Corps of Engineers, has been relieved from his duties at Fort Sam Houston, Texas, and ordered to report to the Commanding General, Hawaiian Department, for duty with the Third Engineers.

First Lieut. LEE S. DILLON, Corps of Engineers, has been relieved from his duties at Camp A. A. Humphreys, Va., and ordered to report to the Commanding General, Panama Canal Department, for duty with the Eleventh Engineers.

First Lieut. JAMES F. C. HYDE, Corps of Engineers, has been relieved from his present duties at Fort Sheridan, Ill., and ordered to report to the Commanding General, Hawaiian Department, for duty with the Third Engineers.

First Lieut. GLENN H. STOUGH, Corps of Engineers, has been relieved from his duties at Camp Grant, Ill., and ordered to report to the Commanding General, Hawaiian Department, for duty with the Third Engineers.

First Lieut. HAROID J. ADAMS, Signal Corps (Corps of Engineers), has been relieved from further detail in the Signal Corps.

First Lieut. ARTHUR W. PENCE, Corps of Engineers, has been ordered from Camp A. A. Humphreys, Virginia, to Fort Howard, Maryland, for assignment to duty as Assistant to the Engineer, Third Corps Area.

First Lieut. ELMER H. PETRIE, Engineers, U. S. A., never having reported for duty and having been absent without leave for more than three months, has been dropped from the rolls of the Army.

First Lieut. BERNARD S. STEARNS, Corps of Engineers, has been ordered relieved from his present duties at Camp Dix, N. J., effective March 15, 1921, and ordered to proceed to Camp A. A. Humphreys, Virginia, for duty as student officer, basic course, 1921.

First Lieut. GLENN H. STOUGH, Corps of Engineers, has been relieved from further detail in the Ordnance Department.

Leave of absence for two days has been granted First Lieut. HEATH TWICHELL, Corps of Engineers.

The resignation of First Lieut. FRED SHEAFF WELLS, Corps of Engineers, of his commission as an officer of the Army has been accepted.

Second Lieuts JAMES W. CLARK and HARRY E. FISHER have been ordered relieved from their duties at the Engineer School, Camp A. A. Humphreys, Virginia, the former being ordered to Camp Jackson, S. C., for duty with the Seventh Engineers, and the latter to Camp Meade, Maryland, for duty with the Fifth Engineers.

Addresses Wanted

The Secretary of the Society would be pleased to receive any information concerning the present addresses of the following named members, whose mail has been returned unclaimed:

Capt. H. L. Baker, Woolwich, Me.
W. G. Baxter, 53 Eddy St., Providence, R. I.
C. Buechner, 1306 Mahoning Bank Bldg., Youngstown, Ohio.
Capt. Edward W. Bullard, Hastings, Mich.
Capt. B. R. Butt, Clarksburg, W. Va.
G. B. Byam, 1600 Q St., Washington, D. C.
Lieut. R. W. Cabell, Lakehurst Proving Grounds, Lakehurst, N. J.
Lieut. Col. J. Edward Cassidy, Office Chief of Engineers, Washington, D. C.
C. L. Catlin, 728 S. Denver St., Tulsa, Okla.
Maj. D. N. Chisholm, Jr., 917 18th St., Washington, D. C.
Capt. J. L. Church, Montana Club, Helena, Mont.
Maj. Robert S. Clemons, 1204 Mills Bldg., El Paso, Texas.
Lieut. E. S. Cloud, 1751 19th St., Cleveland, Ohio.
Mr. C. S. De Puy, 133 No. Maple Ave., East Orange, N. J.
Mr. J. D. Dixon, Chico, Calif.
Mr. D. J. Donovan, 316 19th St., Milwaukee, Wis.
J. L. Doyle, Box 732, Johnstown, Pa.
Mr. J. H. Feehan, 207 S. 45th St., Philadelphia, Pa.
Maj. H. W Ferris, 300 Gun Hill Road, New York City.
E. C. Garvin, Court House Bldg., Brunswick, Ga.
Lieut. N. Gerten, 41 Elmhurst Ave., Long Island, N. Y.
Capt. F. M. Gibson, 2273 83d St., New York City.
G. T. Granger, 1609 Cadiz, Dallas, Texas.
D. L. Greenleaf, 5463 Blackstone Ave., Chicago, Ill.
Capt. J. R. Hall, Oak Park, Ill.
S. L. Kuhn, 103 Real Estate Exchange Bldg., Detroit, Mich.
Capt. H. Loveridge, 1333 21st St., N. W., Washington, D. C.
Edward Lyndon, 136 W. 16th St., New York City.
H. H. Martindale, 3337 Hastings St., Pittsburgh, Pa.
Capt. George E. Milville, 9th Engineers, Camp Travis, San Antonio, Texas.
P. D. Mackie, Zona, La.
Lieut. C. R. Moore, C. E., 61 Princes Gate, London, S. W. 7
Capt. Kenneth M. Moore, 4th Engineers, Camp Dodge, Iowa.
F. J. O'Hara, 1010 Balboa Bldg., San Francisco, Calif.
Col. C. W. Otwell, C. W. S., Lakehurst, N. J.
Lieut R. D. Paquette, care U. S. I. S., Wapato, Wash.
W. L. G. Perry, 1710 H St., N. W., Washington, D. C.
Lieut. J. C. Rickner, Mt. Engrs., Camp Baker, Fort Bliss, Texas.
Lieut. Lester F. Rhodes, C. of E., 8th Engineers, Mt. Camp Baker, Fort Bliss, El Paso, Texas.
Col. S. A. Robertson, Supt. of Construction, Amarillo Petroleum and Refining Co., Amarillo, Texas.
H. A. Roe, 114 Prairie Ave., Chicago, Ill.
A. E. Russell, Westinghouse Elec. and Mfg. Co. East Pittsburgh, Pa.
Lieut. Wilson G. Saville, Engr. School, Camp Humphreys, Va.
A. E. Warren, 1629 Calvert St., Baltimore, Md.
Rees W. Weston, 1412 Riverview Ave., Wilmington, Del.

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ACTIVITIES OF OUR LOCAL POSTS

San Francisco, Cal.

Capt. D. W. Dodge, 733 Rialto Building

On June 15, 1920, a group of Engineer officers and former officers gathered at the U. S. Engineer Office in San Francisco. Col. E. E. Winslow, C. of E., presiding, outlined the history of the "Professional Memoirs" and its proposed broadening into the Society of American Military Engineers, and explained the purpose and policy of the latter. A committee consisting of Col. J. W. Williams, Chester K. Smith and Capt. D. W. Dodge drew up plans for the organization of a San Francisco Post of the Society, which were adopted at a meeting on June 29, 1920.

At this meeting Col. J. W. Williams, E. R. C., Chief Engineer of the Northwestern Pacific Railroad, addressed the meeting, outlining the purposes and scope of the parent Society, and emphasized the importance of local organization and co-operation on the part of former officers of the Army, engineers and civilians interested in military engineering. From an experience that gave him a broad insight into the deplorable conditions out of which the engineering forces were organized from civil life, he urged that every condition be improved toward greater preparedness for the future. From his experience he described the readiness and eagerness of the engineering profession generally to serve the Government at the moment of emergency, and the confusion and inefficiency engendered by the vague ideas on the part of the profession generally as to what was required in order to make their services valuable and effective for military needs. Colonel Williams presented the possibilities for co-ordination presented by such a society as was then proposed, stating that such confusion could be avoided in a large measure through the bringing together of army engineers and representatives of all branches of engineering into a society of this kind, where they would have the opportunity to consult and become acquainted with one another's problems and point of view, and through such association acquire the fundamental understanding of what would be required in case of emergency.

The Post was organized with a membership of twenty-two. The following officers were elected:

President, Col. Thomas H. Rees.
Vice-President, Lieut. Col. Chas. B. Wing.
Treasurer, Capt. J. D. Cleary.
Secretary, Capt. D. W. Dodge.
Assistant Treasurer, Col. J. W. Williams.

At the second meeting, on October 21, 1920, twelve applicants for membership were received and the organization completed.

Col. Thomas H. Rees outlined the proposed plan of presenting subjects and problems of military engineering interest at the monthly meetings. He spoke also of the principle purpose of the Society, the fostering of close relations between Engineer Reserve Officers, former officers and the Corps of Engineers.

Meetings have been held regularly since the organization of the Post. Col. Roger S. Fitch, U. S. A., gave a talk on "The Organization of the Ninth Corps Area." Mr. M. M. O'Shaughnessy, a member of the Post, discussed the Hetch Hetchy water project, which he supervises as City Engineer of San Francisco. Mr. William Hood, Chief Engineer of the Southern Pacific Railroad, will shortly address the Post, and Mr. A. B. Fletcher, Chief Engineer of the California Highway Commission, will discuss the value of the state highway system for military purposes.

The following is a list of the Post committees and their functions:

Activities Committee. To arrange Inspection and Observation Trips; Establish and Maintain Military Relations; Function in connection with courses of training or study.

Program Committee. To prepare the program of meetings and activities of the Post; arrange for the assignment of subjects, presentation of papers, addresses, etc.

Current Events Committee. To study and analyze the happenings of the month along Military Engineering and National Defense lines, and present a report at each meeting.

Publicity Committee. To record and maintain a file of the proceedings of meetings and activities of the Post and the reports of the Current Events Committee. Maintain the file of membership and record individual activities. To furnish papers and information to THE MILITARY ENGINEER. To give our Post and activities suitable local publicity. To develop a library covering Military Engineering.

Membership Committee. The need and function of which is apparent.

Entertainment Committee. To develop social relations to the fullest extent; arrange for outings, hikes, excursions, rifle-range practice, etc.

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The present membership of this Post is fifty-seven, with an approximate tentative membership of thirty additional, and it is reasonably anticipated that a total of one hundred will be reached within sixty days.

To all members of the parent Society resident in the vicinity of San Francisco, or temporarily in this city, a most cordial invitation is extended to attend our evening and luncheon meetings. Information as to time and place of meetings can be had by communication with the secretary, Douglas W. Dodge, 733 Rialto Building, San Francisco, Telephone Kearny 823; and to those in this vicinity who are members of the parent Society and not members of the Post, and to those eligible for such membership, an earnest invitation is held out to meet our members and to join with us.

Philadelphia Post

Lieut. Col. W. B. Ladue, 815 Witherspoon Building

At the January meeting (January 27) of the Philadelphia Post of the Society of American Military Engineers, Col. Mason M. Patrick (late Major General, A. E. F., Chief of Air Service and Director of Construction and Forestry in France) gave a very interesting and valuable paper on the "Duties and Status of the Engineer Reserve Officer."

At the February 24th meeting Col. J. Frank Barber gave a talk on "Experiences of a Regiment of Combat Engineers in connection with an Army Offensive."

Colonel Barber was in command of the 304th Regiment of Engineers in France.

The Philadelphia Post, which takes in the district about Philadelphia, meets every month at the Engineers' Club, and is contemplating excursions to various points of military interest.

St. Louis Post

Lieut. Col. John L. Buchanan, 7th and Clark Avenue

The annual meeting of the St. Louis Post of the Society of American Military Engineers was held at a luncheon at 12.30 P. M. on January 28, 1921, at the Missouri Athletic Association.

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Maj. DeWitt C. Jones occupied the chair, and opened the meeting at 12.45 P. M., with submission of Treasurer's report by Major Skelly.

On motion made by Colonel Jonah, and duly seconded, the Treasurer's report was accepted as submitted, and is appended as part of this record.

Minutes of the previous meeting were read and duly approved.

The Chair called for a general discussion on the subject of programs and meetings. Colonel Jonah suggested meeting at dinner quarterly for renewal of acquaintances and discussion of general subjects pertaining to the Society. It was suggested that this would be an effective manner of keeping contact between the regular and civilian officers, and would keep the Society thoroughly alive to current issues.

In connection with the subject of frequency of meetings, a motion was made by Colonel Laird, and duly seconded and passed, that meetings be held once each quarter in January, April, July and October of each year.

Colonel Perkins suggested leaving the selection of noon or evening for meetings to the officers of the Society, and added that there should be some one present to give a line on current army affairs, either calling on Colonel Youngberg or someone he might select.

In further voting, it was determined that character of meetings, program, dinner or luncheon, etc., should be determined by the Executive Council.

In establishing dues for the year 1921, motion was made by Colonel Laird, duly seconded and carried, that the Post dues be $1.00 for the current year.

The Chair next called for nominations of officers for the year 1921, and made announcement that due to the certainty of him making a change in situation later in the year, he considered it advisable that the Society consider someone else. Upon motion of Colonel Perkins, same being seconded and unanimously passed, Col. F. G. Jonah was elected President.

Other officers were elected as follows:

Vice-President, Maj. A. K. B. Lyman, C. of E.
Secretary, Lieut. Col. John L. Buchanan.
Treasurer, Maj. J. W. Skelly.
Assistant Treasurer, Maj. W. W. Burden.

Colonel Jonah read minutes of meeting of the National Society, and discussed a possible change in the annual meeting date in order to coincide more closely with the American Society of Civil Engineers in New York.

A discussion then followed on ways and means to enlarge the Society, and it was the general opinion that this matter should be worked out by the officers and carried out in a systematic manner by them.

Motion made, duly seconded and passed, calling for adjournment, subject to call of the President.

The following were in attendance at the annual meeting:

Col. A. T. Perkins, Col. N. L. Howard, Col. F. G. Jonah, Col. John A. Laird, Col. John L. Buchanan, Maj. D. C. Jones, Maj. R. J. Lockwood (Prospective Member), Maj. J. W. Skelly, Capt. Chas. Thorburn (Prospective Member), Capt. T. B. Perry, Capt. R. P. Garret, Lieut. A. W. Buckingham (Prospective Member), Lieut. A. O. Schleiffarth (Prospective Member), Lieut. W. B. Frost, Master Eng. L. G. Webber (Prospective Member).

New Orleans Post

Capt. E. H. COLEMAN, 1018 Hibernia Building

The following officers have been elected for the current year:

President, Arthur M. Shaw.
Vice-President, A. W. Jackman.
Secretary-Treasurer, E. H. Coleman.
Director (2 years), H. P. Ralston.
Director (1 year), Lester F. Alexander.

Plans are being made to start a campaign for new members among the large number of ex-service men in this locality who are eligible.

Cleveland Post

Capt. JAMES H. REDING, 1727 Bryn Mawr Road, East Cleveland

This Post has started to work. The temporary organization was called together January 27, and on February 10 a Constitution and By-Laws were adopted and permanent officers elected as follows:

President, Col. John R. McQuigg.
First Vice-President, Capt. Fred S. Curtis.
Second Vice-President, Capt. Harold McGeorge.
Secretary, Capt. James H. Reding.
Treasurer, Capt. Jos. C. Gilliland.
Director (2 years), Col. Elliott H. Whitlock.
Director (2 years), W. E. Stark.
Director (1 year), John Eisemann.
Director (1 year), First Lieut. Chas. W. Everson.

Both meetings were held at Central Armory in the headquarters of the 112th Engineers. The next meeting is to be held February 28 at the rooms of the Cleveland Engineering Society, when a special effort will be made to have a large attendance of eligibles.

We have 31 signatures on the charter application now. This we desire to keep open for at least thirty days longer.

New York Post

Maj. PERCY E. BARBOUR, 29 West 39th Street

At a meeting of the New York Post, S. A. M. E., a committee was appointed to protest against the pro-German meeting in Madison Square Garden on February 28. The following resolution was adopted, and copies of it were sent to the authorities, the American Legion, the Veterans of Foreign Wars, and several other organizations, for the purpose of bringing about closer co-operation between the various patriotic organizations with a view to combating objectionable propaganda:

RESOLUTION

Whereas, a meeting was held in New York City, at Madison Square Garden, on the evening of Monday, February 28, ostensibly for the purpose of protesting against the maintenance of black troops by the French Government on the Rhine, and

Whereas, Maj. Gen. Henry J. Allen, commanding the American Army of Occupation, has stated that there have been no French black troops on the Rhine since June, 1920, and

Whereas, the United States of America is still technically at war with Germany, and there is no present prospect for the conclusion of a satisfactory peace, and

Whereas, it is evident that the published reason for this meeting was fictitious, and that it was merely a gathering of numerous disloyal elements for the purpose of issuing false propaganda against our former Allies and in the interests of an enemy country,

Resolved, That in the opinion of the members of the New York Post of the Society of American Military Engineers, the holding of such meeting was a disgrace to the City of New York and an affront to all loyal Americans, and

Resolved, That this occurrence be brought to the attention of the Department of Justice of the United States, the

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Governor of New York and the Mayor of New York City, with a view of expressing the protest of the members of this Post that such a disloyal demonstration was permitted to be held, and to demand that proper measures be taken to prevent a recurrence.

Signed:

JOHN P. HOGAN,
GEORGE H. GIFFORD,
R. S. TILDEN,
Committee on Resolutions.

Los Angeles Post

Capt. BURT HARMON, 745 West Ocean Avenue, Long Beach, Calif.

At a meeting of the Los Angeles Post on February 1, Capt. Hans Kramer, C. of E., in charge of the Engineer R. O. T. C. unit at the California Institute of Technology, Pasadena, gave an interesting talk on "The Engineer Reserve Officers' Training Corps." Many of the members were not familiar with the valuable work that is being done by the Engineer R. O. T. C. units now established at nineteen of the important technical institutions of the country, and Captain Kramer's talk called forth much interesting discussion.

It is believed that all local Posts would do well to interest themselves in the work of the Engineer units of the R. O. T. C. in their neighborhood, as these units are now training the men who will be the Engineer Reserve Officers of the future.

List of Applicants for Membership

(This list contains only those applicants from whom formal applications have been received since Jan. 1, 1921.)

Acher, A. H., 1523 Kimball Hall, 25 E. Jackson Blvd., Chicago, Ill.
Alvis, Raymond, Fishburne Military School, Waynesboro, Va.
Anderson, Christian, 466 Tenth St., Portland, Oreg.
Avery, Guy T., 9737 Prairie Ave., Chicago, Ill.
Barnes, Paul M., care Dakota Eng. and Const. Co., Valley City, N. Dak.
Boardman, Charles S., Lackawanna Steel Co., Buffalo N. Y.
Brand, P. H., 608 Marion St., Oak Park, Ill.
Breuer, Wm., 2736 W. Montgomery Ave., Philadelphia, Pa.
Capelle, George C., 99 Chauncy St., Boston, Mass.
Carson, C. E., 112 W. Adams St., Chicago, Ill.
Childs, Jas. H., Box 401, Hermosa Beach, Calif.
Clark, Frank J., 42 Cedar St., Dobbs Ferry, N. Y.
Coffin, Samuel P., 12 Remington St., Cambridge, Mass.
Covert, John F., National City, Calif.
Cueller, Arthur E., 307 S. Johnson St., Ada, Ohio.
Cylkowski, V. D., 6943 Calumet Ave., Chicago, Ill.
Dean, Bertram D., 1711 Ravanna Blvd., Seattle, Wash.
Dillman, George L., 14 Montgomery St., San Francisco, Calif.
Ellis, Edmund P., 2007 O St., Washington, D. C.
Ely, Carl B., 80 Maiden Lane, New York City.
Estabrook, Chas. W., A. & N. Club, New York City.
Everson, Chas. W., 9607 Parmelee Ave., Cleveland, Ohio.
Fear, Lyle G., 1014 N. W. Bank Bldg., Portland, Oreg.
Felton, Samuel M., Jr., Glenwood Springs, Colo.
Frost, Wm. Barrett, 4398 Forest Park Blvd., St. Louis, Mo.
Gano, Frank W., First Engineers, Camp Dix, N. J.
Gillies, Daniel, Hd. Co., Fifth Engineers, Camp Meade, Md.
Griffin, John A., 5123 Woodlawn Ave., Los Angeles, Calif.
Haight, Wm. T., 407 So. Broad St., Elizabeth, N. J.
Hale, Frank B., 1867 Crawford Road, N. E., Cleveland, Ohio.
Hall, Roger T., 36 Henderson St., Arlington, Mass.
Harrison, Maj. Wm. B., Washington, D. C.
Hartwell, Arthur E, 1209 Webster Ave, Houston, Texas.
Hindicks, Capt. Frederick, Jr., 1071 Garfield Ave., Pasadena, Calif.
Hoad, Wm. C., 1028 Martin Place, Ann Arbor, Mich.
Holmes, Guy A., Supt. C. & N. W. Ry., Casper, Wyo.
Howard, C. R, Eisenbahn Ministerium, No. 9 Elisabethstrasse, Vienna, Austria.
Hughes, Glenn R., 1628 E. Seventh St., Los Angeles, Calif.
Hunicke, C. C., 27 William St., New York City.
Jackson, Edward C., Thirteenth Infantry, Camp Devens, Mass.
Jellum, Kristen, 2701 Mildred Ave., Chicago, Ill.
Keeyn, James L., 335 Palmetto Drive, Pasadena, Calif.
Keenan, Edward Thomas, 7 Washington Square W., Brewster, Fla.
Kittell, Clark, West Point, N. Y.
Kiyz, Emil W., 6911 Salem Ave., S. E., Cleveland, Ohio.
Lang, Frank A., 7331 Custom House, New York City.
Lancaster, Wm. C., 1328 Broadway, New York City.
Landman, Everett S., Railroad Ave., Closter, N. J.
Lansky, Wm. J., Farmingdale, N. J.
Lee, Richard, Fourth Engineers, Camp Lewis, Wash.
Lewis, Geo. A., 32½ Lewis St., Auburn, N. Y.
Lundgren, Leonard, 419 W. 121st St., New York City.
McCoy, Jos. M., 1155 Colusa Ave., Berkeley, Calif.
McGeorge, Harold, 410, 1900 Euclid Bldg., Cleveland, Ohio.
McLean, Alexander, 3397 Fulton St., Brooklyn, N. Y.
McLean, R. W., 91 Bedford St., Bridgewater, Mass.
McMillan, C. E., New York Athletic Club, New York City.
Manington, Jos. A., 1342 Detroit St., Los Angeles, Calif.
Michael, S. F., 1056 Cleveland Ave., Portland, Oreg.
Millard, R. S., 2086 E. 105th St., Cleveland, Ohio.
Miller, John A., Jr., 79 Lincoln Park, Newark, N. J.
Miller, Perry K., 18 Vera Place, Montclair, N. J.
Mudd, Col. Seeley W., 1208 Hollingsworth Bldg., Los Angeles, Calif.
Murrin, John H., O'Reilly General Hospital, Oteen, N. Y.
Neff, Nettleton, 1308 Ritchie Court, Chicago, Ill.
Newcomb, 1616 B Ave., Cedar Rapids, Iowa.
Newman, J. T., Jr., 22 Garrell Bldg., Wilmington, N. C.
Parker, Claude E., Postoffice and Court House Bldg., Charlotte, N. C.
Paules, E. G., 286 Highland St., Worcester, Mass.
Perry, Chas. E., First Engineers, Camp Dix, N. J.
Petzel, Chas. L., Franklin, N. J.
Randall, G. B., R. R. No. 16, Dayton, Ohio.
Rapplcyea, Geo. W., care D. M. Bright Co., Briscoe Block, Knoxville, Tenn.
Rickner, J. C., Co. B., 1st Engineers, Coblenz, Germany.
Rooney, L. J. F., 1211 Carson St., Tulsa, Okla.
Rosenthal, Emanuel, 128 E. 83d St., New York City.
Ryons, Fred B., 943 No. 23d St., Lincoln, Nebr.
Samson, Chas. L., 7025 Normal Blvd., Chicago, Ill.
Seerie, John D., City Hall, Long Beach, Calif.
Simpson, Colin C., 1330 E. 15th St., New York City.
Slade, James V., Room 1607, 101 Park Ave., New York City.
Smith, Mortimer W., Jr., 437 W. Main St., Clarksburg, W. Va.
Starrett, W. A., 175 Fifth Ave., New York City.
Stewart, Fred J., care M. G. Hall, Centerville, Iowa.
Stuart, Robert Y., Department of Forestry, Harrisburg, Pa.
Taber, John O., Jr., 20 Fletcher St., Roslindale, Mass.
Tuttle, Wm. B., 305 E. Houston St., San Antonio, Texas.
Ware, Samuel H., Camp A. A. Humphreys, Va.
Whitley, Frederick Nelson, 117 Montague St., Brooklyn, N. Y.
Whitlock, Elliott H., 11200 Edgewater Drive, Cleveland, Ohio.
Willcox, H. C., care Carib Syndicate, 90 West St., New York City.
Williar, Harry D., Jr., 601 Garrett Bldg., Baltimore, Md.
Williams, Charles F., Socorro, N. Mex.
Worrell, Magnus Leon, 1122 22d Ave., Meridian, Miss.
Wright, James C., Box 502, Tombstone, Ariz.
Wuest, Chas. E., University of Tennessee, Knoxville, Tenn.

New Engineering Society

On September 22, 1920, the American Society of Lubrication Engineers was formed, with headquarters in the Monadnock Building, Chicago. The purpose of the Society is "To promote a better understanding of the problems of lubrication and the use of liquid fuels, including all problems of application and conservation." Oil companies, manufacturers of equipment, and users of lubricants and liquid fuel will, through the medium of this Society, co-operate for the dissemination of scientific data and useful information.

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Progress in Organization of National Guard Engineer Units

Based on information secured from the Militia Bureau

THE work of reorganization following the passage of the act of June 4, 1920, has progressed far enough to enable us to appreciate the size of the task that confronts those who are charged with the duty of forming Engineer units for National Guard Service.

As is well known, there have been allotted to each of the nine Corps Areas within the continental limits of the United States two National Guard Infantry divisions. With each division is included the unit to be known henceforth as a Combat Engineer regiment, having a prescribed aggregate peace strength of 31 officers (including four medical) and 762 enlisted men. Four Cavalry divisions have likewise been allotted to the entire nine Corps Areas, each division including a Combat Engineer battalion, mounted, with a prescribed peace and war strength of 17 officers (including two medical) and 340 enlisted men.

The remaining components of the Regular Army Engineer organization as discussed in Major Wilby's article in the January-February issue of THE MILITARY ENGINEER will be duplicated in the National Guard Service, the main units being three Auxiliary Engineer battalions (which may be composed of colored troops) and a Corps Engineer regiment with each Corps Headquarters, and six Auxiliary battalions, together with three Army Engineer regiments with each Army Headquarters.

Under the law, the task of organizing the National Guard forces is to be undertaken in annual increments over a period ending June 30, 1923. For the fiscal year ending June 30 next, the following table indicates the allotments of Engineer units that have been made, as well as the status of existing units on January 31, 1921:

State	Division Troops	Corps Troops	Recognized as Nat. Guard
New York	1 regiment	1 regt. and 1 aux. bn.	1 regt. (divisional)
Pennsylvania	1 regiment		
Ohio	1 regiment		1 company
Texas	1 regiment	1 aux. battalion	
Massachusetts	1 regiment		1 regiment
New Jersey	1 battalion,		
District of Columbia	1 battalion, 1 hdqrs. & service co.	1 aux. company	Hdqrs. and service company and 2 companies of the battalion formed by conversion of existing infantry units.
Indiana	1 battalion,		
Iowa	1 battalion,		
Oklahoma	1 battalion,		
Tennessee	1 company		
Mississippi	1 company		
North Carolina	2 companies		
Oregon	1 company		1 company
Nevada		1 battalion, 1 hdqrs. and service co.	

It will be observed that no great progress in organization can be claimed for Engineer units during the past two years, for, aside from the conversion of the Infantry companies of the District of Columbia, only two regiments and a couple of companies out of the eleven regiments allotted have met the requirements for Federal recognition. This observation as to slow progress may, of course, be applied to the National Guard as a whole, but in lesser degree than to the Engineer branch alone, for on January 31, 1921, the Guard enrolled a total enlisted strength of 78,000 out of an allotment of about 208,000.

There have been many explanations offered for the exceedingly slow increase in the strength of the National Guard, but these cannot be discussed within the limits of this article. It may be said, however, that the two statements most frequently made in National Guard circles are these: That Congress by delaying the passage of necessary legislation was handicapping the development of the Guard, and that the high minimum strength required for the recognition of units prevented the presentation of a large number of companies that could not be recruited to the Regular Army prescribed strength until Federal recognition had been extended to a group that could thereafter act as a nucleus of a larger organization. By the passage of the act of June 4 last, Congress removed the legislative barrier and furthermore expressly provided that National Guard companies may be recognized with a minimum strength of fifty men regardless of the previously prescribed strength. With these two handicaps removed it might reasonably have been expected that a great boom in recruiting would follow, but the results have certainly failed to justify any such expectation. It is true that a small spurt in recruiting took place in June and July which added 13,000 men to the net strength of the Guard, but some of this increase must be credited to the fact that enlistments in the National Guard always "pick up" just before the season for the summer encampments. Between July 31 last and January 1 of this year the monthly net gain in strength has only ranged from 2,500 to 4,500 for the entire United States, and the rate of increase tends to grow smaller rather than larger. During the month of January the Guard did not gain in strength, due to the large number of units disbanded.

Assuming that there will be no great revival in the popularity of the National Guard within the reasonably near future (and nothing else is justified either by past experience or present prospects), it is not difficult to prove that on the basis of the monthly rate of increase given above the Guard cannot enroll by June 30, 1923, more than 195,000, as compared with the prescribed minimum of 424,800.

The engineer branch of the National Guard reflects the effects of the widespread apathy toward military service in general, but in addition our branch has acquired a reputation all its own that renders it the slowest of all organizations in recruiting. The cause of this situation is not far to seek, though the writer is reluctant to refer to it. However, it has been cited so consistently throughout the recruiting service of the National Guard that it seems to have a foundation in truth, in which case it is wisest to face the situation. The truth appears to be that the engineer service is

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decidedly less popular han other branches, as a result of the fact that engineer soldiers were so largely employed as manual laborers during the A. E. F. operations.

Those officers who were so fortunate as to serve with an engineer regiment attached to a combatant division and whose commands consequently saw more or less active service may be inclined to dispute this statement, but such men are few in number and they are easily voted down by the far greater number of officers and the great bulk of the enlisted engineers who were consistently employed on construction work far behind the lines in France and who saw no frontline service. Even those members of divisional regiments of engineers whose battle experiences were limited to carrying on bridge and road work under long-range artillery fire cannot be expected to become enthusiastic over the chances for glory in an engineer regiment.

It may be repeated that the truth appears to be that during the World War the enlisted engineer had to swing the hammer or the pick or ply the saw to such an extent and so far removed from the zone of combat—the field of Death and Glory—that the popularity of that branch of the service has suffered to a marked degree. The mass of demobilized engineer soldiers throughout the country are not boosting our stock with thrilling accounts of trench raids put over, of machine-gun nests bombed off the map, and of prisoners of war gathered in by the hundred. The Adjutants General of most of the 48 states agree that the engineers are trailing the popularity procession, and some of them have been embarrassed by being called upon to explain that these units do not deserve the name of "Safety First Outfits."

In this case it is easier to describe the symptoms than to prescribe a remedy for the disease. Furthermore, the trouble is complicated by the fact that most of the doctors will agree that in times of peace the useful constructive work required of engineers is a source of greatest satisfaction and benefit to both officers and enlisted men. Presumably the situation will improve as the new generation of men comes on, men whose preconceived notions of war are not as faulty as those who "went in" during the recent conflict and who suffered the bitter pangs of disillusionment when they found that engineering in war is still engineering—only more so. Poets and historians have ever depicted war as a romantic adventure, and even the engineer, who is fundamentally an adventurer, loves romance. The agent who advertises for engineer recruits nowadays must watch his step. He must be a word painter of no mean ability and, in any event, he cannot afford to be as baldly direct in his methods of salesmanship as the old darky down South whose shingle read, "We bury others, why not you?"

The authorities, both at G. H. Q. and in the S. O. S., recognized that conditions surrounding the necessary engineer work in the A. E. F. were not such as to appeal to those who loved the smell of burning powder. A study was indeed made as to the possibility of "rotating" the service in the combat zone, but the war ended before the plans could be matured.

We are prone to draw conclusions from our experiences in the World War and to disregard all previous experience as well as to overlook other factors which will have a bearing on future operations. Just as the World War differed radically from all wars that preceded it, so it is reasonably certain that our next war will be very unlike that just finished. There will, no doubt, be a tremendous demand for engineering service, but in a new theatre of operations and under new conditions of warfare one may safely venture the prediction that no small part of the engineering work will be done under conditions that will contain the necessary spice of romance, and will furnish that modicum of truth essential to tales of high adventure and heroic daring.

The Military Mind

The discussion between Colonel Graves and Major Keesler in the last issue is surely an encouraging sign. The spirit shown between both principals in this "go" is the kind we need to bring about the desired results. The regular and emergency men are getting together all right. Just give the emergency fellows a chance to unload some of their ideas, especially those who have had the experience, and we will get these and the "Military Mind" boiled down and consolidated into perfect form for future use.

Just as the regulars had the opportunity to lead and instruct us in the methods and mysteries of the Military Mind while we were in the Service, now we have the opportunity to teach them a few things while we are out of the Service. Those who had to do with operations involving men and material in civil life surely have things worth while, especially after their experience in the Service, to bring before the men of the regular army.

The "Military Mind" needs a "tail piece" to meet the emergencies of these times, the integral parts to be supplied by "all concerned." Much of this material can be supplied by the emergency men of the late war and it is our duty to do so in a constructive manner for the good of the Service. There is one point we should bear in mind—we *all* faced an unusual emergency at the same time and had to learn a lot of things together.—B. W. VALLAT, *formerly Major 107th and 6th Engineers, A. E. F.*

Detroit, Mich.

Chicago Bascule Bridge

Many new features of construction were incorporated in the new double-deck double-leaf fixed-counterweight trunnion bascule highway bridge of 256-foot span over the Chicago River at Michigan Avenue, which was opened in May, 1920. It is believed to be the only double-deck bridge ever built having highways on both levels in order to provide for a separation of fast and slow traffic. Viaduct approaches connect the street level of the avenue with the upper roadway of the bridge, the lower roadway being for the slow and heavy traffic between various industries, terminals and steamship docks in the vicinity of the river. At the ends of the bridge the approaches are widened to form broad and ornamental plazas.

With a span of 256 feet c. to c. of trunnions, the structure provides a clear channel width of 220 feet. Its navigation headroom was required by the War Department to be 16½ feet from water line (city datum) for 80 per cent of the channel width with the bridge closed, and 120 feet for the entire width of channel with the bridge open. The lower deck has a traffic clearance height of 13½ feet, while the upper deck is free of overhead obstruction. Both floors are paved with creosoted yellow-pine block paving on transverse planking bolted to the I-beam stringers. Back of the trunnions, however, the lower deck has sandstone block paving on concrete on a buckle-plate floor, in order to add weight to the tail and to give a better footing for teams on the 3 per cent grade from the street. Provision is made for the future construction of two street car tracks on the lower deck.—*Eng. News-Record.*

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Mobile Printing Train of A.E.F. Now with 2d Engineers

[The experimental mobile printing train of the A. E. F., sometimes spoken of as the "traveling circus," aroused so much interest and created so much comment in France that our readers will be interested to learn something about the train and also that it is still in existence.—ED.]

THE printing train now with the Second Engineers has had a varied experience. After being assembled in the United States during the war with Germany, it was sent overseas and assigned to G-2, of the Third Army. When the Armistice was signed it was sent into Germany with the troops. At this time the personnel consisted of two hundred and fifty selected men. Each man was a specialist in some department of printing, photography, or lithography. It remained in Coblenz some time, and was then sent to the United States to Camp Humphreys, Virginia. In February, 1920, it was decided to send the train to the Second Engineers at Camp Travis, Texas. It arrived there in May, rather the worse for its two thousand mile trip.

The train consists of eighteen trucks, one machine shop, three searchlight trucks for light and operating power, and three tank trucks. The first truck is the composing room. In it are type cabinets for hand composition and also a linotype machine. From this truck the work to be printed is passed on to truck two or three. Large jobs, when many copies are required, go to Kelly press in truck number two. while the smaller jobs go to the job press in truck three. This last truck also contains a multigraph, a stitcher, and a folding machine.

From printing we pass on to lithography, and truck number four contains a small rotary press where the finished zinc plates are printed. The next truck contains the apparatus and chemicals for sensitizing the zinc plates. In truck number six the zinc plates are exposed under a vacuum frame; in nine they are etched, and in seven they are rolled up and prepared for the rotary press. The work goes first to truck number six where the sensitized plates from five are exposed. Then this plate goes to nine; then to five and seven, and finally to four for printing.

Truck number eight contains a large wet plate camera capable of taking pictures 20 by 24 inches. This is used in photographing the maps and reducing them to exact dimension. The exposed plates go to truck number thirteen to be developed. The plates when finished are sent to truck number six, where they are printed to the sensitized zinc plates.

In truck number ten there is a routing machine where zinc cuts are made for the Kelly press or job presses, and are routed out and made clear.

Truck number eleven is now being used as a drafting room, and truck number sixteen as an office. However, number eleven was originally intended for aerial restitution work. No work of this kind is being done at present.

There are two supply trucks, one containing the paper supply and also a hand cutter for trimming the paper. The other contains the supply of chemicals and other materials used about the train.

There are two trucks used in connection with dry plate photography, which contain a small rotary press similar to the one in number four.

The train is capable of printing all kinds of matter; orders, circulars, letters, booklets, or newspapers; of photography; of printing posters; of all types of photography and of restitution from aerial photos.

The operation of the train is somewhat hampered at present by the lack of skilled men. When it first arrived in May there were only two men on hand who knew anything about handling it. Master Engineer Rodgers, from Headquarters Detachment, 2d Engineers, had served with the train throughout its tour in France and Germany, and was invaluable in helping to put it into operation here. The second man was Mr. Goedike, formerly a Captain in the Engineers, who was with the train in France and Germany. He was employed by the Government for a year to put the plant in operation and then to act as technical advisor for the officer in charge. The men are detailed from the 2d Engineers. They are, as a rule, untrained when they are first detailed, but they rapidly acquire a working knowledge of the departments of the train to which they are assigned by actually doing the work. It is not a school in the usual sense of the word, but rather a producing plant where the soldier learns by observing the results of his work.

Tightening Up a Wooden Block Pavement

An ingenious solution of paving difficulties was found in St. Louis last summer. Due to exaporation the wooden blocks had shrunk, which allowed them to rock under traffic, the pitch filler tending to work down under the blocks. Instead of taking up and relaying, which would have cost $10,000 for 7,500 square yards, and would have stopped traffic, the pavement was cut across its width (22 feet) at intervals of 150 to 250 feet, and jack frames carrying short trench braces inserted flush with the pavement. By tightening on the jack screws during hot weather the pavement was moved and tightly closed for a distance of 75 to 125 feet each way from the jacks. Under maximum temperatures (July, 1919) of 81 to 93 degrees, the total movement varied from 30 inches at a point 5 feet from the jacks, to 1 inch at a point 100 feet from the jacks. Movement in the direction against traffic was somewhat greater than in the direction of traffic, as the tractive effort of tires on the one-way street helped to push the pavement in the direction opposite to traffic. Three men manipulated 16 openings whenever the temperature conditions were favorable and obtained a total spread, between June 14 and September 14, of 23½ feet, or about 1 per cent of the original surface length. The openings were temporarily filled with blocks and the jack screw slots covered with small steel plates in order to accommodate the traffic during the course of the work. The cost was $1,200 for labor and supervision, $200 for material, a total of $1,400, as against $10,000 for repaving.

The new practice in paving is to use greater compression in laying the blocks in order to avoid a recurrence of trouble due to shrinkage.—*Eng. News-Record.*

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Wire Drag Sounding Line

Construction. Assuming the depths to be measured in the particular case are from 18 feet to 33 feet, the line is constructed as follows: Starting with an ordinary 8-pound sounding lead fitted with a short leather thong, attach one piece of No. 14 galvanized wire with a small eye in the free end, to make over-all length from lower end of lead to the eye at free end 18 feet, then 7 lengths of No. 14 galvanized wire, each 1 foot long over their eyes, making an over-all length of 25 feet. In the last eye (25 feet) bend in 10-foot length of shrunken ¼-inch cotton line, making total over-all length 35 feet. The line is then marked thus: At the 18-foot, 24-foot and 30-foot distances, small pieces of black muslin are tied in the eyes or sewed on the line. At 21 feet, 27 feet and 33 feet, small pieces of red muslin are tied in the eyes or sewed on the line. At all the other foot marks, small pieces of white muslin are tied in the eyes or sewed on the line. The eyes in the wire should be made no larger than is necessary to allow hinge action, and the markings should be no longer than is necessary for the leadsman to see readily, because the eyes and markings all offer resistance to currents and tend to cause sag in the line. Tenths-of-foot between the foot marks can, after a little practice, be quite accurately estimated. Lines to measure lesser or greater depths are made on the same principle, viz: Wire length at maximum and rope length at minimum. The rope length serves as a handle, enabling the leadsman to obtain a satisfactory grip on the line without cutting his hands on the wire.

Use. The leadsman stands on the stern of the sounding boat, preferably a row boat, holding the line overboard continuously with the lead a foot or so above the river bottom. The boat is propelled at a rate of 2 to 3 miles an hour, and when soundings are required the line is lowered to the bottom, the foot mark above or below water line noted, the tenths estimated and added or subtracted from the noted foot mark below or above the water line, as the case may be. A forward and after swing of the leadsman's arm will usually bring the lead directly under the stern of the boat, making the measurement vertical, but in case this method does not give a truly vertical measurement the slant in the line is observed and the boat is checked and backed up, so that the line becomes truly vertical. The difference between the slant line and vertical-line soundings will give the error for slant-line sounding, which should be recorded for each line as is done with tide readings, and applied to the observed soundings to reduce them to their proper datum values.

Rapidity and accuracy. With the wire line, soundings may be readily obtained at 10-foot intervals, and their accuracy in deep water exceeds those obtained from a sounding rod, due to increased sensitiveness of touch on the river bottom. The flotation of the sounding rod deadens the sensitiveness of touch, so that in soft material the heel of rod has to penetrate the soft mud before the leadsman is aware that he has touched bottom. In the method of the ordinary casting line, the soundings obtained are always excessive, due to the three principal errors of the method: (1) Line not vertical; (2) lead sinking in soft material or lying on its side; (3) the catenary form taken by the ¼-inch line due to its resistance to currents.

The wire line will consistently give 4 per cent to 8 per cent less than the ordinary casting line.

The wire sounding line for depths greater than 16 feet (for depths less than 16 feet a sounding rod is used) has been used exclusively in the Washington District for twenty years, not only for cross-sectioning dredge channels, but also over extensive water ways of miles in width and length. In the large waterways it is customary to have two sounding boats, one moving out taking soundings, the other coming in tow of a gas launch to next station with party at case, making a continuous operation for the locating parties. The location of soundings is obtained by tag line or instrumental trisection.— *W. B. Harrison, Major, Corps of Engineers.*

Substitutes for Wood Cross-ties

There is probably no subject to which the mind of the inventor has turned more frequently than that of a substitute for wooden cross-ties. Yet in all the history of railroading no satisfactory substitute has been produced. It was hardly to have been expected before the present time. Wood was cheap and satisfactory, and there was nothing that could compete with it. But now that wood is becoming constantly scarcer and more costly, it is to be hoped that the effective substitute will be forthcoming.

The American Railway Association believes that this substitute will be produced by progressive development rather than revolutionary design.

At present there are 3,000 billion feet board measure of standing timber in the United States. This increases at a rate of 35 billion feet per annum, and is destroyed or wasted at the same rate. The annual consumption amounts to about 100 billion feet. At present rates then, the visible supply will be exhausted in 30 years. It is to be expected, however, that there may be a decline in consumption and an increase in production as the cost increases. Also the railroads will be less "fussy" as to the kind of ties required. Accordingly, our forests will probably continue to supply cross-ties for at least 50 years. Before that time a substitute should be developed.

The report of the Committee on Ties of the American Railway Association gives some valuable hints to any who may wish to take up the study of substitute cross-ties.

Flood-check Dams Formed by Fill

To check the velocity of streams in flood times and to store the surplus water which flows down the sandy and porous California river beds, there have been built lately some special dams known as the "Pratt Porous Dams" after their designer and builder, A. A. Pratt, of Los Angeles, Cal. They consist of a gaged wire frame stretched across the dry bed of the stream behind which frame there builds up during a flood a mattress of debris which constitutes an effective barrier to the water.

Such a dam was built for the Water Conservation Association of Riverside, Cal., on the Santa Ana River. The dam is constructed of iron posts or angle irons set into the bed of the stream and standing about 6½ feet above the bed and about 3 feet deep. These posts are guyed upstream by heavy wires to anchors set in boulders in the bed of the stream. The lower line of posts for the supplemental sections is set on the bed of the stream but not below the surface. They are guyed upstream as in the main dam. Upon these posts transverse angle irons are bolted, forming a frame on which wire mesh is stretched. The mesh in this case was made of ¼-inch wire with 6-inch mesh. The wire mesh is carried upstream above the river bed for about 16 feet and boulders laid upon the apron so formed.—*Eng. News-Record.*

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Functions of Division Engineers in War

[NOTE—The following is a proposed paragraph in the new Staff Manual. The paragraph has been prepared with a view of defining, for the information of all arms, the duties and functions of the Divisional Engineers in War. The Chief of Engineers would be pleased to receive criticisms from interested officers and former officers. It should be noted that the strength of the Engineer Regiment has been prescribed by higher authority.—ED.]

Combat Engineer Regiment for Infantry Division

(*a*) This consists of two battalions and one Headquarters and Service Company; each battalion of 3 companies of 106 enlisted men each. (Total strength, 806 enlisted.) It forms only 4.35 per cent of the strength of the Infantry division. It will be equipped with automatic rifles, a small amount of pack transportation and a small mounted platoon in the Headquarters and Service Company. In addition it has its ordinary Engineer equipment.

(*b*) Besides its combat training (see *k* and *l* below) the regiment should be trained for performing all military engineering duties required by the division. Specifically these duties include:

Topography—

1. The regiment prepares and reproduces such topographical maps as are needed by the division, and cannot be elsewhere obtained.

2. It reproduces the situation sketches and special diagrams required by the division general staff.

3. It procures and distributes all maps to the division.

Communications—

4. It examines routes of communication and supply during an advance, including bridges and water-crossings; and makes such repairs as are necessary.

5. It constructs and maintains, with the assistance of other troops when necessary, routes of communication (including roads, railroads, bridges or stream crossings) required by the division, except as they are maintained by Engineers belonging to higher units, or Cm. Z. troops.

6. It provides and places signs marking routes of communication and division headquarters; and provides other signs required by the division.

Organization of the Ground—

7. It marks on the ground such defensive positions in rear of the outpost position as are directed by higher authority; and constructs, or supervises the construction of the defensive works included in these positions.

8. It may be called upon (as an exceptional measure) to select, construct, or supervise the construction of defensive works in the outpost position. All the work on this position is usually carried out by its Infantry garrison, which always maintains the works it occupies, including the wire entanglements.

9. It executes the technical details of the more important field works required by the division, when such execution requires specialists or tools not available to the organization which is to occupy the work.

10. It assists in the selection of, and constructs, division O. P.'s and advanced P. C.'s.

Demolitions and Obstacles—

11. It removes or overcomes obstacles encountered on the march of a division, such as land mines, barricades, etc.

12. It executes all required military demolitions, including the destruction of military stores threatened with capture.

13. It recommends the means to be used in the removal or passage of obstacles encountered in the attack of, or raid upon a prepared enemy position; furnishing tools or equipment and the assistance of such technical specialists as are necessary.

Supply of Engineer Tools and Material—

14. It procures, stores, and issues Engineer supplies to the division. For facilitating the issue of entrenching equipment to the Infantry, the regimental transportation includes: 1 escort wagon (loaded with entrenching tools) for each Infantry battalion in the division.

Shelter and Water Supply—

15. It executes, with the assistance of other troops when necessary, all general construction work in a divisional area (including bath-houses and delousing stations) not done by Engineers of higher units, or Cm. Z. troops.

16. It operates the various utilities, such as electric light plants, water supply stations, etc., within an advanced area; and within a rear area where these are not controlled by Engineers belonging to higher units, or by Cm. Z. troops.

17. It assists in the selection and lay-out of camps for the division, when called on.

18. It furnishes an adequate water supply for the division when in contact with the enemy, and in rear areas where this is not arranged for by Engineers belonging to higher units, or Cm. Z. troops; except, that, in mobile warfare or on the march, as water must be obtained from widely scattered local sources, water supply points must frequently be located, inspected, and marked by each organization for its own use.

(*c*) Auxiliary labor is normally required in road work in stabilized warfare (clause 5 above); construction of defensive positions (clauses 7 and 8 above); and general construction work (clause 15 above). Such labor should be requisitioned from the division commander by the regimental commander and employed as provided in Army Regulations. It is desirable that the officers and men detailed be taken from organizations who will benefit directly from the work done, if such a course is practicable.

(*d*) Engineer troops should habitually work under the orders of their regimental commander. It may be advisable, under unusual conditions to attach Engineer units for work with regiments, or bridges, but it should always be understood that their work is under the direction of their regimental commander. The policy of attaching all the Engineers to different brigades, leaving no reserve in the bands of the regimental commander, is particularly to be condemned. The distribution of Engineer work can seldom be foreseen in mobile warfare, and, when need for this work arises, the division commander must have Engineers available to meet the situation promptly. The *method* of performing engineering work including the details as to

[Abbreviations: Cm. Z.—Communication Zone; O. P.—Observation Post; P. C.—Post of Command.—ED.]

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the number of men required, will always be decided by Engineer officers.

(*e*) The commanding officer of the division combat Engineer regiment is also division Engineer. He should actively perform both duties. Whenever possible, his regimental headquarters should be at, or in the immediate vicinity of, division headquarters.

(*f*) Engineering work, no matter how skillfully conceived and executed is of no value, unless it is accomplished so as to serve the military purpose for which it was designed. It must, therefore, at all times, be planned, directed and carried out with the fullest knowledge of the military situation, of the technical aims of the commander, and of its relation to their fulfillment. To enable him to acquire this knowledge, the division Engineer must have free access to the Chief of Staff.

(*g*) The division Engineer should be consulted in connection with:

1. The training in military engineering of all arms in the division.
2. The selection of defensive positions by the division commander or his staff.
3. The preparation of those paragraphs of division orders which relate to the Engineers; to the method of overcoming obstacles in an attack; or to the consolidation of captured ground, or preparation of defensive works.
4. The organization and control of routes for traffic within a divisional area, including the preparation of traffic control maps.
5. The selection of target ranges insofar as they might endanger public utilities.
6. All general construction work for the division.

(*h*) The division Engineer, subject to the approval of the division commander, prescribes rules for traffic over bridges and water-crossings.

(*i*) The division Engineer maintains close liasion with his corps Engineer, in order that the work done by his regiment may fit in with the plans of the corps Engineer. He makes such technical reports direct to the corps Engineer as the latter may require; furnishing his division commander with copies of such reports, if written, and keeping him informed of the nature of any important verbal or telephonic reports.

(*j*) In a rear area, the division Engineer may be charged with maintaining laision with the Cm. Z. Engineers, with a view to facilitating the shelter and water supply of the division, and ensuring the efficient operation of local utilities.

(*k*) Divisional Engineers will be trained to fight as infantry. The training should be sufficiently thorough to enable them to be of real value, and to acquit themselves creditably when so employed. However, Engineers are to be used as infantry only in a real emergency. If the Engineers are unnecessarily depleted, due to being used as Infantry when no emergency exists, the division may suffer later due to lack of the skilled personnel for handling some technical work of vital importance to the entire command. The frittering away of the small technical personnel assigned to the division by unnecessary employment of the Engineers as Infantry is especially to be avoided. *The use of Engineers as infantry in an attack is seldom justifiable.*

(*l*) In the preparation of field orders, it is a pernicious practice to immobilize the divisional Engineers by assigning them to duty as a divisional reserve in a designated locality. The regiment is automatically a division reserve. Its assignment to a designated locality hampers its proper utilization as Engineers and such an immobilization should be postponed until it becomes probable that their services as Infantry will immediately be required. In field orders, the regiment should normally be placed at the disposal of the division Engineer in order to enable him to carry out his mission. This mission may or may not be outlined in a paragraph or appendix devoted to Engineer Operations.

A New System of Power Transmission

A new system of power transmission having a wide range of adaptability, but particularly useful in the driving of percussion tools, has been devised and is being introduced in England. It makes use of the very slight compressibility of water or other liquid to introduce in a liquid filled conduit, impulse transmissions that are received at the opposite end of the line and converted into useful energy. This differs from compressed air and hydraulic transmissions in that there is no actual flow of the power medium nor is there required a source of supply of that medium and a corresponding waste of that medium at the power-using end. Just as direct current electricity has its analogy in hydraulics, this wave system of power transmission has its analogy in alternating current electricity, the laws and formulae of the two coinciding to the extent that they are almost interchangeable. Thus the wave transmission system has its direct equivalents for volts, amperes, frequency, angle of phase, induction, inductance, capacity, resistance, condensers, transformers and single-phase and poly-phase phenomena. Features of both systems are generators, rotary and reciprocating motors, heating apparatus, transmission lines, etc. The wave system promises to come into more direct competition with compressed air than any of the other usual forms of power transmission. In a comparison of costs between the two as applied to rock drilling operations, for instance, the promoters of the wave system claim savings of 80 per cent in power, two-thirds of the expense for maintenance, and one-third on the initial cost of the installation.—*Railway Review.*

French Government to Regulate River Rhone

Probably the most important and gigantic engineering work now being planned in France is the development of the Rhone River from Lake Geneva (Lac Leman) to the sea. The proposed development is to be in the three-fold interest of waterpower, navigation and irrigation. The upper Rhone is practically non-navigable, and is essentially a torrential stream. Beyond Lyons the river is full of rapids but has been rendered navigable by certain regulatory works mentioned below. The present plan calls for the immediate development of the water powers of the section above Lyons. These will be readily utilized at a minimum of expense, and the revenues and power derived from them will be of aid in constructing the remaining works. Briefly, the plan contemplates: (1) Rendering the river entirely navigable by the construction of canalized passes around the most objectionable rapids; (2) The development of power at the dams placed at the heads of these passes; (3) the use of some of the water for irrigation, which will be pumped by some of the electric power developed. It is believed that the total undertaking will cost in the neighborhood of 1,530 millions of francs ($295,290,000), of which 1,320 millions is for development of electrical energy and 210 millions for accessory works (passes, etc.) to render the stream navigable.—*Eng. News-Record.*

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The Army Mule in the World War

ONE contributing force in the success of the World War which has received but scant recognition is that hybrid, the mule. The part played by the mule in the American Expeditionary Forces is an outstanding feature.

A remarkable array of mules took part in the World War in the United States Army. There were 124,137 of them in the United States, and of that number 18,596 went overseas and actually took part in the war. Added to this lot were 11,036 from Spain, 8,992 from France and 6,794 from England, a total of 45,418. Many of the mules purchased from England and a number secured from the French had been bought in the United States by those countries. But those secured from Spain were the product of that country.

Literally there is no comparison between the small, poorly nourished mule secured in Spain, and those purchased in southern France, and the powerful, upstanding, mealy-nosed product of the Middle West. There was sharp criticism in some places of the class of animals which came up from Spain for duty on the battle front. But these little animals were able to haul machine gun carts, releasing the heavy animals for duty with the artillery and ammunition trains.

There were times during the final stage of the World War when it was impossible to give much needed rest to those animals. There were not enough to do the work which confronted them, and the result was that it was necessary to keep on the move, forty-eight, sixty, and sometimes seventy-two hours, with hardly a pause. Then it was possible to feed only a small amount of grain, and a few handsful of hay. Under this strain the mule went forward, giving his all uncomplainingly.

The recuperative powers which he showed were remarkable. Sometimes when engaged it would seem impossible to get him back to the front again, but his powerful constitution came to his rescue, and in a remarkably short time he was able to return to duty. The mule has always been given the credit of having his full quota of brains, but at times it seemed he had more than his share. He may run when hitched to a wagon, but invariably does no harm to himself or the wagon. When tired he makes his condition known by quitting. However, this quality did not come to the fore during the days of St. Mihiel and in the Argonne.

There are some interesting figures shown in the percentage of losses by death among mules as compared with horses during the World War. From July 1, 1917, when the United States Army first received animals in France up to November 11, 1918, the percentage of losses among mules was 10.88 per cent, while the losses among horses reached 25.37 per cent. The losses from July 1, 1917, to June 28, 1919, the date of the signing of peace, among mules were 13.12 per cent, while it ran to 27.97 per cent among horses. Figures compiled on both horses and mules from July 1, 1917, to August 31, 1919, when the American forces in Germany had disposed of practically all of their surplus animals, show a loss of 26.1 per cent. A further comparison shows that even though animals are not exposed to the rigors of campaigns that replacements in rather large figures are essential to the upkeep of the Army. From April 6, 1917, to November 11, 1917, the loss among horses was 9.5 per cent, while among mules it was only 3.7 per cent. From the beginning of the war to June 28, mules they were 4.6 per cent or less by 10.3 per cent among mules than among horses.

The record of the mule through the World War has been such as to reflect much credit upon the dam, the farm mare of the United States, as well as upon the long-eared, loose-jointed progenitor of that hybrid—an animal indispensable to the success of our Army in the field.

The mule, a hybrid, is the offspring of two distinct species—dam of the horse kind, and burro, known in Biblical history as the ass. The ass, a quadruped of the horse kind, but smaller, and having long ears, and as distinct from the attributes accredited to the horse, is defined as dull, stupid, slow and stubborn, but withal not lacking in strength and courage—a combination peculiar to the hybrid-mule.

In his wild or natural state the horse travels in bands or droves, and in distinction the ass or burro travels in single file, or step of its fellow. Again, the habitat of the horse by natural selection is high table land, and, in the case of the burro, hilly or mountainous sections. Hence the opportunity for fleetness in the horse and the acquired disposition of the burro to climb. The one prefers rich grasses, while the other is content to browse on the hillside. Due to the distinct traits, the horse is best adapted as a saddle or riding animal, and the burro and mule as a burden carrier, and were so employed by man before the introduction of the wheel. Many instances may be related of the traits or peculiarities of the mule, inherited from the burro. In a free or wild state the action of the mule is free, at the walk and trot, but when placed in harness or carrying a burden, the nature of the animal, by inclination, changes from a free to a stubborn, slow and stupid gait.

The horse is by nature an impulsive animal, whereas the mule by inclination is the reverse of impulsive. Again, the horse will resist abuse with the whip or club, or may spring into action, while the mule may receive abuse without protest, and lacks the impulse to action which must be induced by the liberal use of the whip or club.

The question has been asked, "Why does the mule show such attachment for the horse?" All nature loves the mother, and the animal mule is not an exception. It is nursed and cared for by the dam of the horse kind, and attachment is a natural sequence. The attachment of the mule for the horse has led to the employment of the latter to lead a train of pack mules; that is, mules carrying a burden. A train may consist of any number of mules, and may be likened to a railroad train. The horse leads in the same manner as the engine propels, and the mules are content to follow in the step of the horse, without regard to sex or color. During travel, when the horse may be out of sight, a bell with a strap attached is placed around the neck of the horse to indicate that the horse is in the lead, and the mules are content to follow. Should the tinkle of the bell not be heard and the horse be out of sight for some time, they show uneasiness by constant braying. Some mules show more fondness for the horse than their fellows, and as they become attached they follow in the step of the horse in consecutive order, and in no instance will one mule

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permit the other to advance out of its regular order. In the attempt to do so it is fought down the line until it regains its former position.

During the year 1882, while stationed with a pack train at old Fort Cummings, New Mexico, the "bell" horse, due to age, was sold for a song to the manager of the stage line from Cummings to Silver City, and another horse was supplied by the commanding officer. The animals, when taken to herd-ground for grazing, noticed the stranger and advanced for inspection by sense of smell and immediately protested by kicking at the stranger, braying and running around at a terrible rate, much like a child in search of its mother. A few days later while traveling with the train from Cummings to Fort Bayard, while passing the stage, old 'Vic," the former "bell" horse, recognizing the sound of the bell, began to whinny. The pack mules in turn recognized the cry of their old favorite and gathered about the stage in numbers that compelled the driver to stop. The passengers, noting the commotion, got out to witness so unusual a scene. Seemingly, each mule in turn had to approach old 'Vic," rest the head on his neck, and bray with lusty token of recognition, the braying continuing for some time after separation.

During the year 1866, while packing supplies to the mining camps in the upper Kootenais, British Columbia, while crossing the Dog Tooth Mountains, the bell horse had a leg broken and had to be shot. On the return trip, in passing the scene of the accident, the animals one and all gathered about the body of their old comrade, and with heads bent and mouth open, brayed in seemingly intense misery.

Another peculiar trait of the mule, inherited from the burro, is shown in a disposition to distinguish by sense of smell the trail of its fellows of one band or "Mulado," from another, as well as that of man—white from Indian. The mule also may be credited with sagacity, and even cunning. His sense of danger is unerring, as he will not attempt to enter bad or dangerous places, and it is well for the rider or driver to pay heed to the admonition.

Instances have been known where a pack mule would loaf about the army kitchen while the cook was baking bread until he observed the cook busy at some other duty, when he would approach the fire, raise one foot and paw off the lid of the Dutch oven, grab the hot loaf within, and make off with it on the run. He would do the same if he observed a hunk of bacon within easy reach.

Another instance was that of a messenger's saddle mule at the old corral adjoining the Alamo at San Antonio, Texas, before the advent of Fort Sam Houston. At noon time, on the toll of the bell, he would approach the gateway, and with his nose raise the latch that held the wicket and enter, then turn and with his nose push the wicket closed, go to the stall where his noon-day meal was ready.—*War Department News Bureau.*

Book Reviews

THE AMERICAN ENGINEERS IN FRANCE. By William Barclay Parsons, late Colonel, Eleventh U. S. Engineers. D. Appleton and Company.

Colonel Parsons is eminently well fitted to draw the general picture of the important part which the Engineers of our country were called upon to perform in the greatest task which has confronted civilized man in the past century, that of overcoming the aspirations and results of the false and debasing teachings of German Kultur. Not only was Colonel Parsons one of the prime factors in securing the law under which was made possible the organization for national defense of our resources of trained technical men in civil life as reserve officers of the Army, but also he was the first engineer to receive a commission, and the Lieutenant Colonel of the first volunteer regiment formed, the 11th U. S. Engineers, the second volunteer regiment sent abroad for service. His own service in the Engineer Commission ordered to France in May, 1917, and subsequently with his regiment throughout the war gave him the opportunity to obtain the comprehensive grasp of the situation which he has portrayed so graphically in the book just issued from the press.

The table of contents shows how wide was the scope of Engineer activities. Colonel Parsons does not attempt detailed descriptions of any individual works. His book is not an engineer text-book, nor is it the story of any campaign. It is, however, a clear statement of the tasks confronting Engineers in modern war, and of the methods followed by France, England and the United States in carrying on the work to a successful termination. The reader cannot fail to be impressed by the fact that in war, as in peace, transportation is one of the factors essential in the life of today.

Though the book is a tale of great accomplishments and of duty well done, the reader throughout sees how costly, if not actually criminal, is our traditional policy of unpreparedness.

BATTLE STUDIES. By Col. Ardant du Picq. With a foreword by Marshal Foch and a preface by Frank H. Simonds. Edited by Col. John N. Greely, F. A., U. S. A., and Maj. Robert C. Cotton, G. S., U. S. A. Cloth. $2.50. Macmillans.

Of this book Marshal Foch says: ". . . a very valuable work . . . amply verified in the experience of the American Army during the last war . . ."

Of this book Frank H. Simonds says: ". . . although he died in 1870, du Picq lives, through his book, as one of the most useful guides to a proper understanding of a war fought nearly half a century later . . ."

These two quotations are enough to establish the applicability of this old French military classic to the warfare of to-day, and to explain the first appearance of an English translation, made by two officers who fought in France in 1918.

The studies were made half a century ago by an obscure French colonel, who gave in them a luminous statement of the fundamental principles of warfare, the neglect of which led to Gravelotte and the first Sedan. He belonged to an army which was defeated, and fell on the eve of a battle which not only gave France over to the enemy, but disclosed a leadership so inept as to awaken the suspicion of treason.

Nowhere can be found a clearer statement of the bases of battle, a better analysis of the all-important human element in war, than in the paragraphs of Ardant du Picq. Reading him, "one understands something of the soul as well as the science of combat." Every American soldier reader will somewhere say, "That's Gospel truth," or "That reminds me of the day . . ."

Reunion of the 29th Engineers

Sixty-two officers and men of the Twenty-ninth Engineers met at their annual reunion on February 18th at the Cosmos Club, Washington, D. C. Major General Beach was unable to attend, and Brig. Gen. Harry Taylor was the guest of honor. General Pershing and Brig. Gen. Dennis Nolan sent their regrets at not being able to attend.

Lieut. Col. Alfred H. Brooks presided, and Col. Gilbert

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Youngberg gave a valuable and interesting address on the plans for the Reserve Corps organization. Letters were read from Col. R. G. Alexander, now on duty at West Point, and Captain Ardon, the former French liaison officer, who is now engaged in private engineering work in the Federated Malay States. Humorous anecdotes and a vivid moving picture of A. E. F. life occupied the balance of the evening. Comrades attending came from as far as Connecticut and New York City for the purpose. Capt. R. T. Evans was the chairman of the committee of arrangements.

Lieut. Col. Augustus Trowbridge, formerly with the General Staff in the A. E. F., and in charge of Sound and Flash Ranging Organizations, is in charge of the Division of Physics at the National Research Council in Washington, D. C., for this year.

Maj. Theodore Lyman, formerly in command of the 2d Battalion of the 29th Engineers, later the 74th Engineers, is with the Jefferson Physical Laboratory at Harvard University.

Capt. George S. Young, formerly of the 29th Engineers, is with the General Petroleum Corporation in San Francisco, and hopes to have a reunion of about 75 members of the organization from the Coast in March.

Lieut. Col. W. W. Kirby, of the 29th Engineers, is now a Major of Engineers in the Regular Army and is in charge of the Engineer Reproduction Plant at Washington Barracks, D. C.

Maj. H. R. Richards, after a severe illness of some months' duration, is Business Manager of THE MILITARY ENGINEER and Secretary of the Society.

Lieut. Col. G. S. Smith, of the 29th Engineers, is now out of uniform, though still in the Reserve Corps. He has charge of surveys being made by the Republic of Santo Domingo.

Capt. O. G. Taylor, of the 29th Engineers, is now Resident Engineer of Yosemite National Park.

Capt. Stuart P. Penick, of the 29th Engineers, is now Technical Assistant in the Reclamation Department of the State of Texas.

Col. J. P. Hogan, Maj. L. B. Roberts and Capt. C. H. Davey, of the 29th Engineers, are with Parsons, Klapp, Brinckerhoff and Douglas, in New York water-power investigation.

Lieut. John W. Brashears, Jr., formerly with the 29th Engineers, is touring the Southern States in a Dodge car, converted into a comfortable and home-like dwelling on wheels.

Capt. A. P. Meade, of the 29th Engineers, is conducting a lithographic establishment in New York City.

Lieut. McKinley W. Kreigh, formerly of the 29th Engineers, is practicing law in Springfield, Mo.

The Military Mind

In THE MILITARY ENGINEER for November-December, 1920, we published a brief discussion of the workings of the Military and the Non-Military Mind. The violent reaction after the Armistice against all things military was, in the main, a manifestation of war fatigue, which is a condition fairly well recognized as the aftermath of every war. It is undoubtedly true that one of the factors contributing to the intensity of the war fatigue following the World War was the failure of the military and the non-military mind "to go along," one with the other, during the war. An impartial verdict would lay the blame in some measure on both sides, and thus a further consideration of the operations of these types of mind should prove illuminating to the respective possessors thereof on the Burns principle, that it is well to "see ourselves as others see us." The following from a member of our Society is a non-military point of view on military appointments and some things to be avoided in connection therewith:

The last issue of the Journal contained some very interesting articles, and in reading about the "Military and Non-Military Mind" it occurs to me that the Army should try to understand the "Non-Military" mind in some cases, particularly with reference to obtaining recruits and new officers.

The writer recently journeyed some hundred miles or more to Camp Meade, for examination for a commission in the Regular Army. Nothing further was heard of the matter until a telegram (delivered two days late) advised of an appointment in one grade below that applied for by the writer. The A. G. Dept. gave me two days to send in my acceptance, and I believe ten days to report for duty.

Now, a civilian with any kind of a position at all is not going to leave his company on short notice, when doing so will seriously handicap the organization with which he may have enjoyed many years of pleasant association. The non-military point of view would be to remain for at least thirty days with his company, or until some one could be secured to handle his work. Furthermore, before accepting a commission in a lower grade than expected, a civilian would like to have several questions answered, but the two-day limit prohibited anything other than "take it or leave it," without understanding the new listing system or any of the other changes which may have been made since the World War.

The above may explain why the War Department itself prevented some officers from accepting commissions in the Regular Army. It goes without saying that no one would take the trouble to be examined if he were not interested in the proposition.

Characteristics of the German Long Range Gun

The German long range guns used in bombarding Paris were constructed from worn out 15-inch, 45-caliber naval guns, mounted on concrete emplacements. The converted guns were of two parts; the main section was 98.5 feet long, and the forward section 19.7 feet. The 15-inch gun was bored out, and a heavy uniformly-rifled tube 8.26 inches in diameter inserted, 42.3 feet of this tube projecting beyond the muzzle of the gun. Over this projecting portion a hoop was shrunk. The muzzle section, 23.6 feet in length, was screwed to the end of this hoop tube. This forward tube was unrifled and was probably added to impart additional lineal velocity and better align the axis of the projectile with that of the bore of the gun. The reliners used in this gun were of such a thickness that when worn out they could be rebored to 9.3 inches, and then to 9.93 inches. Up to the time the firing on Paris ceased, at least one of the seven guns constructed had been rebored and was firing 9.3 inch projectiles.

A comparison of the general characteristics of this gun with our 14-inch naval gun, model 1920, is shown below.

Source of information: Ordnance Department.

Comparison of German Long Range Gun and American 14-inch Navy Gun.

	German 8.26-inch	American 14-inch Navy
Muzzle Energy, foot tons	467,250	85,750
Range, yards	132,000	39,000
Length, feet	118.2	59.7
Weight, pounds	318,000	180,395
Muzzle Velocity, feet per second	4,760	2,800
Elevation degrees (maximum)	55	38
Chamber Pressure, pounds per sq. in.	44,000	40,000
Length of Projectile, feet	3.44	5.09
Accuracy Life, rounds	50	250
Weight of Projectile, pounds	264	1,400

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River Bank Protection by Sedimentation

The Mississippi was forced to build its own dike for the protection of a sliding bank at Natchez, Miss., by W. C. Curd, drainage engineer for the Missouri Pacific System of railroads.

A 125-foot bank, composed of conglomerate near low water, overlain by sand and clay strata, was being cut away by undermining in the sand at high water, thus endangering the railroad on top of the bank. Owing to the excessive cost of obtaining material for fill, it was decided to retard the current so as to bring about the formation of a silt deposit upon which permanent concrete paving could be placed. A mud-cell dike 1100 feet long and 23 feet high was built in 1912, at a distance of 75 to 100 feet from the foot of the hill, so as to give a 2 to 1 slope to the top of the hill. The mud cells were made from live brush and poles. A brush mattress 1 foot thick and 30 feet wide was formed of bundles or fascines, wired together and anchored to deadmen at the foot of the hill. Tiers of cells 5 by 5 feet were then built on the mattress by placing single rows of brush and poles at right angles to each other, very much after the fashion of a log cabin. Five tiers of cells, each 5 feet high were built; the bottom tier was 5 cells wide, and each superimposed tier was one cell narrower; the settled height was 23 feet. The cells were bound with wire and cable to the foundation mattress, anchored to the deadmen at the foot of the hill, and ballasted with conglomerate.

The downstream end of the dike was joined to an abandoned transfer barge sunk in line during high water. Six lateral mud-cell dikes, or baffles, 15 feet wide by 100 feet long, were connected into the main dike and run up the hill to Gauge 40, to prevent parallel currents and eddies in the area where sedimentation was being sought. The head of the mud-cell dike was protected against head-water by a pile dike 600 feet long, extending from a point upstream to an outside lap connection. Cypress piles 32 to 62 feet long were driven 16 to 20 feet into the conglomerate. The upstream 112 feet had a single row of piles, the next 216 feet a double row, and the lower 272 feet a triple row. The piles were spaced 8 feet center to center, staggered and braced; 3½ by 10-inch white oak sheeting formed the outer or river face of the dike.

By low water of 1916 the enclosed area was practically filled with sediment and decay had set in among the brush and poles forming the mud-cells. A concrete toe wall, reinforced with galvanized mesh, was started at a depth of 3 to 5 feet below the surface of the conglomerate, to afford protection against under-scour, and carried up to a gauge height of 14 feet, at which height concrete slabs were connected to it and laid on a 3 to 1 slope back to the hill. The slabs were 4 inches thick, 54 inches wide and 14 feet long, reinforced with galvanized mesh. Some filling was necessary to give proper support to these paving slabs. The paving amounted to 39,774 square feet, being 46 feet wide on the slope and 864 feet long. The total cost of the work was:

Mud-cell dike	$9,292
Permanent pile dike	10,604
Concrete paving and wall	18,845
Total	$38,741

The volume of material recovered by sedimentation was estimated at 56,000 cubic yards, at a cost of 16.6 cents per cubic yard, very much less than would have been required in that location by any other method.

In spite of frequent interruptions caused by high water, nature worked hand in hand with the engineers.—*Eng & Cont.*

Derrick Boom Supports Leads for Steam Hammer Driving Batter Piles

In the construction of the barge canal terminal in Flushing Bay, Flushing, Long Island, the McHarg-Barton Co., New York City, has driven a large number of long foundation piles, including several hundred spur piles, 17 to 19 inches in diameter and 80 to 85 feet long, battered 1:3, by the use of the swinging leads supported by a derrick boom. Piles are driven to an average penetration of 55 feet through mud, clay and mud strata, to bearing in a heavy blue clay, without the use of a pile driver tower or the elaborate mechanism often employed for driving battered piles.

The piles are set in position by a floating derrick and penetrate the mud several feet by their own weight. The tops are guyed and pulled into position, giving approximately the required angle at which they are maintained by the guy ropes while the pile is driven by a No. 7 McKiernan-Terry double-acting steam hammer making about 225 strokes per minute. The hammer weighs 5,000 pounds, and the striking part weighs 800 pounds, giving it a high efficiency which drives the piles at an average rate of 32 per 8-hour shift.

The pile hammer operates in a pair of 6 by 6-inch swinging timber leads, with 2-inch planking extending about 8 feet below the butt of the pile, thereby affording a batter support. The leads and hammer are handled by a hoisting tackle operated from the end of a 78-foot derrick boom which is very quickly adjusted to the required position for successive piles.—*Eng. News-Record.*

Using Large Size Aggregate

Provided it can be readily secured so that the cost of transportation is not governing, large stone makes the most economical aggregate for mass concrete, particularly when strength necessities are so low that the leaner mixtures can be used. The main reason why stone above the standard 3 or 4 inches is not more generally used is the fear that the ordinary concrete machinery will not handle it. Nevertheless, in an increasing number of cases it is being proved that regular mixing and chuting equipment, with only a few changes to provide proper clearance, will stand up under the battering of the big stones and deliver a well-mixed concrete. The latest instance is the Stevenson dam work. Here there was an ample gravel supply handy to the site, a condition which often exists but is not always utilized, and the engineers estimate that about $250,000 was saved in the concrete cost due to the decision to use the gravel even up to the 6-inch rejections, which means some irregular pieces of larger dimensions. Furthermore, they testify that the maintenance charge and out-of-order time losses were little if any greater than with stock material. The practice is well worth consideration for other jobs. —*Eng. News-Record.*

Spring Meeting, American Association, M. E.

May 23 through 26 has been set as the date of the Spring Meeting of The American Society of Mechanical Engineers. It will be held in Chicago at the Congress Hotel.

Sessions are planned by the Professional Sections on Aeronautics, Fuels, Management, Material Handling, Machine Shop, Power, Forest Products and Railroads.

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Training of Reserve Officers

The Adjutant General has published the following information on the subject under date of March 14, 1921:

1. The following policy will be observed and will be brought to the attention of reserve officers who tender their resignations before acceptance of such resignations. It is desired that it be given as much publicity as practicable:

(*a*) On account of the necessity for economy in expenditures and other considerations, it will be possible, in the immediate future, to call but a very small number of reserve officers to active duty for training purposes. Prior to June 30, 1922, no reserve officer will be called to active duty for training without his consent. Available funds and other considerations will probably make it impossible to call all those officers who request active duty for short periods of training.

(*b*) During the time specified, to June 30, 1922, the organization of units of the Organized Reserve and the assignment of reserve officers thereto will be proceeded with. Such assignments will not demand a material amount of time of reserve officers.

(*c*) The present number of reserve officers is insufficient. Those who now hold commissions are urged to defer any withdrawal from the reserve contemplated by them until the Organized Reserve has been formed and definite policies for its training formulated. When such has been done, and regulations governing the Officers' Reserve Corps have been published, reserve officers will have a better understanding of their obligations, duties and privileges and will be better qualified to determine whether or not other interests necessitate their withdrawal from the Officers' Reserve Corps. The present reserve consists of veteran officers of the World War whose moral and material assistance in the building up of the Organized Reserve will be a very material factor in the efficiency of that force and the state of preparedness of our reserve forces.

By order of the SECRETARY OF WAR:

(Signed) T. H. LOWE,
Adjutant General.

Reserve Officers' Instruction Department Proposed for The Military Engineer

Plans are under consideration for the establishment in THE MILITARY ENGINEER of a department devoted entirely to the instruction of Engineer Reserve Officers, who make up the bulk of the membership of the Society of American Military Engineers.

It is planned to have the Engineer School at Camp Humphreys, Va., assume control of the department. Instruction will probably be carried on under three general headings, viz:

a. Military Administration, including administration, supply, military law, military courtesy, etc.

b. Minor tactics.

c. Military Engineering, or engineering problems based on tactical situations.

The material presented under each subject will be logically progressive—references, illustrations, and cuts will be included, and each issue will contain approved solutions of problems presented in the previous issue.

Plans in detail will be published at a later date. It is hoped that such a department can be instituted beginning with the May-June issue of the journal.

Notice to Subscribers

In order to simplify the accounts of the Society, bills for dues or subscriptions will henceforth be made out for a period expiring with the November-December issue of each year. Those whose dues expire during the first half of the current year will be billed for the remainder of the current year only. Those whose dues expire between June and December of this year will be billed for the remainder of this year and for all of next year. The amounts in the latter case will exceed the annual subscription price, but it is requested that remittances be made in accordance with the bills sent out, in order to reduce the time and expense of accounting.

Utilization of Tidal Energy. The scarcity of fuel has turned the attention of both French and British to the possibility of deriving power from the tides, which have a very great range on the coasts of France and Britain. The power obtainable from a given area is proportional to the square of the tidal range, the cost of machinery also decreasing as the operating head of water increases. At some localities spring tides have a range of over 40 feet, neap tides being somewhat less than half. With a tidal range of only 20 feet for springs and 10 feet for neaps, operating on both rise and fall, each square mile of basin area can, without storage, produce a daily average of 110,000 horsepower.

The most difficult problem is the equalization and saving of power by storage. Accumulators are too expensive, and the most feasible suggestion is to utilize the surplus power to pump water to a high level reservoir, from which power may be drawn as needed.—*Journal Frank Inst.*

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The Operation of Motor Trucks in War

(Continued from Page 103)

Discussion

James G. Harbord

Major General, U. S. Army; formerly Chief of Staff, A. E. F., Commanding General, 2d Division, and Commanding General Service of Supply, A. E. F.

During the war the energies of the Motor Transport Corps were centered on the assignment and distribution of motor vehicles. The assignment and distribution of the vehicles included a comprehensive plan of convoy operation, as the distribution of assigned vehicles to combat organizations and sections of the A. E. F. and convoy work were inseparable. Both entailed the movement of transportation from Base Ports to the intermediate and forward areas.

Except in the sections of the Services of Supply, the question of the operation of these vehicles, after their assignment and distribution, was generally left to the judgment of the motor transport officer attached to the organization to which the vehicles were assigned. This arrangement was far from satisfactory, and was the result of the lack of a comprehensive plan of operation of the vehicles. The question of either permanent assignment or pooling was still in the stages of discussion, and the result was that where the training of the officer in charge of the transportation led him to believe that best results were to be secured from pooling the transportation, or by assignment, the method which he believed correct was used.

The urgent demands for motor transportation overshadowed the questions of operation of the transportation after assignment to units, and the constant cry of "More transportation" drowned efforts to satisfactorily work out a definite plan of operation, except in the Services of Supply.

After the armistice the assignment and distribution fell off to a marked degree, and in proportion to the decrease in activities pertinent to assignment, grew the opportunities for development along the lines of controlled operation.

Inspectors were sent out for the purpose of studying the methods of operation in use at the different motor transport activities within the Services of Supply, and the recommendations resulting from these inspections had for their purpose more efficient operation of motor transportation, and the result was more concentrated pool operation and greater efforts toward proper traffic control.

Traffic control is the foundation of efficient operation, regardless of the merits of either assigned or pooled transportation; without traffic control neither system can function with efficiency.

In taking up here the subject of traffic control, it is believed advisable to explain the expression "traffic control." Traffic control does not consist entirely of directing transportation while it is moving, but in reality consists of studied disposition of trucks so that the maximum efficiency in their use will result.

Perhaps the traffic control of motor transportation may best be compared with traffic control as exercised in railroad activities, i. e., properly allotting the cars with a view to requiring their full capacity to be utilized between whatever points the cars may be operated, thus avoiding an empty back haul.

With proper traffic control, the number of motor trucks necessary to perform certain work would be cut down to 60 per cent of the number of trucks used when there is no traffic control exercised. It is safe to say that with proper control, the apparent shortage of motor transportation in the United States Army would disappear.

Further, with the decrease in the number of vehicles operated, would come the decrease in maintenance, with its problems of replacements, spare parts and money cost.

So it is seen that whatever method of handling transportation is used, whether it be pooled or assigned, the solution to satisfactory service lies in proper operation.

So strong is the writer's belief in the efficiency of pooled transportation over the method of individual assignment that it is not considered worth while to discuss here the relative conveniences which assignment transportation is said to give.

Our experiences in the war showed us conclusively the advisability of pooling transportation, and this method followed by the French demonstrated the superiority of such a system. With far less motor transportation than we possessed, the French were able to meet all emergencies requiring the use of motor vehicles, and their system was exclusively one of pooled operation.

Behind the French Armies were placed at strategic points, groups of motor transportation, each having a given radius of operation. Should the high command direct the movement of troops or material from one point to another, the motor group nearest to the body to be moved would be informed as to the amount of tonnage to be carried, and would direct the requisite amount of transportation to effect the movement to report to the organization, transport it from its position to the desired point, and upon completion of the movement the transportation would return to its group, ready for further work.

By the foregoing method the French were enabled to shift the transportation where the need was greatest, and so avoid the embarrassing situation of having one unit of its army sorely in need of transportation while another boasted a "sufficient" number of vehicles.

It is a matter of opinion among many students of motor transport problems that the success which the French had with their transportation was due entirely to its efficient operation. This successful operation had for its basis proper traffic control. Again, it is sometimes alleged that one of our war failures was that our demands for motor transportation could not be met, with the result that we were always short on the amount of motor transportation needed, so short that at the signing of the armistice we were but little more than 50 per cent equipped. This is true only if we consider as a basis the amount of motor transportation allotted by tables of organization then in force.

The writer is of the opinion that the difficulty lay not so much in the shortage of motor transportation as in the absence of a comprehensive plan of operation of the vehicles on hand. So, too, we may say that the shortage of spare parts could be partly traced to this same lack, as the improper operation of the vehicles precluded the possibility of establishing any sort of a reserve, and without a reserve it is impossible to discontinue operating certain trucks for even minor repairs; and continuous operation of a given number of trucks, which must be the case where no reserve exists, will eventually break down the allotted number.

Undoubtedly the new tables of organization now in process of completion will contain many interesting changes resulting from our experience in the war, and with these changes should come a well-defined plan for standardized operation of pooled transportation.

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M. L. Walker

Colonel, Corps of Engineers; formerly Brigadier General, Chief of the Motor Transport Corps, A. E. F.

This excellent paper deals largely with the question which stirred the A. E. F. as much as any other one thing, *i. e.*, "The Pooling of Motor Transport." Many differing opinions were apparently held concerning "pooling," but it is a fact that whenever the situation got tight a resort to practical "pooling" was forced, whether admitted or not.

A commander is assigned a mission, and is given certain instruments for its accomplishment, among others a limited amount of motor transportation. No matter what tabular assignment of this motor transport is made, the officer who measures up to the requirements of a commander is going to use it as he deems best to carry out his mission.

Knowing that conditions are practically certain to arise which will render the massing of motor transport and its operation in large units necessary, it seems logical to adopt an organization which will render such employment most feasible, viz, standard units and a standard system of training and control. This was all that was desired and recommended by the M. T. C., A. E. F., together with the policy that, as set forth in Major Young's article, there should be a minimum of motor transport permanently assigned and the remainder would be attached whenever or wherever most needed, its operation to be controlled by the local commander through his own Motor Transport Officers as long as it was at his disposal. The recommendations which Major Young made following a meeting of the Military Board of Supply were the same recommendations which the Motor Transport Corps had been making almost from its inception, but without success in getting them adopted.

The above method of dealing with motor transport worked in the S. O. S., and it will work in the Combat Zone. In the S. O. S. each Base Section Commander was given certain transportation, and this he distributed through his area and operated through his own Motor Transport Officers. H. Q., S. O. S., never entered the area except to increase the transportation by additional allowance upon approved requests of the Base Commander, or to make withdrawals when more pressing needs elsewhere rendered such action necessary. In case of withdrawals the Base Section Commander was informed that he must give up a certain number of truck tons; where he should take it out and the making of necessary re-adjustments were left entirely to him.

It was due to the following of such policy in the S. O. S. that we were able in August, 1918, to pull out 2,500 truck tons for immediate employment in the St. Mihiel offensive, and a month later produce an additional 1,500 tons for the Meuse-Argonne Campaign. But the S. O. S. was no magician's bag from which such large quantities of motor transport could be produced without visible disturbance. The stoppage of many construction projects of vital importance, if the war were to carry over the coming winter, was necessitated. The C-in-C was informed personally by the C. G., S. O. S., as to the effect produced, and wisely decided to gamble on an earlier termination of the war.

The problem of traffic control was never solved in the A. E. F., nor were the systems of either France or Great Britain above criticism—certainly neither one should have been adopted by us bodily.

The French system grew, like Topsy, from the scheme for handling motor transport during the Verdun campaign, developed by Commandant Dumenc, which led to the creation of the French "Service Automobile" and left the handling of such traffic, and all other on the controlled roads, in the hands of this organization. The French never claimed that their system was perfect, but they did claim, and justly, that it worked. Personally, it has seemed to me that the French solution was a good one. Whenever traffic becomes so dense as to need control, motor transportation is going to be the dominant consideration, and the control should be exercised by personnel thoroughly conversant with the operation of such transport. However, there are good arguments for placing traffic control under the Military Police, who must cover all roads for police work, and also for placing it under the Engineers, who build and maintain the roads and must know more than anyone else the traffic possibilities of these roads. I have never been able to decide that traffic control *must* go to any particular agency, but I am sure that the personnel actually doing this work must, above all else, be fully informed concerning the operation of motor transportation in large masses.

The scheme for traffic control put forth in the fall of 1918 by G-4, G. H. Q., would have worked—anything will work if intelligent and loyal people get behind it and make it go—but it was fundamentally wrong, in that G-4 was planning to operate directly and thus go outside of its legitimate sphere as a section of the General Staff. I have always understood that what prevented the actual carrying into effect of the traffic control order mentioned, was not the coming of the Armistice, as stated, but the violent opposition of at least one other of the General Staff Sections at G. H. Q.

Malin Craig

Brigadier General, U. S. Army; formerly Chief of Staff, 1st Corps and 3d Army, A. E. F.

Major Young, the writer of this article, was afforded perhaps the greatest opportunity given to any officer of the American Expeditionary Forces to study the question of motor transport in war from a broad, unbiased viewpoint. His conclusions are accordingly deserving of serious consideration.

The pooling of motor transport was absolutely the result of necessity. It is believed that the maximum efficiency of truck-carrying capacity is obtained when the vehicles can be run practically continuously, withdrawal being necessary only for disability due to accident or for periodical general overhauling. Pooling permits of the foregoing, while the permanent assignment results in all vehicles being run but part of the time and many of them being laid up in reserve, loaded or unloaded, most of the time. There is no question in my mind that had the First Corps failed to pool its motor transport its successes in point of time and distance would have been greatly diminished. It is to be regretted that the author did not include in his paper a discussion of the capacity of trucks, as it is believed that those of greater than one and one-half tons cargo capacity have no place in the transport (supply or combat) of divisions, except special vehicles. Furthermore it was demonstrated during the three great campaigns of the A. E. F. that the single cargo truck can handle with practically equal facility ammunition, supplies, combat personnel, as well as evacuating sick and wounded and salvage. Many officers of the Artillery Service claim that they must have special vehicles under their own control to handle artillery ammunition. It is believed that they base this claim on too narrow a view of the entire situation. Their arguments are certainly controverted by experience, as we habitually used the ordinary cargo trucks for the artillery ammunition

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Among such national activities as the publishing to the profession of a Code of Ethics, written for A. A. E. by the late Isham Randolph, the maintenance of a Practice Committee to enforce the Code, a great compensation service conducted in accordance with professional ethics, the Service Department stands in the forefront.

The positions filled during July saved members $35,000 which commercial agencies would have charged to place them in the same positions. This is more than two times the total monthly dues of the 21,000 members of the Association. Furthermore, the department did not fill all the positions on its list. It has 200 vacancies a month for mechanical engineers.

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service and there was never any just cause for complaint on this score. There must, of course, be artillery specialists at the dump for fusing and other technical operations incident to the character of the cargo.

Another matter not touched upon is the fact that in the general case trucks are not properly loaded, or loaded to capacity. This is frequently so in the case of single vehicles, and is practically always so in the case of companies or trains. I refer, of course, to conditions as they existed in the zone of the armies in the A. E. F. This matter has a great bearing on road space and traffic control, as well as the truck tonnage allotted as the minimum for units. There seems to be every argument based on results in actual practice in favor of pooling, both in peace, in garrison and in war at corps, army and probably general headquarters.

H. C. Smither

Colonel, General Staff, U. S. Army; formerly Chief of Staff, G-4 S. O. S., A. E. F.

Amongst those who, during the war, viewed all activities in simultaneous operations, I think there can remain no doubt as to the soundness of the theory of pool transportation. The theory of fixed assignment is largely dictated by convenience. Pooled effort is dictated by economy in the use of limited resources. In a struggle of such proportions as the late war there can never be an over-abundance of that type of equipment on which the mobility of units and the speed of their operation must depend.

In this article Major Young is partly in error with reference to 1,200 "truck tons" supplied for the St. Mihiel operations. In this case the S. O. S. had, in anticipation of such a need, assembled the trucks in question at Dijon to act as a reserve to meet the unexpected developments of the St. Mihiel operations. The need for a system of equalizing reservoirs became early apparent in the S. O. S., which, as Major Young states, was kept practically stripped by reason of the urgent needs of combat troops. There was, in consequence, never a time when automotive capacity approximated meeting the routine load and reserves were always in use.

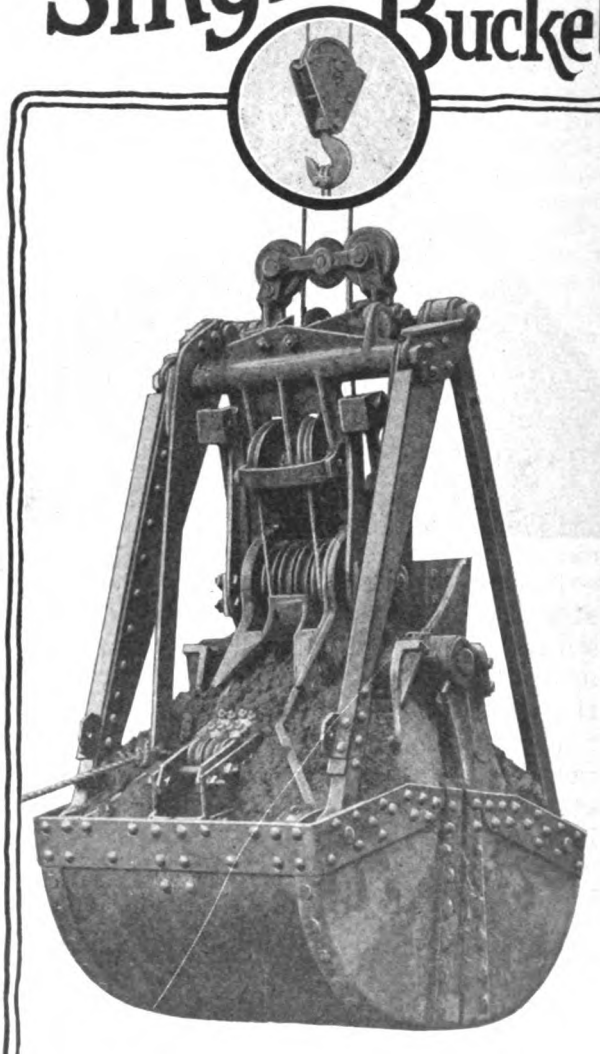
Geo. P. Tyner

Lieutenant Colonel, General Staff, U. S. Army; formerly Colonel, Assistant Chief of Staff, G-4, 2d and 3d Armies, A. E. F.

Major Young's efficient handling of the distribution of the limited supply of motor trucks in the Zone of the Armies, under the stress of battle and of conflicting demands from all directions, was such that the writer hesitates to attempt any criticism.

It might not be amiss to describe briefly the transportation within a division. This transportation consisted of two kinds, that belonging to regiments and that belonging to the division. The regimental transportation consisted of the field train carrying the two days' field and the one day's reserve rations, and the regimental combat train carrying the regimental reserve ammunition. Both of these trains were supposed to be animal drawn. Under the control of the division commander were the supply train, carrying two days' field rations for the command, and the ammunition train carrying the division's reserve supply of small arms and artillery ammunition. Prior to the war the supply train was animal drawn, but as Major Young describes, it was motorized for service in France. In the tables for European service, the division ammunition train was also largely motorized, only a small percentage of it remaining animal drawn. Due to the shortage of animals in France, no divisions other than the First and Second ever

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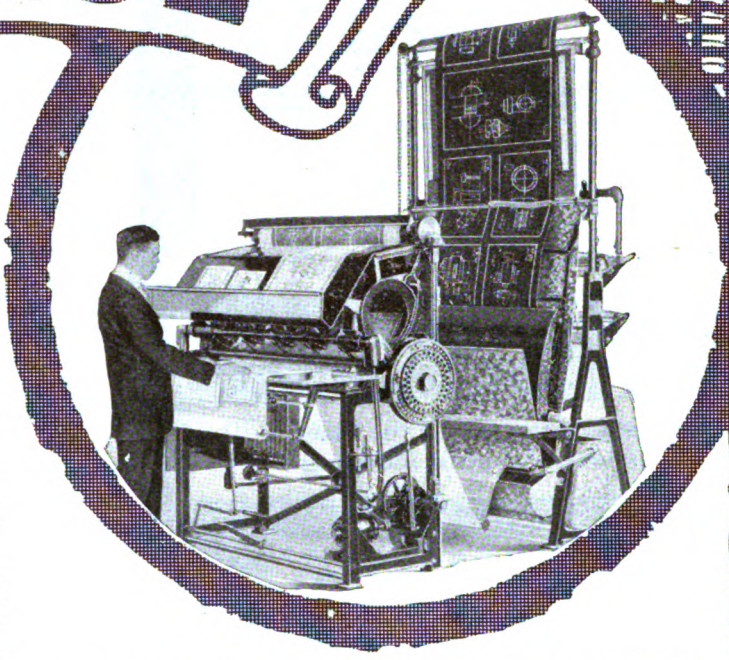
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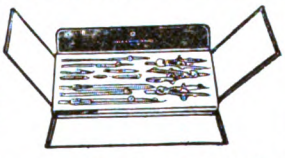
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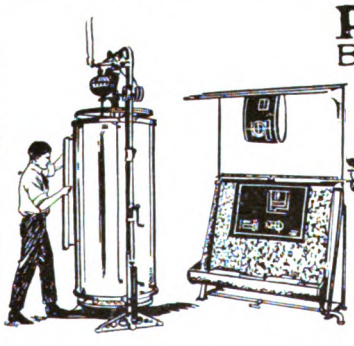
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The largest of the three plants of the Allis-Chalmers Manufacturing Company, known as the West Allis Works, is located at West Allis, Wisconsin, a suburb of Milwaukee.

The bird's eye view of the West Allis Works depicts the layout of this plant. Specific products are made in each of the six machine shops, extending East and West and at right angles to the three long buildings shown in the cut, each machine shop having its proportion of pattern shop, foundry and erecting shop. From the west end of the plant, patterns travel in one direction to the foundry, and the finished castings through the machine shops in the direction of the erecting shop, where they are assembled, loaded and shipped out at the extreme opposite or east end of the plant.

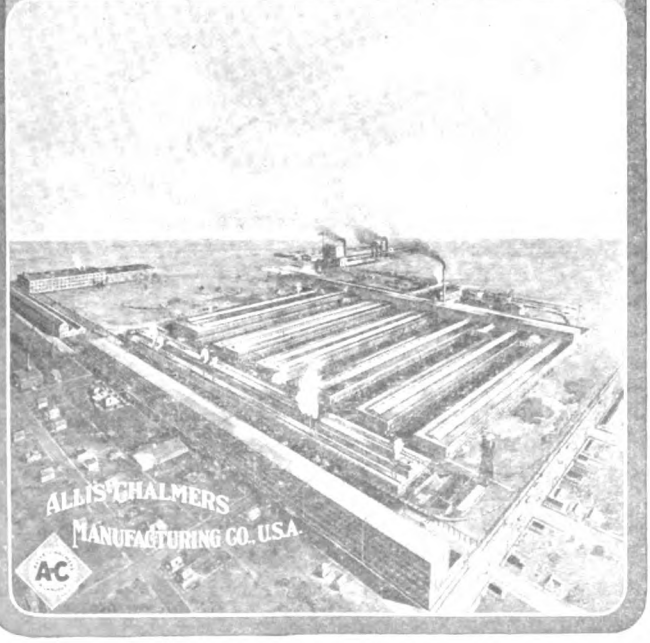
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Principal Products:

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Oil Engines
Reciprocating Pumps
Rolling Mill Machinery
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Steam Hoists
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Total floor area of plant, square feet, 2,381,947.
Total ground area, acres, 116.
Plant boiler horsepower, 10,700.
Miles of railway track, 17.
Number of locomotives, 3.
Length of overhead flask unloading track, 2,604 feet 9 inches.
Reservoir for condensing water for power plant (size 200 feet by 360 feet by 15 feet 6 inches), capacity 4,650,000 gallons.
Number of cranes, 143.
Total capacity of cranes (tons), 3,000.
Foundry day capacity (tons), 350.
Heaviest casting produced, 130 tons.

ALLIS-CHALMERS
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approached a state where the animal-drawn vehicles described above were furnished with horses. Consequently the demands made upon the motorized supply train were all the greater.

I believe that the shortcomings described in Major Young's article have been corrected in the Tables of Organization, approved by the War Department on August 31, 1920. Under these approved tables all field and combat trains of regiments and similar independent organizations, are animal drawn. The infantry division, whose war strength is now slightly over 19,000, has a supply train of four truck companies of 1½-ton trucks, 27 trucks to a company, and two mule-drawn wagon companies, of 60 escort wagons each. The allowance of rations in the field remains unchanged, but the number in the division supply train, now known as the division train, is reduced to one day. This train also carries all ammunition except that for the Field Artillery. The Field Artillery ammunition is carried by one truck company, which is part of the Field Artillery brigade of the division.

Major Young's argument for pooling in commands higher than a division has been met by the assignment of 12 truck companies, each of 27 3-ton trucks, to the corps commander, which, together with a wagon train of 270 wagons, mule drawn, gives the corps Commander the pool necessary to augment the divisional transportation of any of his divisions requiring assistance. As an additional pool, we have in the new organization under each army commander, 18 truck companies, each of 27 3-ton trucks. The approved report upon the re-organization of the Army also contains the statement that traffic control will be a function of G-4, using the military police under the direction of G-1.

It is well to remember that the probability of our having sector warfare within the territorial limits of the United States is very remote. The situation in Europe was a well-defined line with one flank on the ocean and the other upon a neutral state. The chances are small of our having a war in this country where both flanks are impassable. In view of these conditions, our divisions must be so organized that they can carry on a war of movement over roads found in any part of this country.

For this reason our troops must always have as part of their organization sufficient transport to carry such equipment as the troops will inevitably need whenever the enemy is encountered during maneuver.

L. D. Gasser

Lieutenant Colonel, Infantry, U. S. Army; formerly with Motor Transport Section, G-4, G. H. Q., A. E. F.

Major Young portrays very accurately the history of our difficulties in supplying and operating motor transportation in France.

Economy and efficiency both demand the pooling of motor transportation; this was recognized by both the First and Second American Armies in France, where the pooling system was partly placed in effect prior to the Armistice.

Ammunition trucks were left out of the tentative organization of the motor transport reserve, mainly on account of the claim of the technical character of the cargo to be handled and transported. There are many widely divergent opinions on this subject, and I have no intention of discussing them here, except to state that the principle of motor transport pooling, which recognized economy and efficiency in the problem of transporting troops and supplies, evacuation of the battlefield, etc., would, it is believed, also increase the efficiency of ammunition supply in large commands.

I concur in Major Young's conclusions. It was on this

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basis that the tentative motor transport reserve regulations were prepared, *i. e.*, limiting the permanent assignment of motor transportation in divisions to the barest necessities, leaving to the motor transport reserve the larger problems of supply of the whole force, or when special missions were assigned to divisions, of furnishing sufficient transportation to enable them to carry out their missions.

The problem of traffic control, which is essential to the proper utilization of the highways in the theatre of operations, is one which has never been satisfactorily worked out in our service. It will be even more difficult in this country than it was in France, owing to the character of the roads, and the fact that there will also be a smaller number of roads within any given theatre of operations, rendering heavy concentration of troops a far more difficult problem. This is a function of the military police in our service, but the system of dispatching and controlling traffic has not been fixed, and one function cannot be separated from the other with the expectation of efficient results.

Coincident with the principle of unit control, comes the question of which General Staff section should co-ordinate and control traffic. It would seem that the best results would be obtained if the section of the General Staff charged with the supervision of roads would also have charge of the supervision of the traffic thereon, in the same manner as it has charge of the supervision of railroads, both as to roadbed and operation of the rolling stock.

J. Edward Cassidy

Formerly Lieutenant Colonel, Engineers

The two theories of handling trucks in operations has been discussed in this article, and the good and bad features of each pointed out. There are some of the conclusions I cannot agree with, however. The matter of use of trucks for military transportation is comparatively new, but the principle dates back to antiquity. There are two essential features necessary for the successful conduct of an operation, *i. e.*, men and *materiel*. It has been amply demonstrated in modern warfare that men alone cannot combat *materiel* successfully, and to win success in battle the enemy's *materiel* must be neutralized. The greater the degree of mobility of men and *materiel* available for an operation, the greater the chances of success will be. Motor transport has two important functions, one the transport of *materiel* and the other the transport of men. The movement of whole divisions by means of motor transport was a feature developed during the World War, but the principle is old. In one of his campaigns against the Indians, General Miles could not keep his infantry in contact, so he used ponies in order to give them a mobility equal to the Indians. The dragoon of other days was merely a more mobile infantryman. The development of internal combustion engines made possible new variations of the old principles.

The author of this article appears to conclude that it was better to wait until a standardized truck could be produced in this country than to use trucks which were already on a quantity production basis, and while the theory is all right, it did not work out practically. The American Army in the beginning of the Argonne-Meuse offensive had approximately 20 per cent of its proper motor equipment, and on November 11, 1918, was approximately 10 per cent equipped with such transport. (Report of Lieut. Gen. Hunter Liggett.) The available supply consisted of all sorts, kinds, and classes, and almost every make—with few repair parts available. We might as well have had a variety of trucks of our own make as to have had a conglomeration

(Continued on Page 166)

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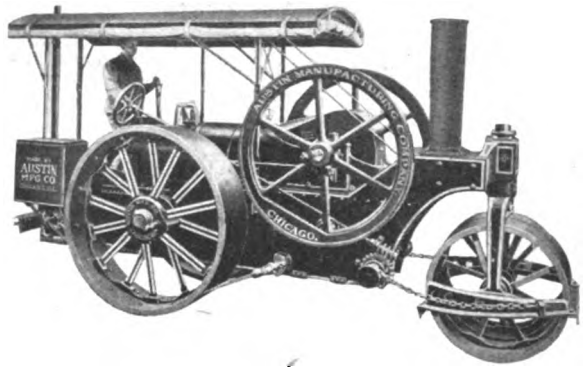
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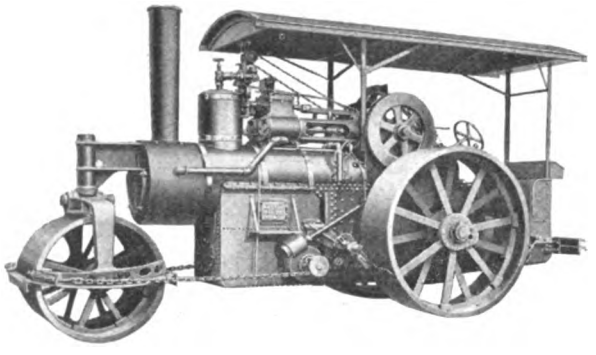
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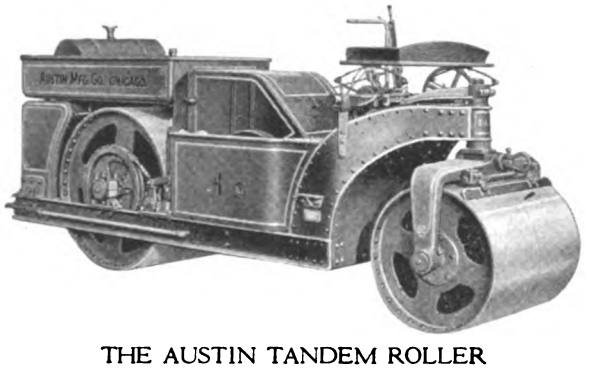
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(Continued from Page 136)

Appointments in the Corps of Engineers

[Editor's Note]

The foregoing circular from The Adjutant General deals with appointments to the Regular Army to the number of nearly 2,600; of these, 118 will be in the Corps of Engineers, all in the grade of second lieutenant, but promotion to the next grade will follow at an early date for those who pass examinations with a high mark. No prediction can be made as to the rate of promotion above the grade of first lieutenant.

The following information will be of interest to engineers who contemplate taking the examinations:

The preliminary examination will be mainly physical, and for graduates of and senior students in engineering institutions of acknowledged excellence the mental part will be nominal.

The final examination will be fairly comprehensive in its scope, but exemptions will be allowed under certain conditions, so that anyone who has graduated or who, within six months of the date set for the examination, will graduate in the upper fourth of his class at one of the leading technical educational institutions of the United States need take examination only in one of the four following subjects, viz, Analytical Geometry, Calculus, Advanced Mechanics or Surveying. The choice rests with the candidate and his place on the list will depend upon the marks made in examination. Men who did not graduate in the upper fourth of their classes, and non-graduates, are also eligible to compete for appointment, but they will be examined in the subjects prescribed.

Senior students at engineering institutions who will graduate this year should note that the minimum age requirement (21 years) applies not to the date of final examination (April 25), but to the date of appointment, which it is contemplated will be about two months after the examination.

It might be inferred from the circular that senior students in college may become eligible for the final examination only by enlisting in the National Guard or the Organized Reserve, but Par. 9 of the new Army Regulations No. 605-5, Dec. 9, 1920, states that—

"Any candidate who has graduated from, or who will graduate within six months from a technical course in any recognized college, university, or technical school, may, for the purpose of taking the final examination, be considered eligible for appointment. Upon receipt of examination reports in individual cases, decision will be made by the Secretary of War whether or not the institution and the course therein are approved as making the candidate eligible for the appointment he seeks."

Successful applicants will be allowed to continue their studies until graduation.

Civilians not graduates of an approved technical institution and not members of the Officers' Reserve Corps may, after passing the preliminary examination, become eligible for the final by enlisting in either the enlisted Reserve Corps or in the National Guard, or by securing an appointment in the Officers' Reserve Corps.

Officers commissioned in the Corps of Engineers can be assured of a varied and interesting career. Service will consist of duty with troops, duty as instructors and inspectors with the Organized Reserves and on construction work connected with fortifications and improvement of rivers and harbors. The annual pay of a second lieutenant is $1,700 with a bonus of $420 per annum, supplemented by allowances for quarters, medical attendance, an annuity upon retirement from active service by reason of age or physical disability in line of duty, and other perquisites. The pay is increased by 10 per cent of the base pay in each grade for each five years' of service, but not to exceed 40 per cent after twenty years' service.

Members of the Society of American Military Engineers will render a kindness to their young acquaintances engaged in or preparing for the practice of engineering by bringing this information to the attention of such as they believe would be interested in army service. All who desire to compete will receive full information upon application in person or by mail to the Commanding Officer at the nearest Army Post or Corps Area. Corps Area Headquarters are located at Boston, Mass.; Governors Island, New York City; Ft. Howard, Md.; Ft. McPherson, Ga.; Ft. Benjamin Harrison, Ind.; Ft. Sheridan, Ill.; Ft. Crook, Nebr.; Ft. Sam Houston, Texas; and San Francisco, Calif.

Strength of Aged Cement

Because of cement shortage in the District of Columbia the Corps of Engineers has proposed to use some cement which has been in storage about eighteen months. In order to determine the proper strength assumptions for concrete made of such cement the Bureau of Standards made a number of tests on it. The cement as received was first put through a sieving process to remove the lumps. The cement after sieving, as well as the crushed lumps, were then made into separate concretes which were compared with concrete made from cement recently purchased in the local market. It was found that a 1:1¼:2½ mix of the old cement would give approximately the same strength as a 1:2:4 mix of fresh cement, and it was recommended that the lumps be sieved out of the old cement before using. Similar tests were conducted on aged cements submitted by the U. S. Engineer Office at Vicksburg, Miss. The results indicated that a 1:2¼:4½ mix of the aged cements gave approximately the same strength as a 1:3:6 mix of fresh cement.—*Eng. News-Record.*

Tractors Replace Teams for Scrapers

Two 5-ton tractors, each hauling three wheeled scrapers, are used for grading work by the American Cement Plaster Co. at its plant at Acme, Tex. The two tractors are doing as much work as twelve wheeler teams according to the superintendent of the company. With a maximum haul of about 1,200 feet the two machine outfits are moving about 400 cubic yards per day. The excavation is 12 feet in depth and the dump is on the surface of the ground, so that the machines run up hill and down hill all day. The tractors load the scrapers on low gear, haul them to the dump on direct drive, and return to the pit on high gear when the ground is sufficiently level. Each machine uses an average of 25 gallons of gasoline per 10-hour day, and about a gallon of lubricating oil, besides cup grease. The maintenance on the machines has been very small—*Eng. News-Record.*

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When undertaking any work involving excavating material and conveying a distance of 200 to 600 ft., it will pay you to investigate our equipment. Catalog on request.

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(Continued from Page 163)

of foreign trucks, many of which were trucks which had been practically discarded by the British and French Armies. Valuable time was lost after the declaration of war in experimenting with machine guns, airplanes, trucks, and other impedimenta of war instead of getting busy on *materiel* which could have been placed on quantity production basis at once. We adopted a rifle which was largely used by our forces, which was very inferior to the U. S. Magazine Rifle, Model 1903, usually termed the Springfield, because the Springfield was not on a quantity production basis while the other was. This same system should have been applied to trucks and other classes of equipment. Once the pressing needs of the army had been supplied, then the work of producing standardized equipment could have gone forward. Of course, the British Navy and the French and British Armies were between ourselves and trouble, so nobody seemed to be in any great hurry to get properly equipped for making war. Had we been faced with the same situation Great Britain faced in 1914, our methods would undoubtedly have been changed.

I do not agree with the contention that the motor industries of this country could not have supplied the necessary motor equipment working on an enlarged commercial basis, and could not under present conditions supply the needs of any armies we might have to raise. The time to prepare data for the utilization of industries in the time of war is not after war has been declared, but before. The motto on many of our coins—"In God we trust"—has been applied too literally to the matter of our national defense during the entire history of the country, and while it is well to put your trust in God, the nation that keeps its powder dry and a little reserve stock on hand for special occasions, is more liable to survive in the contest of nations than the nation which trusts to God alone to preserve its integrity.

The American system of handling trucks in France was a sort of hybrid affair, and from rather long intimate contact with it, fails to arouse any enthusiasm in the writer. Still this system cannot be used as a criterion because of the fact that at no time was there sufficient motor equipment available to make definite systems possible. Had the war lasted a year or two longer we would undoubtedly have gotten out of the amateur into the professional class in the art of making war.

Conclusions drawn from detailed observations and experiences on British, French and American fronts, lead me to believe that the French motor transport system, with various modifications, is about as good as can be found. I am not a believer in a Motor Transport Corps in any sense of the word, except possibly a small unit in the Service of the Rear for use as a co-ordinating unit in arranging a supply of trucks with the zone of the interior. I found too often when truck units were drawn from the Motor Transport Corps, the personnel were more interested in the operation from the standpoint of the M. T. C. than they were in the good of the military operations going on, apparently feeling that their first allegiance was to their own Corps. It was the old story, "The operation was successful, but the patient died."

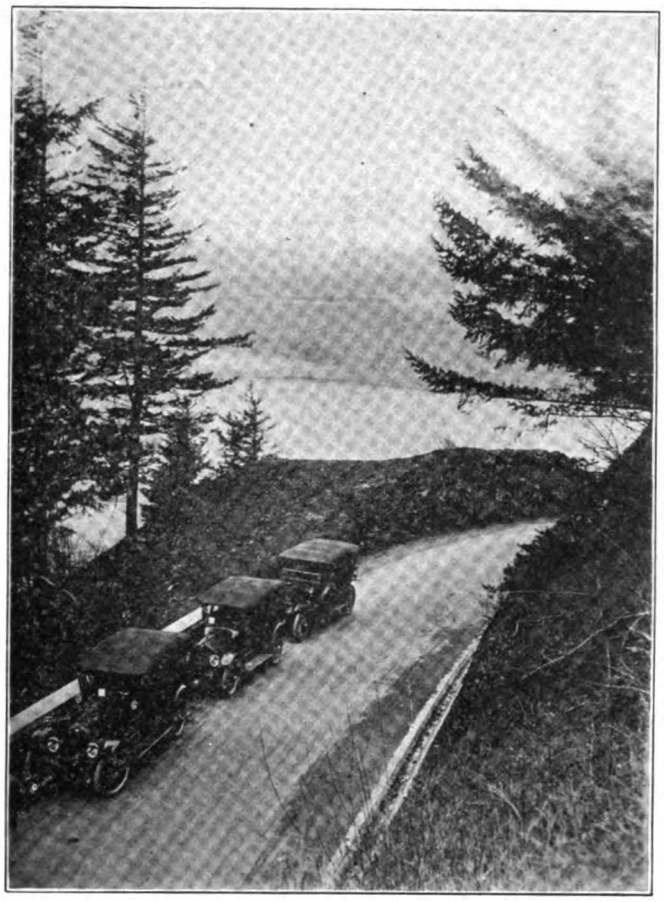
I believe a good organization for the motor-truck service would be found in the following general outline:

(a) Combat units to be supplied with a fixed truck capacity sufficient for their average needs. This equipment to be entirely under control of the various units. By combat units in this case, I refer to regiments and independent battalions operating in divisions and corps.

(b) Divisions to be equipped with truck trains for average supply, and for reserve—the ordinary supply to be in the hands of an officer acting under G-4; the Reserve being under the control of G-1.

(c) Corps units, such as the Corps Engineer Regiment, to be on the same footing as the divisional units. There should be an ample truck reserve in the corps and under G-1 of the corps, which would be used

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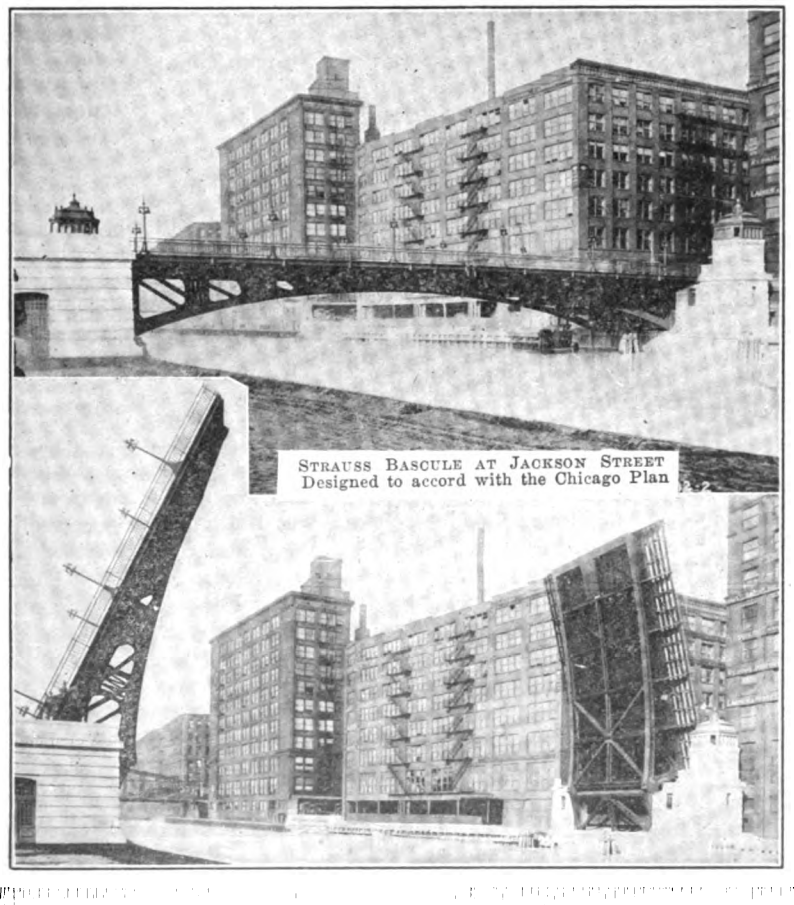
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to supply the extraordinary demands of the divisions in the corps and to move troops within the corps for tactical purposes.

(d) Army units will, of course, be provided with a fixed supply for average requirements. In addition, the army must have an army reserve sufficient to move entire divisions for tactical purposes, and to take care of extraordinary supply when occasion demands. The army reserve would be called on to replace the fixed truck capacity of the divisions when depleted by battle losses. As in the corps and division, I contend that the proper place for the control of this truck reserve is not in G-4 or a Motor Transport Corps, but under G-1. The army reserve to be replenished from the S. O. S.

The control of motor transport must be in the hands of a staff section which is directly interested in operations, and my experiences lead me to believe that G-1 is the proper place for such activities.

In addition to the distribution and handling of motor trucks, there must be adequate control of roads and classes of transportation. Road control in the American Army in France was a joke, and supervision of the impedimenta moved forward with the divisions in combat operations received little attention, as a result divisions carried forward everything, including the "piano and kitchen stove," blocking the roads with a great deal of transport which should have been left behind and brought up later. As regards road control, I have seen division and corps M. P.'s stationed within forty feet of each other with widely different instructions, and as these were so contradictory, the officers or men usually paid little attention to them. I think the highest ranking officer on road control I ever saw in France was a major, and only one of him—the M. P. private usually being the only representative of the road control and most generally he knew little or nothing about roads, so it is not surprising that things did not function very well. Inasmuch as the American Army was only in existence for a period of four months during active operations in the war, it is not surprising that we were still in the amateur stage when the Armistice was signed.

There should be a Chief of Roads for each army, and this officer should not just be picked because he has a certain rank, but he should be picked solely for his qualifications, and these specifications should also apply to the corps chief of Roads. Chief of Roads of the army and the Chief of Roads in each corps should be under G-1, and each have a competent staff of specially picked officers. The Chief of Roads of the corps should be vested with full authority over road plans and traffic control. An assistant to the Chief of Roads of the corps should be with each division working with the Division G-1. Proper supervision should be exercised over classification of materials and supplies, and the Assistant Chief of Roads in the divisions should be supplied with steel disc markers to be carried by each truck, indicating the class of road. For instance, a round, steel disc painted red might be used for priority materials or supplies, this disc to have a circular, countersunk area painted with luminous paint for night indication. The truck to carry four markers, two front and two rear, these markers to show the extremities of the truck. With the luminous markers, the movement of traffic at night in areas where lights could not be allowed would accelerate traffic movement 50 per cent. The adoption of such a system would result in an accelerated movement of necessities instead of the roads being cluttered up with useless stuff, which might as well be brought up later when things are slack.

The necessary impedimenta for a modern army is so great that all unnecessary material must be kept off the roads to the greatest possible extent, and it is morally certain that the supervision must be done by corps agencies and not left to the divisions.

Another thing vitally essential is that motor-truck units

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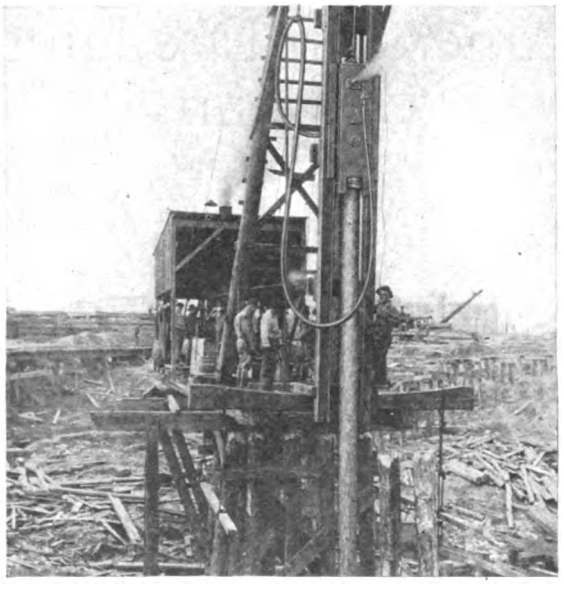
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drawn from a reserve, whether corps or army, and sent for duty to a certain organization, must remain under control of the unit to which it is ordered to report until it is released to the reserve again by proper authority. My experience with Motor Transport Corps units sent for special duty with my regiment, was that these units felt that they were in no sense under my command and that they were free to come and go as they pleased, as their first allegiance was to the M. T. C. This was not due primarily to the individual units, but to the lack of proper control.

Jno. F. Franklin

Major, Infantry, U. S. Army; formerly Motor Transport Corps, A. E. F.

Major Young presents a very able discussion of this subject from a broad point of view. I heartily agree with the conclusions drawn, though I am sure they would meet with considerable opposition in the service if put into effect.

The only criticism that I have of the article is that he has not sufficiently stressed the advantages of his plan of operation over those of the "fixed assignment" in the maintenance of the equipment. When an army is equipped with proper motor transportation, the efficient operation of the work is only begun. The real job is the maintenance of that equipment. If this subject is not given the proper thought and the work properly organized, the army will be crippled for lack of proper transportation in a surprisingly short time.

The advantages in maintenance of the "pooled system" over the "fixed assignment" are obvious.

Marmion D. Mills

Major, Engineer Reserve Corps; formerly in charge of Transportation Branch G-4, 1st Army, A. E. F.

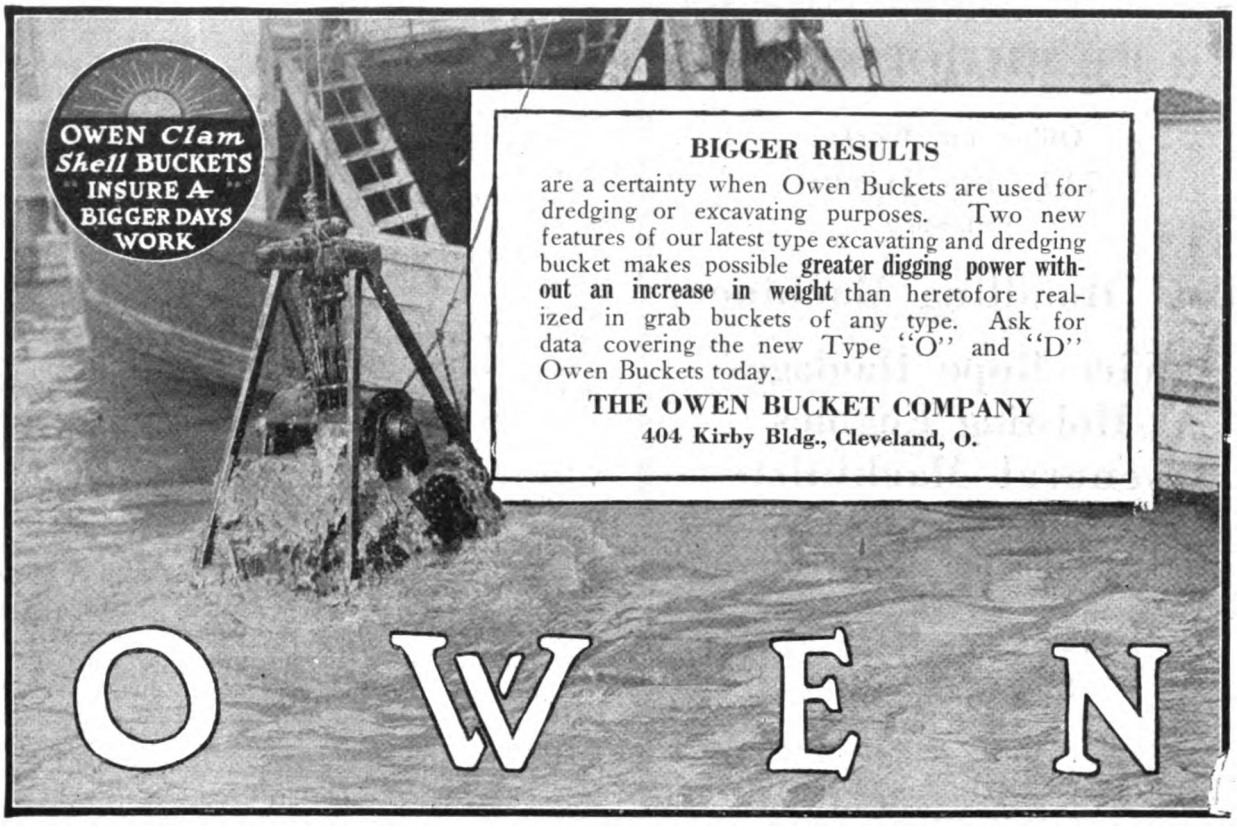
In the interest of a higher efficiency in the supply service of future armies in the field it is to be hoped that Major Young's admirable article will be widely discussed from the viewpoint not only of those who saw the Motor Transport problem in the A. E. F. from the operating side, but also of those who saw it as a means to an end, *i. e.*, the movement of men, supplies and munitions.

Probably no division commander would wish thrust upon him the operation of a railroad within his area, simply because he depended upon that railroad for his supply. He would realize that the operation of the road was a highly technical matter, and as long as his supplies were received when and where wanted, and that he was assured that the road could meet an emergency promptly, his interest in the actual operating problems would be nil. He would have enough troubles of his own.

The operation of motor transport in the area of a modern army in an active sector is as highly technical a problem as is the operation of a railroad. One operates trains of cars drawn by power units between certain points over a previously laid track, and by means of a dispatching system or traffic control is able to handle a maximum tonnage or passenger movement in both directions. The other operates convoys of separate cargo or passenger-carrying power units between points over an existing road system and by means of a centralized traffic control, *and by this means only*, is enabled to insure the maximum movement of tonnage in both directions.

The loose operation of separate convoys from various corps and divisional units over a road system by which a large force is supplied, not only is a primary cause for traffic jams, but it represents an ineffectual use of available transportation. During the early phases of the Meuse-Argonne operation when the various corps were making

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daily demands upon G-4 of the First Army for additional transport, a casual inspection of either of the two main roads in the corps areas generally disclosed a large number of empty or partly loaded trucks going in both directions. This condition improved somewhat as the shortage of trucks forced the various staffs to more rigid economy in their use.

The several reasons given by Major Young for the "bending" of the system of fixed assignment thoroughly cover the situation, but some amplification may be of interest. To the factor of "Shortage of Vehicles" should be added the failure to obtain spare parts and repairs; which, despite the heroic efforts of the Motor Transport officers of the 1st Army and of the smaller units with the pitifully few means at their disposal, brought the condition of the motor transport of the army to a point that would have made a winter campaign a rather desperate venture from a supply standpoint. It is fortunate we did not have one.

The maintenance of such motor transport as the army possessed was primarily handicapped by the large number of different makes of vehicles represented; by the actual shortage of essential spare parts in France, caused probably by inability to secure these parts from the manufacturer, also by the faulty system with which they were forwarded abroad, and by the faulty existing practice of operating the greater part of the transport by personnel from arms of the service other than the Motor Transport Corps and over which the Corps had no technical control. The functions of operation and maintenance are so inter-related that to place the responsibility for the proper use of vehicles upon practically every arm of the service but the Motor Transport Corps, and then to expect the Corps to be prepared to supply parts and to make repairs made necessary by abusive treatment over which the Corps could exercise only the most remote control, is a fundamental error in organization.

The shortage in motor vehicles in the 1st Army fell heaviest upon the units of corps and army troops, particularly engineers and artillery. The divisions were reasonably well equipped, to each complete division being assigned seven hundred (700) "truck-tons" of cargo and ammunition vehicles, or 89 per cent of the authorized allowance. Priority in assignment was always to the divisions, while the corps and army troops came in for the small amount of transportation that was left, generally operating with about 40 per cent of the authorized vehicles. Part of the army services met this situation early by organizing pools, as did also the several corps.

In addition, three provisional water-tank trains were formed by the army and operated under the control of the Army Engineer, while, during the Meuse-Argonne operation, a gasoline-tank train was organized to distribute gas and oil to the various divisions and other units.

Finally, in late October, 1918, the general shortage and the increasing length of haul as the army went forward, created a situation that caused the army commander to issue instructions to G-4 to form a general pool of cargo transportation in the army, by withdrawing operating units from the divisions. G-4 recommended that this pool be formed by withdrawing the various division supply trains, each to be equipped with three hundred truck-tons. This would leave four hundred tons with each division, of which one-half would be for general supply and technical purposes while the other half would be for ammunition. The army pool would then consist of fifteen divisional supply trains and one composite train from the three corps (two companies each), or a total of sixteen hundred trucks with a carrying capacity of forty-eight hundred tons or thirty thousand men.

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It was further recommended that the pool be formed and operated in conformity with plans, at this time being prepared at G. H. Q. to accomplish the same purpose. This recommendation was approved, and after consultation between G-4, G. H. Q. and G-4, 1st Army, Col. L. D. Gasser, G. S. of the former section, drafted a proposed order for the formation of the army pool, and the operation of the same, this order to take effect November 15. This pool was to have been operated along the lines of the French C. R. A., but on account of the Armistice was never organized.

From beginning to end of the battle operations of the 1st Army the only motor transportation available for troop movement was that furnished by the French. Prior to the concentration for the St. Mihiel offensive, arrangements were made through the 4th Bureau Etat Major of the French Group of Armies of the N. E. whereby the American 1st Army would have at its disposal sufficient trucks of the French *Service Automobile* to move a complete division, or about 20,000 seats, and in addition about 2,000 tons of cargo trucks for the movement of munitions and supplies. This transportation was to be operated by the *Service Automobile* through the Commission Regulatrice Automobile (C. R. A.) stationed at Toul and Ligny en Barrois, and which controlled not only the operation of these trucks, but also all traffic on the roads of the army area.

The control of traffic for this operation was largely handled by the C. R. A. functioning under G-1 of the army, while the operation of the troop and cargo truck convoys was handled through G-4 of the army.

The writer believes that a system by which two different staff sections are responsible, one for traffic control and the other for the movement of supplies and men, is as fundamantally wrong as would be the case of a railroad division superintendent sending out a series of trains when and from where he pleased, for a dispatcher not under his direction to control.

The operations of the C. R. A. are by far superior to any other means of controlling dense traffic, used by the A. E. F. With the approval of G-1 of the army the C. R. A. laid out the main road system for the supply of the army. Certain roads were assigned to animal transportation, while the main axial roads (Routes Gardees) were reserved for motor transport only. The "Routes Gardees" were under the absolute control of the C. R. A., who, by means of movable cantons of special road police, connected together by a special telephone system, insured proper dispatching of all convoys.

The "Routes Gardees" could be crossed by animal-drawn transportation or marching troops when such crossing did not interfere with any movement of controlled truck convoys.

In addition to the special police the C. R. A. maintained a sign-making department, in which sufficient road signs were made for the proper marking of all roads in the army. This was an extremely important phase of road control, especially where dense movement was made at night and without lights. The best signs were made so that they could be illuminated enough to be seen at a short distance, though not enough to be seen by enemy avions.

"Loop" roads, sometimes called by the French "Gare d'automobile," were laid out as part of the road system in circling divisional billeting areas in rear of the Army Zone, as well as at forward debussing points. This was necessary as it is not practicable to turn around a convoy of a thousand trucks on a single road.

The best example of troop loading seen by the writer was somewhat as follows: Trucks to move a division were parked in a complete circle around a divisional area

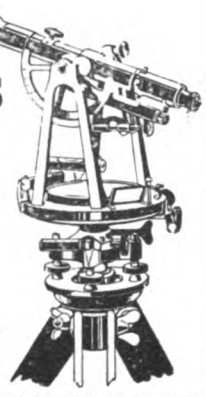
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pointed, of course, in the direction toward which they were to go and divided into convoys of sufficient size to carry the various units of the division, and parked as closely as possible to the billeting area of the unit they were to carry. The rear truck of each convoy was slightly in advance of the point at which the head of the column of troops was directed to reach the road. All the truck drivers were gathered by the convoy commander at the rear of the trucks, and as the troops came up they were cut off into groups of 20 men, the first group being turned over to the driver of the leading truck, the second group to the driver of the second truck, etc., and were conducted by the drivers directly to the trucks and embussed. This system of embussing worked quickly either by day or night and is worthy of record in that it is one of the many well worked-out details which made possible a large troop movement by truck during the two operations.

By means of the French trucks at the disposal of the 1st Army, 108,490 men were moved an average distance of 91 kilometers for the St. Mihiel concentration, while for the Meuse-Argonne offensive 428,635 men were moved an average distance of 77 kilometers, this latter being one of the largest troop movements by truck carried out in France. Both of these movements were executed entirely by night, without lights and with only two serious accidents.

With the French cargo trucks at its disposal G-4 1st Army moved a total of 12,988 tons of ammunition and supplies during the St. Mihiel offensive and 42,233 tons, of which 81 per cent were munitions, during the Meuse-Argonne operation. A much larger tonnage could have been moved during this latter operation but for the badly jammed roads and the poor layout of many of the forward ammunition dumps, at which trucks were generally forced to turn around on soft ground, resulting in much miring and consequent delay.

The writer believes with Major Young that only the necessary technical vehicles and a minimum number of cargo trucks should be assigned directly to tactical units. All other trucks should be pooled under the direction of the High Commander and either operated under the direction of Army Headquarters to carry out requests for transportation made by corps and divisions, or temporarily assigned by Army Headquarters to these units if conditions warranted their use in this way. He further believes that the principles of traffic control should be made known to the army through incorporation in Field Service Regulations.

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Echoes of the St. Lawrence Waterway Project

Discussion by NORMAN M. McLEOD.

In reference to the article on Great Lakes-St. Lawrence Route to the Sea by Maj. J. C. H. Lee, I wish to make the following comment:

(1) With a speed of 6 feet per second, a canal 200 feet wide at the bottom, 31 feet at the top, with a 25-foot depth of water, would provide 200,000 gross horsepower instead of 2,000,000, as stated. This would require a slope of about 6 inches per mile, which, in 182 miles, would mean a gross fall of 91 feet, which reduces the power head from 225 feet to 135 feet gross. From St. Regis to Ogdensburg, the drop in 54 miles would be 27 feet, leaving 63-foot head out of 90-foot fall. From Lake St. Francis to Lake St. Louis a drop of 7 feet in 16 miles leaves 73 feet for power head.

(2) The river water is estimated at 200,000 cubic feet per second average. If the channel is 500 feet wide and 40 feet deep, this would require a velocity of 10 feet per second and about 6-inch slope per mile.

This means that to obtain the full horsepower out of the river water a series of dams must be built. In that case the water will flow more rapidly in the narrow portions. A channel 500 feet wide would give 200,000 cubic feet per second at 10-foot velocity, which at 5 horsepower per cubic foot gives 1,000,000 horsepower in the first section, with an efficiency of 50 per cent, the consumer would get 500,000 horsepower, giving a gross income of $10,000,000 per year, in which project not more than $50,000,000 could be profitably invested.

NORMAN M. McLEOD.

[Abstract from *Electrical World.*]

Before a recent meeting of the Boston Society of Civil Engineers, in discussing a paper on New England waterpower resources by H. K. Barrows, a consulting engineer of Boston, Harry I. Harriman, president of the New England Power Company of that city, commented upon the possibilities of the St. Lawrence River hydro-electric project and outlined additional phases of the proposed development. The speaker said that in the St. Lawrence 240,000 cubic feet of water drops 221 feet per second. Four or five dams would be built with effective operating heads of 35 feet to 60 feet. On the St. Lawrence the maximum flow varies less than 25 per cent from the mean, owing to the 9,000 square-mile drainage area of Lake Ontario. The storage of this lake is so vast that it can be utilized to produce energy to equalize the low season of many New England and New York waterpowers and to supply the peak load of the winter months. If New England were to get behind the project, it would be entitled to about 6,500,000,000 kw.-hr. from the river plants, or say to 6,000,000,000 kw.-hr. at local substations.

In 1919 the railroads of New England used about 6,000,000 tons of coal on their 5,000 miles of track. Eighty per cent of this was consumed on less than 1,500 miles of track. The speaker said that $25,000 per mile should cover the track structures and substations, making about $40,000,000 to electrify the 1,500 miles, which burn most of the coal in that section. Electric locomotives will add another $40,000,000, but in so far as these are used to replace obsolete steam locomotives, their cost should not be charged to capital. Further, electrification probably will not proceed more rapidly than the steam equipment wears out. Accordingly, Mr. Harriman said, it seems fair to assume that the electrification of the main lines of the New England railroads will not cost more than $50,000,000.

The coal now burned by the New England main lines per year could be replaced by about 1,800,000,000 kw.-hr. from the St. Lawrence, costing about $18,000,000 and yielding a saving of from $20,000,000 to $30,000,000 for fuel outlay. The cost of electrification will be covered in a very few years of full operation. After that the New England roads will obtain their power on as favorable a basis as roads passing through the coal regions.

The electric utilities of New England generate about 2,000,000,000 kw.-hr. a year, of which more than 75 per cent is produced in steam plants. The present combined use of the railroads and utilities of the section is less than 3,500,000,000 kw.-hr., leaving 2,500,000,000 if the St. Lawrence supplies all of the energy.

There are about 18,500,000 cotton spindles in New England, and, allowing 22 spindles per horsepower, it is estimated that on the basis of a 48-hour week these mills use something less than 1,400,000,000 kw.-hr. yearly. At least 25 per cent of these spindles are driven mechanically by water, and therefore 1,000,000,000 kw.-hr. would replace all of the coal-produced energy in these cotton mills.

In New England there are about 2,100,000 woolen spindles, with 4,200 cards. These spindles require about 200,000 horsepower. Much heat is needed in process work. Not over half the power required by the woolen mills can be supplied by the central station, hence about 175,000,000 kw.-hr. would be required by the woolen mills. The paper mills would use about 200,000,000 kw.-hr. from the St. Lawrence. The boot and shoe factories, wire and rubber-goods plants, and brass establishments might utilize 100,000,000 kw.-hr. It is doubtful if the present industries of New England would use over 2,000,000,000 kw.-hr., and there would be a surplus of 500,000,000 if the railroads used 2,000,000,000 and the utilities 1,500,000,000. Enough is known, said the speaker, to assure that power can be delivered to the New England states in wholesale blocks from the St. Lawrence for less than 1 cent per kilowatt-hour.

R. O. T. C.

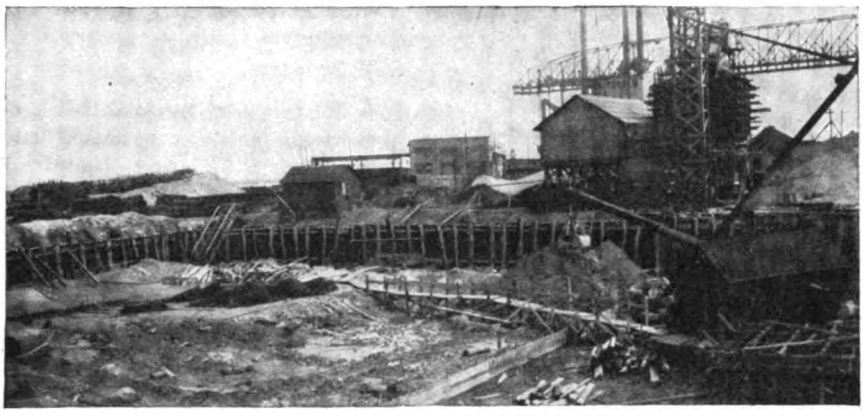
The small-bore rifle team of the R. O. T. C. Alabama Polytechnic Institute, Auburn, Ala., met and defeated the R. O. T. C. team of the Oregon Agricultural College of Corvalis, Oreg., in a telegraphic gallery match on January 29. The course consisted of the usual course as outlined in the S. A. F. M. Ten men composed the team of each institution. The final score was: A. P. I., 946; Oregon, 927. During the 1921 season, the Alabama Polytechnic Institute has matches scheduled with Texas A. and M., University of Illinois, and Cornell.

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Here is an excellent Lackawanna Steel Sheet Piling Construction for Sewage Disposal Plants

The cofferdam shown was constructed by the American Construction Company in connection with sewage disposal facilities installed for the Masters & Mullen Company, Cleveland, Ohio. It is 250 feet wide by 280 feet long, the walls being composed of a single line of Lackawanna 8½-inch Straight-Web Sheet Piling in cantilever and reinforced for stiffness by timber piles and wales.

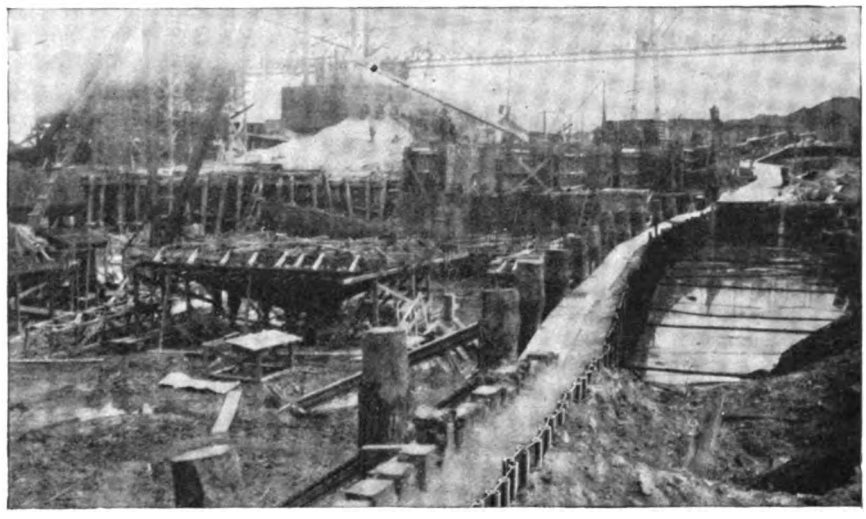
This large cofferdam is located on filled land on the lake front and the level of the lake is only two to three feet below the top of the steel sheet piling line. *In spite of these very unfavorable conditions the entire cofferdam is kept dry by a 3-inch pump working part time.*



For watertightness, it would be hard to improve upon such performance, but it will also be noted that the general arrangement is very economical in both first cost and maintenance.

If you have any shallow cofferdam work, let Lackawanna Engineers submit some interesting designs, with cost comparisons.

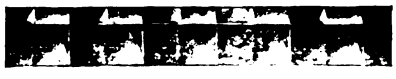
Large shallow cofferdams, especially in wet soil or standing in water, should always have walls of Lackawanna Steel Sheet Piling, because this steel sheeting keeps the water out, is very easy to install, and can be used temporarily or permanently as the conditions may demand. In the former instance, the salvage value of the Lackawanna Steel Sheet Piling should be close to 100 per cent, and in the latter there is practically no time limit for the full efficiency.



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When An Officer Leads His Men

By

C. A. Bach

Lieutenant Colonel, General Staff, U. S. Army

[*Note.*—The following article is from an address delivered by Colonel Bach to the students at the Officers' Training Camp, Fort Sheridan, Ill. It sets forth the fundamental principles of military leadership in a particularly clear and convincing manner, and cannot fail to be helpful to any who may ever be called upon to exercise such leadership.—ED.]

IN a short time each of you men will control the lives of a certain number of other men. You will have in your charge loyal but untrained citizens, who look to you for instructions and guidance.

Your word will be their law. Your most casual remark will be remembered. Your mannerisms will be aped. Your clothing, your carriage, your vocabulary, your manner of command will be imitated.

When you join your organization you will find there a willing body of men who ask from you nothing more than the qualities that will command their respect, their loyalty and their obedience.

They are perfectly ready and eager to follow you as long as you can convince them you have these qualities. When the time comes that they are satisfied you do not possess them, you might as well kiss yourself goodbye. Your usefulness in that organization is at an end.

From the standpoint of society, the world may be divided into leaders and followers. The professions have their leaders, the financial world has its leaders. We have religious leaders and political leaders, and society leaders. In all it is difficult, if not impossible, to separate from the element of pure leadership that selfish element of personal gain or advantage to the individual, without which such leadership would lose its value.

Not All Officers Are Leaders

It is in the military service only, where men freely sacrifice their lives for a faith, where men are willing to suffer and die for the right or the prevention of a great wrong, that we can hope to realize leadership in its most exalted and distinguished sense. Therefore, when I say leadership, I mean military leadership.

In a few days the great mass of you men will receive commissions as officers. These commissions will not make you leaders; they will merely make you officers. They will place you in a position where you can become leaders if you possess the proper attributes. But you must make good—not so much with the men over you as with the men under you.

Men must and will follow into battle officers who are not leaders, but the driving power behind these men is not enthusiasm, but discipline. They go with doubt and trembling and with an awful fear tugging at their heart strings that prompts the unspoken question: "What will he do next?"

Such men obey the letter of their orders, but no more. Of devotion to their commander, of exalted enthusiasm which scorns personal risk, of their self-sacrifice to insure his personal safety, they know nothing. Their legs carry them forward because their brain and their training tell them they must go. Their spirit does not go with them.

Great results are not achieved by cold, passive, unresponsive soldiers. They don't go very far, and they stop as soon as they can. Leadership not only demands, but receives the willing, unhesitating, unfaltering obedience and loyalty of other men; and a devotion that will cause them, when the time comes, to follow their uncrowned king to hell and back again if necessary.

You will ask yourselves: "Of just what, then, does leadership consist? What must I do to become a leader? What are the attributes of leadership, and how can I cultivate them?"

What Leadership Is

Leadership is a composite of a number of qualities. Among the most important I would list self-confidence, moral ascendency, self-sacrifice, paternalism, fairness, initiative, decision, dignity, courage.

Let me discuss these with you in detail.

Self-confidence results, first, from exact knowledge; second, the ability to impart that knowledge; and, third, the feeling of superiority over others that naturally follows. All these give the officer poise.

To lead, you must know—you may bluff all your men some of the time, but you can't do it all the time. Men will not have confidence in an officer unless he knows his business, and he must know it from the ground up.

The officer should know more about paper work than his first sergeant and company clerk put together; he should know more about messing than his mess sergeant; more about diseases of the horse than his troop farrier. He should be at least as good a shot as any man in his company.

If the officer does not know, and demonstrates the fact that he does not know, it is entirely human for the soldier to say to himself, "To hell with him. He doesn't know as much about this as I do," and calmly disregard the instructions received.

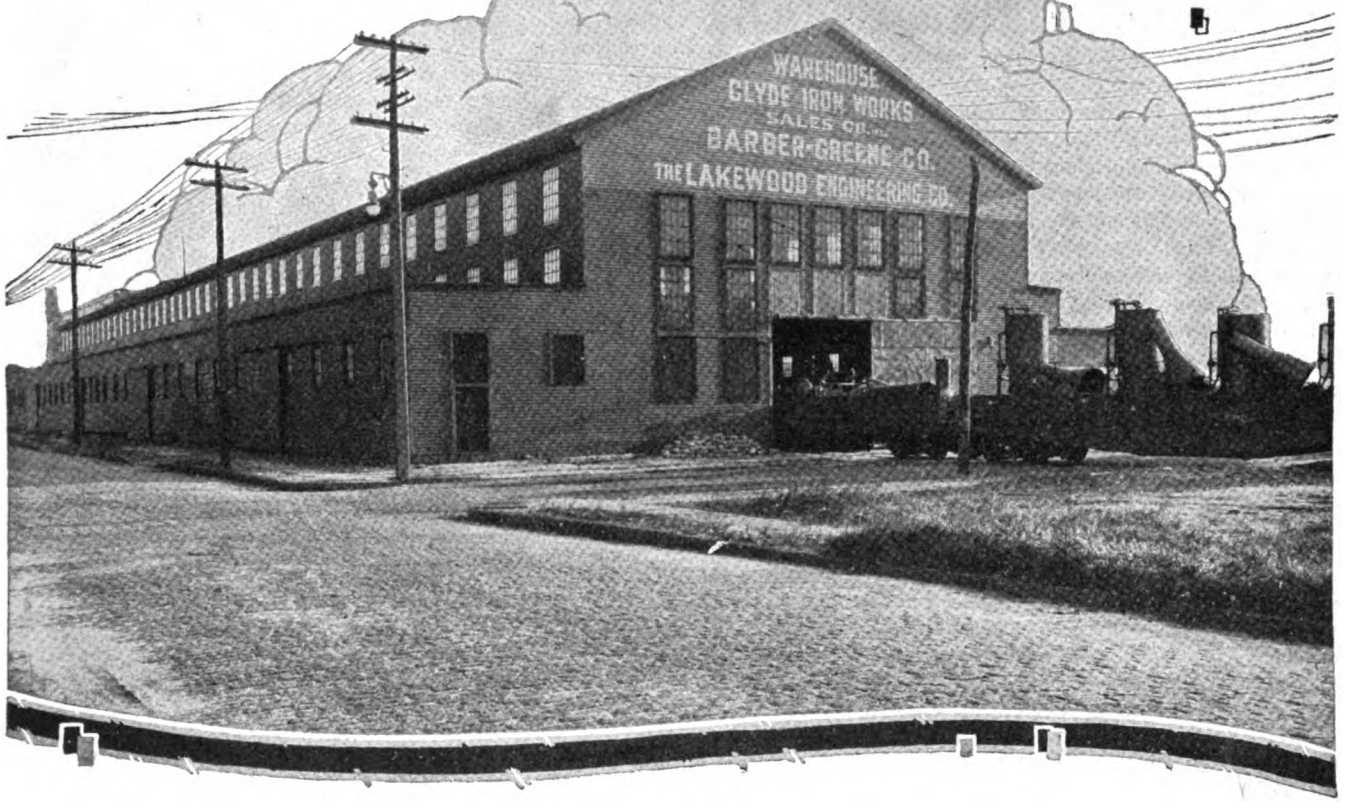
There is no substitute for accurate knowledge. Become so well informed that men will hunt you up to ask questions; that your brother officers will say to one another, "Ask Smith, he knows."

And not only should each officer know thoroughly the duties of his own grade, but he should study those of the two grades next above him. A twofold benefit attaches to this. He prepares himself for duties which may fall to his lot at any time during a battle; he further gains a broader viewpoint which enables him to appreciate the necessity for the issuance of orders and join more intelligently in their execution.

Not only must the officer know, but he must be able to put what he knows into grammatical, interesting, forceful English. He must learn to stand on his feet and speak without embarrassment.

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I am told that in British training camps student officers are required to deliver 10-minute talks on any subject they may choose. That is excellent practice. For to speak clearly one must think clearly, and clear, logical thinking expresses itself in definite, positive orders.

While self-confidence is the result of knowing more than your men, moral ascendency over them is based upon your belief that you are the better man. To gain and maintain this ascendency you must have self-control, physical vitality and endurance and moral force.

You must have yourself so well in hand that, even though in battle you be scared stiff, you will never show fear. For if you by so much as a hurried movement or a trembling of the hands, or a change of expression, or a hasty order hastily revoked, indicate your mental condition, it will be reflected in your men in a far greater degree.

In garrison or camp many instances will arise to try your temper and wreck the sweetness of your disposition. If at such times you "fly off the handle," you have no business to be in charge of men. For men in anger say and do things that they almost invariably regret afterward.

An officer should never apologize to his men; also an officer should never be guilty of an act for which his sense of justice tells him he should apologize.

Another element in gaining moral ascendency lies in the possession of enough physical vitality and endurance to withstand the hardships to which you and your men are subjected, and a dauntless spirit that enables you to not only accept them cheerfully, but to minimize their magnitude.

Make light of your troubles, belittle your trials, and you will help vitally to build up within your organization an esprit whose value in time of stress cannot be measured

Moral force is the third element in gaining moral ascendency. To exert moral force you must live clean, you must have sufficient brain power to see the right and the will to do right. Be an example to your men. An officer can be a power for good or a power for evil. Don't preach to them—that will be worse than useless. Live the kind of life you would have them lead, and you will be surprised to see the number that will imitate you.

A loud-mouthed, profane captain who is careless of his personal appearance will have a loud-mouthed, profane, dirty company. Remember what I tell you. Your company will be the reflection of yourself. If you have a rotten company, it will be because you are a rotten captain.

Self-sacrifice is essential to leadership. You will give, give all the time. You will give of yourself physically, for the longest hours, the hardest work and the greatest responsibility is the lot of the captain. He is the first man up in the morning and the last man in at night. He works while others sleep.

You will give of yourself mentally, in sympathy and appreciation for the troubles of men in your charge. This one's mother has died, and that one has lost all his savings in a bank failure. They may desire help, but more than anything else they desire sympathy.

Don't make the mistake of turning such men down with the statement that you have troubles of your own, for every time that you do you knock a stone out of the foundation of your house.

Soldiers As Children

Your men are your foundation, and your house of leadership will tumble about your ears unless it rests securely upon them.

Finally, you will give of your own slender financial resources. You will frequently spend your own money to conserve the health and well-being of your men or to assist them when in trouble. Generally you get your money back. Very frequently you must charge it to profit and loss.

When I say that paternalism is essential to leadership, I use the term in its better sense. I do not now refer to that form of paternalism which robs men of initiative, self-reliance and self-respect. I refer to the paternalism that manifests itself in a watchful care for the comfort and welfare of those in your charge.

Soldiers are much like children. You must see that they have shelter, food and clothing, the best that your utmost efforts can provide. You must be far more solicitous of their comfort than of your own. You must see that they have food to eat before you think of your own; that they have each as good a bed as can be provided before you consider where you will sleep. You must look after their health. You must conserve their strength by not demanding needless exertion or useless labor.

And by doing all these things you are breathing life into what would be otherwise a mere machine. You are creating a soul in the organization that will make the mass respond to you as though it were one man. And that is esprit.

And when your organization has this esprit you will wake up some morning and discover that the tables have been turned; that instead of your constantly looking out for them they have, without even a hint from you, taken up the task of looking out for you. You will find that a detail is always there to see that your tent, if you have one, is promptly pitched; that the most and the cleanest bedding is brought to your tent; that from some mysterious source two eggs have been added to your supper when no one else has any; that an extra man is helping your men give your horse a supergrooming; that your wishes are anticipated; that every man is "Johnny on the spot." And then you have arrived.

Fairness is another element without which leadership can neither be built up nor maintained. There must be, first, that fairness which treats all men justly: I do not say alike, for you cannot treat all men alike, for that would be assuming that all men are cut from the same piece; that there is no such thing as individuality or a personal equation.

You cannot treat all men alike; a punishment that would be dismissed by one man with a shrug of the shoulders is mental anguish for another. A company commander who for a given offense has a standard punishment that applies to all is either too indolent or too stupid to study the personality of his men. In his case justice is certainly blind.

Study your men as carefully as a surgeon studies a difficult case. And when you are sure of your diagnosis apply the remedy. And remember that you apply the remedy to effect a cure, not merely to see the victim squirm. It may be necessary to cut deep, but when you are satisfied as to your diagnosis don't be diverted from your purpose by any false sympathy for the patient.

Hand in hand with fairness in awarding punishment walks fairness in giving credit. Everybody hates a human hog.

When one of your men has accomplished an especially creditable piece of work, see that he gets the proper reward. Turn heaven and earth upside down to get it for him. Don t try to take it away from him and hog it for yourself. You may do this and get away with it, but you have lost the respect and loyalty of your men. Sooner or later your brother officers will hear of it and shun you like a leper. In war there is glory enough for all. Give the man under you his due. The man who always takes and never gives is not a leader. He is a parasite.

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There is another kind of fairness—that which will prevent an officer from abusing the privileges of his rank. When you exact respect from soldiers, be sure you treat them with equal respect. Build up their manhood and self-respect. Don't try to pull it down.

For an officer to be overbearing and insulting in the treatment of enlisted men is the act of a coward. He ties the man to a tree with the ropes of discipline and then strikes him in the face, knowing full well that the man cannot strike back.

Consideration, courtesy and respect from officers toward enlisted men are not incompatible with discipline. They are parts of our discipline. Without initiative and decision no man can expect to lead.

In maneuvres you will frequently see, when an emergency arises, certain men calmly give instant orders which later, on analysis, prove to be, if not exactly the right thing, very nearly the right thing to have done. You will see other men in emergency become badly rattled; their brains refuse to work, or they give a hasty order, revoke it; give another, revoke that, in short, show every indication of being in a blue funk.

Regarding the first man you may say: "That man is a genius. He hasn't had time to reason this thing out. He acts intuitively." Forget it. Genius is merely the capacity for taking infinite pains. The man who is ready is the man who has prepared himself. He has studied beforehand the possible situations that might arise, he has made tentative plans covering such situations. When he is confronted by the emergency he is ready to meet it.

In Emergencies

He must have sufficient mental alertness to appreciate the problem that confronts him and the power of quick reasoning to determine what changes are necessary in his already formulated plan. He must have also the decision to order the execution and stick to his orders.

Any reasonable order in an emergency is better than no order. It is better to do something and do the wrong thing than to hesitate, hunt around for the right thing to do, and wind up by doing nothing at all. And, having decided on a line of action, stick to it. Don't vacillate. Men have no confidence in an officer who doesn't know his own mind.

Occasionally you will be called upon to meet a situation which no reasonable human being could anticipate. If you have prepared yourself to meet other emergencies which you could anticipate, the mental training you have thereby gained will enable you to act promptly and with calmness.

You must frequently act without orders from higher authority. Time will not permit you to wait for them. Here again enters the importance of studying the work of officers above you. If you have a comprehensive grasp of the entire situation, and can form an idea of the general plan of your superiors, that and your previous emergency training will enable you to determine that the responsibility is yours and to issue the necessary orders without delay.

Don't Cheapen Yourself

The element of personal dignity is important in military leadership. Be the friend of your men, but do not become their intimate. Your men should stand in awe of you—not fear. If your men presume to become familiar, it is your fault, not theirs. Your actions have encouraged them to do so.

And, above all things, don't cheapen yourself by courting their friendship or currying their favor. They will despise you for it. If you are worthy of their loyalty and respect

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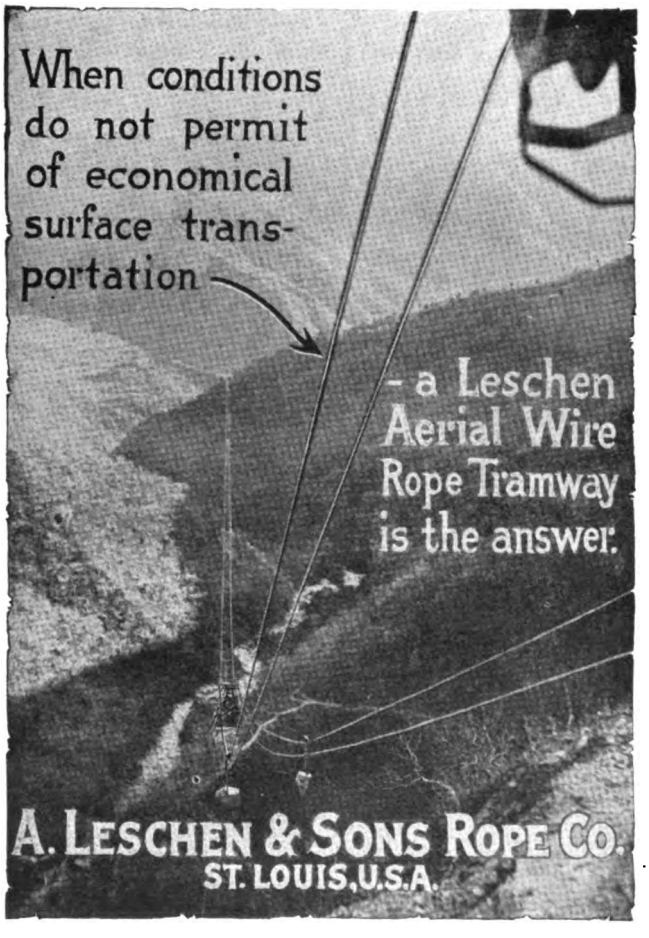
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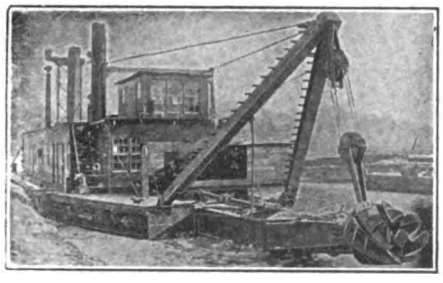
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and devotion, they will surely give all these without asking. If you are not, nothing that you can do will win them.

It is exceedingly difficult for an officer to be dignified while wearing a dirty, spotted uniform and a three-days' stubble of whiskers on his face. Such a man lacks self-respect, and self-respect is an essential of dignity.

There may be occasions when your work entails dirty clothes and unshaven face. Your men all look that way. At such times there is ample reason for your appearance. In fact, it would be a mistake to look too clean—they would think that you were not doing your share. But as soon as this unusual occasion has passed, set an example of personal neatness.

And then I would mention courage. Moral courage you need as well as physical courage—that kind of moral courage which enables you to adhere without faltering to a determined course of action, which your judgment has indicated as the one best suited to secure the desired results.

You will find many times, especially in action, that, after having issued your orders to do a certain thing, you will be beset by misgivings and doubts; you will see or think you see other and better means for accomplishing the object sought. You will be strongly tempted to change your orders. Don't do it until it is clearly manifested that your first orders were radically wrong. For, if you do, you will be again worried by doubts as to the efficacy of your second orders.

Every time you change your orders without obvious reasons you weaken your authority and impair the confidence of your men. Have the moral courage to stand by your order and see it through.

Moral courage further demands that you assume the responsibility for your own acts. If your subordinates have loyally carried out your orders, and the movement you directed is a failure, the failure is yours, not theirs. You would have been the honor had it been successful. Take the blame, if it results in disaster. Don't try to shift it to a subordinate and make him the goat. That is a cowardly act.

Furthermore, you will need moral courage to determine the fate of those under you. You will frequently be called upon for recommendations for the promotion or demotion of officers and non-commissioned officers in your immediate command.

Keep clearly in mind your personal integrity and the duty you owe your country. Do not let yourself be deflected from a strict sense of justice by feelings of personal friendship. If your own brother is your second lieutenant, and you find him unfit to hold his commission, eliminate him. If you don't, your lack of moral courage may result in the loss of valuable lives.

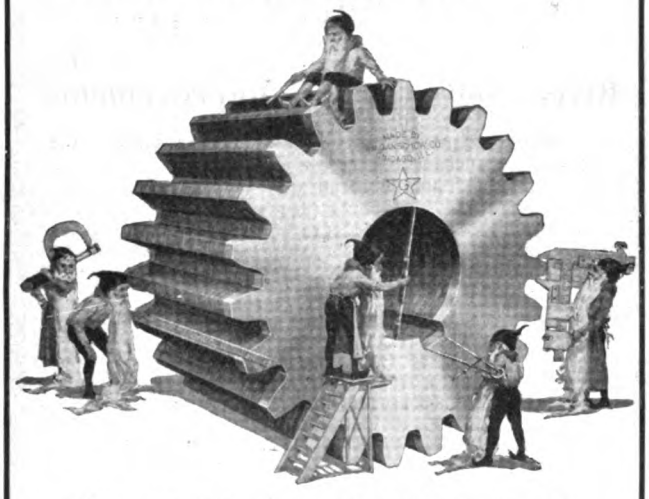
If, on the other hand, you are called upon for a recommendation concerning a man whom, for personal reasons, you thoroughly dislike, do not fail to do him full justice. Remember that your aim is the general good, not the satisfaction of an individual grudge.

I am taking it for granted that you have physical courage. I need not tell you how necessary that is. Courage is more than bravery. Bravery is fearlessness—the absence of fear. The merest dolt may be brave, because he lacks the mentality to appreciate his danger; he doesn't know enough to be afraid.

Courage, however, is that firmness of spirit, that moral backbone which, while fully appreciating the danger involved, nevertheless goes on with the undertaking. Bravery is physical; courage is mental and moral. You may be cold all over; your hands may tremble; your legs may quake; your knees be ready to give way—that is fear. If,

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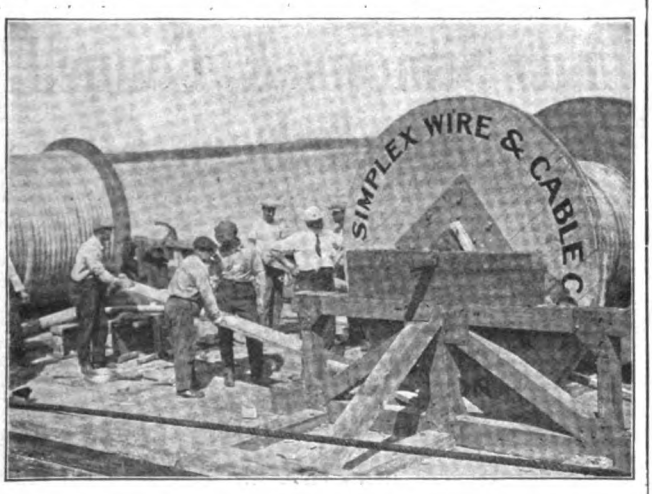
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nevertheless, you go forward; if, in spite of this physical defection, you continue to lead your men against the enemy, you have courage. The physical manifestations of fear will pass away. You may never experience them but once. They are the "buck fever" of the hunter who tries to shoot his first deer. You must not give way to them.

A number of years ago, while taking a course in demolitions, the class of which I was a member was handling dynamite. The instructor said regarding its manipulation: "I must caution you gentlemen to be careful in the use of those explosives. One man has but one accident." And so I would caution you. If you give way to the fear that will doubtless beset you in your first action, if you show the white feather, if you let your men go forward while you hunt a shell crater, you will never again have the opportunity of leading these men.

Use judgment in calling on your men for displays of physical courage or bravery. Don't ask any man to go where you would not go yourself. If your common sense tells you that the place is too dangerous for you to venture into, then it is too dangerous for him. You know his life is as valuable to him as yours is to you.

Occasionally some of your men must be exposed to danger which you cannot share. A message must be taken across a fire-swept zone. You call for volunteers. If your men know you and know that you are "right," you will never lack volunteers, for they will know your heart is in your work, that you are giving your country the best you have, that you would willingly carry the message yourself if you could. Your example and enthusiasm will have inspired them.

And lastly, if you aspire to leadership, I would urge you to study men.

Get under their skins and find out what is inside. Some men are quite different from what they appear to be on the surface. Determine the workings of their minds.

Much of Gen. Robert E. Lee's success as a leader may be ascribed to his ability as a psychologist. He knew most of his opponents from West Point days, knew the workings of their minds, and he believed that they would do certain things under certain circumstances. In nearly every case he was able to anticipate their movements and block the execution.

You cannot know your opponent in this war in the same way. But you can know your own men. You can study each to determine wherein lies his strength and his weakness; which man can be relied upon to the last gasp and which cannot.

Know your men, know your business, know yourself.

Wire Mesh Roads—Loose sand, smoothed and leveled and covered with chicken wire netting, firmly pegged down, made roads which gave good service to the British Army in Egypt and Palestine. These roads were very satisfactory for foot troops and of some use for motor transport, but were rapidly rendered useless by animal drawn transport. Repairs are easily made. As ruts develop the netting is raised and the rut wiped out.

As an example of the successful practice of the art of the military engineer, namely, utilizing for his purposes whatever is available, these roads are most interesting.

Chicken wire has many military uses other than the retention of chickens, for which purpose it has been found almost useless in time of war. It is employed for roads, trench revetment, reinforcement for concrete, support for camouflage, or for siding for temporary buildings, etc.—*Reserve Engr.*

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The Three Hundred

A lamentation of the ineligible

[With apologies to Ella Wheeler Wilcox, Lord Tennyson, The Three Hundred, the rest of the Army, and anybody else who may take umbrage.]

In accordance with the provisions of the Army Reorganization Act of June 4, 1920, the War Department, in General Order 74, December 16, 1920, published the initial list of some 300 officers eligible for General Staff duty.

The act further provides that, "After the completion of the initial General Staff Corps eligible list the name of no officer shall be added thereto unless upon graduation from the General Staff School he is specifically recommended as qualified for General Staff duty."

This procedure, as was of course inevitable, has moved some to laughter and others to tears. Our anonymous correspondent, whose contribution appears below, is moved to versification:

I

Half a life, half a life,
All a life working.
All in the Service Schools,
All but three hundred.
Cheers! for the staff brigade!
Cheers! for the schools they've made!
Cheers! for the life we'll lead!
All but three hundred.

II

Hurrah for the Staff Brigade,
Are any undismayed?
Not though the army knew,
Some one had blundered.
Theirs not to make reply,
Theirs but to school to hie,
There just to bone and die,
All but three hundred.

III

Schools to the right of them,
Schools to the left of them,
More schools in front of them,
Nothing but schools.
All know 'tis but a sell,
All who have worked like hell,
But 'tis fixed all too well,
'Tis of our hopes the knell,
All but three hundred.

IV

Flashed all our records bare—
Examined all with care,
Selecting this staff affair,
Back in some secret lair,
While the world wondered.
Screened in department smoke,
Till one day the service woke,
Undone at a single stroke.
All but three hundred.

V

Schools to the right of them,
Schools to the left of them,
More schools in front of them,
Nothing but schools.
Mark you the orders fell,
Hark to the tale they tell,
You that have fought so well.
Come through the jaws of death,
Back to a life of hell,
Back to your student's cell.
All but three hundred.

VI

When can their glory fade?
Oh! the fine schools they made!
While a world wondered.
Honor the schools they made,
Honor the Staff Brigade,
Lucky three hundred.

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12th Engineers, Camp Grant, Illinois

"I know of no better motto than 'Essayons' for the Corps of Engineers," was the remark of the Camp Commander when he inspected the recently constructed officers' quarters upon their completion. The entire building work, which provided housing facilities for fifty families, was performed by the 12th Engineers.

From the exterior the neatly arranged bungalows present a pleasing colony effect, and the interior arrangements and conveniences leave nothing to be desired.

"Everybody and his wife" has moved in from Rockford, and in the evenings "Home Sweet Home" seems to the passerby to be Camp Grant's favorite tune.

An interesting feature of the instruction being given to the officers of the regiment is the series of lectures on "Civil Duties of Officers of the Corps of Engineers," by Col. T. H. Jackson, C. of E., commanding officer of the regiment. A number of years in charge of a flood-control district of the Ohio River and as a member of the California Debris Commission, enables the colonel to make his talks particularly valuable.

Although much regret was expressed by the members of the Sixth Division and their friends in Rockford over the loss by fire of the beautiful and commodious hostess house of the camp, the new building now practically completed in its stead by the 12th Engineers, bids fair to be a worthy successor. The arduous work of transporting the material for the new structure from distant parts of the cantonment in all kinds of weather did not daunt the officers and men of the regiment who have in a short time constructed a building that is the admiration of the camp.

The officers and ladies of the regiment gave a Valentine dinner-dance on February 8 at the Jewish Welfare Hostess House. Since the burning of the Camp Hostess House this building has been used in its place. Brig. Gen. George Bell, Jr., Camp Commander, was the guest of honor of the evening. Sixty couples were present and enjoyed dances between the courses and following the dinner.

The tastefully decorated rooms evoked much favorable comment. Hearts in Engineer colors were prettily displayed. A large one bearing the motto "Essayons" occupied a conspicuous place.

Music for the occasion was furnished by the 12th Engineers' orchestra.

The enjoyment of the evening was largely due to the painstaking efforts of Mrs. T. H. Jackson, who, in customary manner, worked for the success of the entertainment.

Capt. A. B. Shattuck, Jr., First Lieuts. William W. Wanamaker, W. P. Trower, Charles B. Jewell, Chester K. Harding, and W. A. Calla-way have left for the Engineer School, Camp Humphreys, Va.

Prior to their departure the bachelor officers of the group gave a farewell card party to the officers and ladies of the regiment. Refreshments were served and a very enjoyable evening spent.

Engineer officers recently assigned to the regiment are: Second Lieuts. G. H. Lambert, S. C. Joslyn, H. F. Hannis, T. T. Knappen, L. B. Robinson, and J. S. Seybold These officers are graduates of the latest U. S. Military Academy class, and completed a course of instruction at Camp Humphreys, Va., prior to their assignment to this command.

An Engineer Chapter of the Army Relief Society has been formed among the ladies of the regiment. The officers chosen for the coming year are: Mrs. T. H. Jackson, President; Mrs. B. B. Browne, Vice-President; Mrs. Alva H. Perkins, Secretary and Treasurer; Mrs. F. T. Bass, Relief Work.

The foreign-service detail has claimed four of the camp's most popular officers, all members of this regiment. Capt. R. H. Stock, First Lieuts. G. H. Stough, and J. P. Hyde have been transferred to the 13th Engineers, Hawaii, and First Lieut. A. B. Jones goes to the 11th Engineers in the Canal Zone.

After two months' sole possession of the southwest corner of the cantonment, orders have been issued from headquarters that we make arrangements to accommodate the 6th Field Signal Battalion in the area.

Everybody is working to have things in good condition for the signalers when they move in, and pleasure is expressed by all in anticipation of the arrival of such pleasant neighbors.

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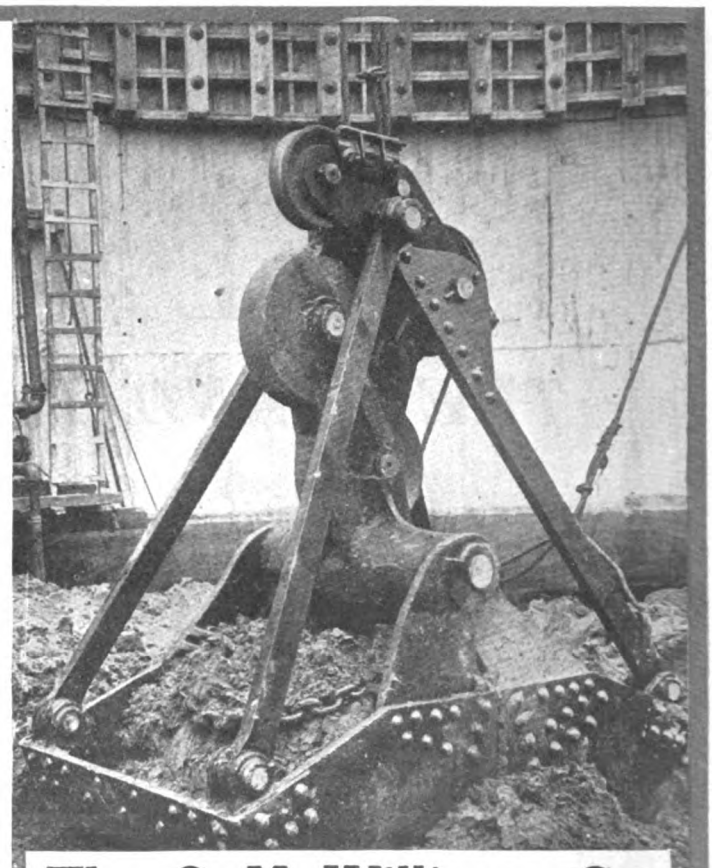
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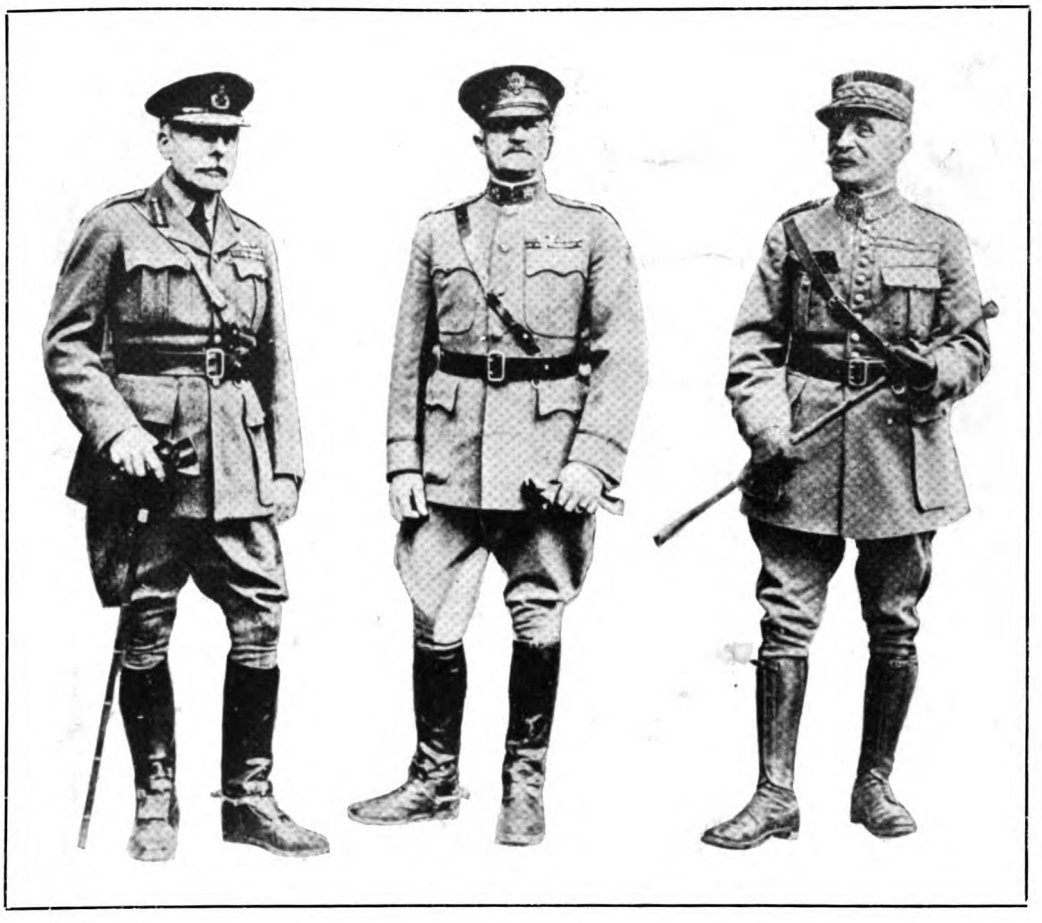


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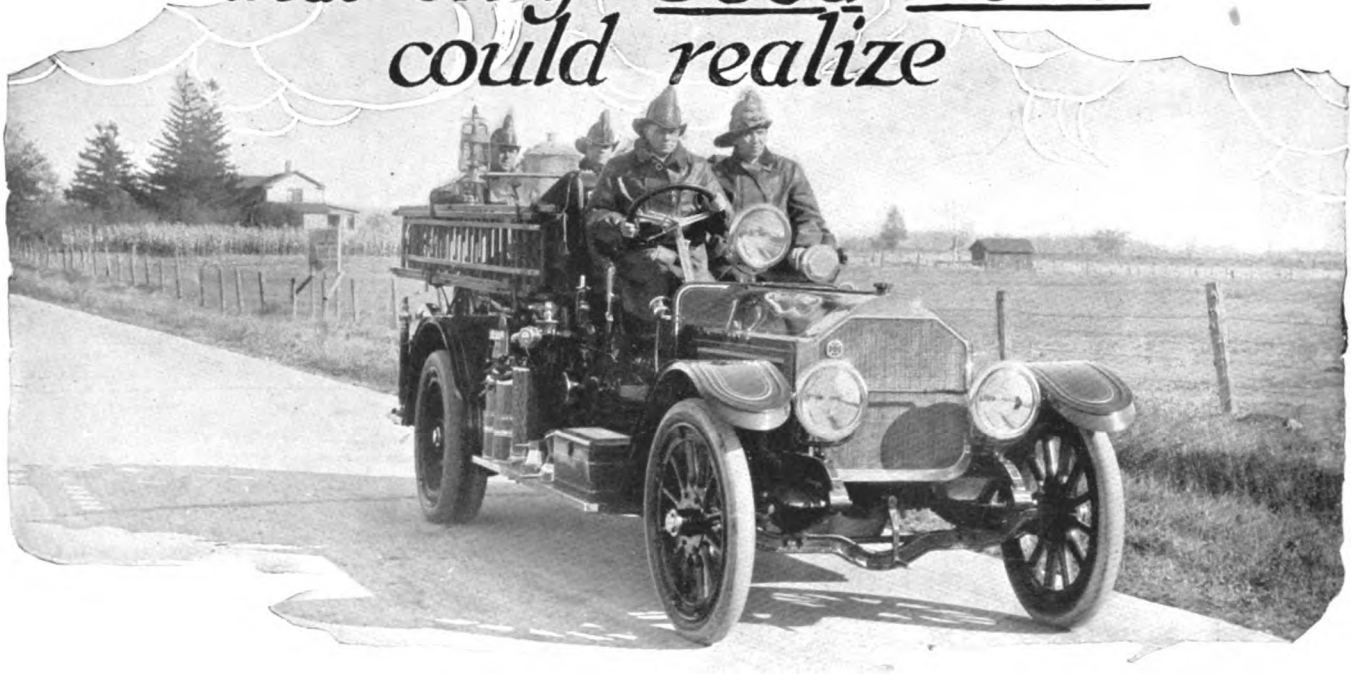


The Vicksburg Campaign
The Officers Reserve Corps and the Organized Reserves
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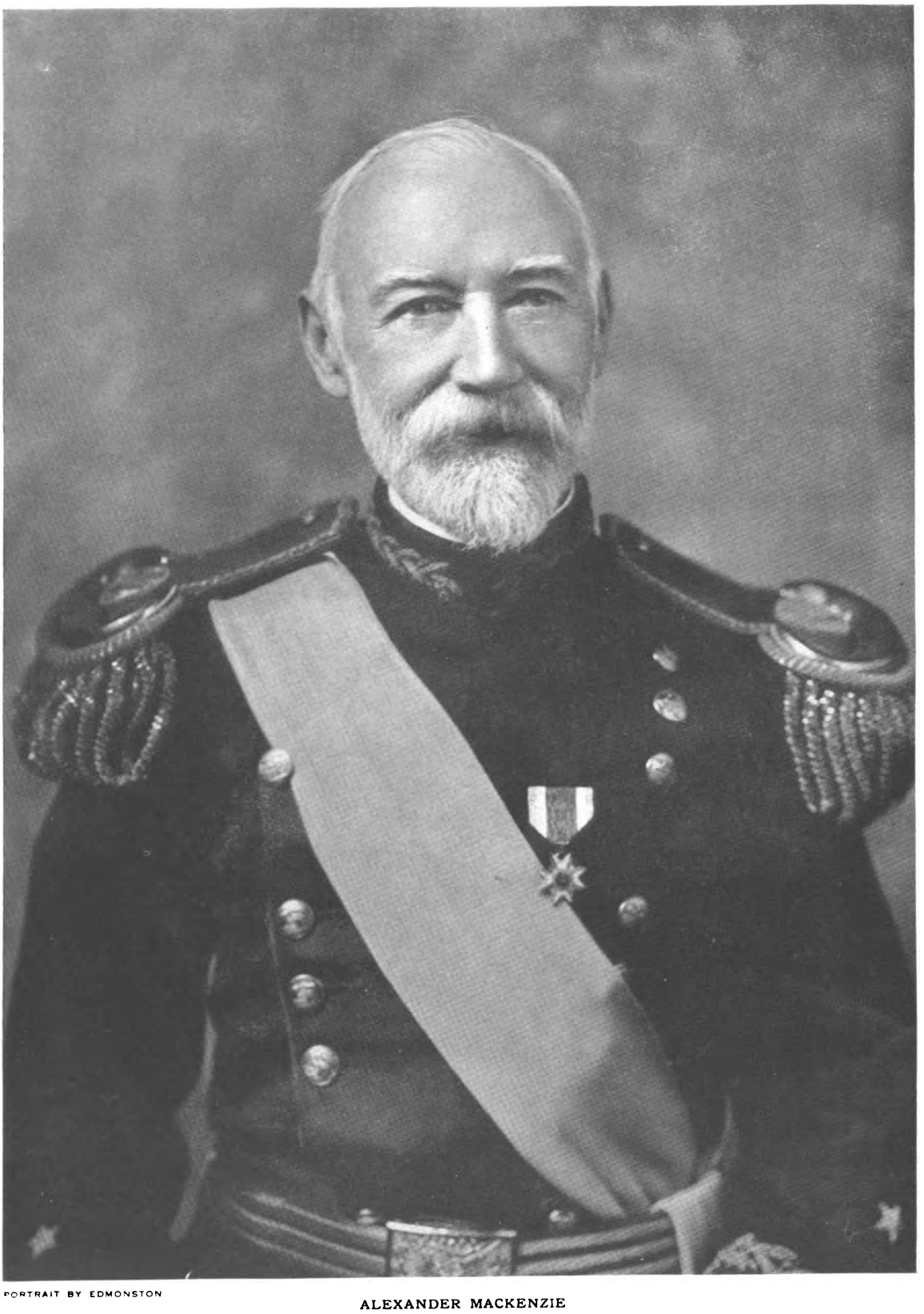
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PORTRAIT BY EDMONSTON

ALEXANDER MACKENZIE
Major General, U. S. Army
Chief of Engineers, January 23, 1904-May 25, 1908

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The Vicksburg Campaign

By

Peter C. Hains

Major General U. S. A. (retired)

THE annals of history do not disclose the story of a military campaign of greater interest than the campaign of Vicksburg fought by Gen. U. S. Grant in 1863, nor one that teaches better the lessons of grand tactics. Grant had already proved himself a great general on other fields, but the Vicksburg Campaign stands out in bold relief as the most daring and at the same time the most completely successful one in all the career of this remarkable man. The Appomattox Campaign that culminated in the surrender of Lee and the collapse of the Rebellion was the climax to which that of Vicksburg was the prelude.

While too much can not be said in praise of the brilliancy of Grant's maneuvers, it must be confessed that if Lee or Stonewall Jackson had been in command of the Confederate Army of the Mississippi at that time, the story would have been, in some respects at least, different.

Grant was no stickler for the rules either of strategy or logistics as laid down in the books. It is probable that he never opened a book on those subjects after he left West Point. He followed the dictates of common sense, and he had more of that commodity in his make-up than most men. If one were to define strategy, it would be difficult to describe it better than to say, it is the art of applying common sense to the directing of masses on the theater of war. As a matter of fact, the rules of strategy are based on common sense. One fundamental rule, is that it is wise to do that which your antagonist does not think you will do, and to avoid doing that which he thinks you will do. This rule of common sense was followed by Grant in the entire Vicksburg Campaign, as well as other of his campaigns, both before and after. It contributed in no small measure to his success.

The first attempt to capture Vicksburg was made in December, 1862, and this might be considered as the opening chapter of the Vicksburg Campaign. In this attempt Grant organized an army of about 22,000 men at Grand Junction and proceeded south along the line of the Mississippi Central Railroad, Haynes Bluff being the objective aimed at. At the same time another army of about 35,000 men under Sherman was collected at Memphis and proceeded south on transports with the idea of entering the Yazoo River and attacking Haynes Bluff from a westerly direction. The two armies were expected to co-operate and unite somewhere near Haynes Bluff. They were so far apart, however, that co-operation was not practicable. Grant's force proceeded down to the vicinity of La Grange, when his depot established at Holly Springs was raided by a force of cavalry and his supplies destroyed. As these were necessary to the further advance of his army he was compelled to fall back. Sherman succeeded, with the aid of Porter's fleet of gunboats, in entering the Yazoo River and made a fierce frontal attack on Haynes Bluff, but was repulsed with heavy loss. Both expeditions proved to be lamentable failures. Sherman did not hear of Grant's failure until after he had himself failed and Grant did not know of Sherman's failure until after he himself had failed. The difficulty of trying to combine tactically the movements of two separate armies operating on exterior lines is illustrated in these movements. They were both directed by Grant but they do not look like his work.

While these attempts might be considered the beginning of the Vicksburg Campaign, they are not generally so considered. The campaign is generally assumed to have begun April 30th, when Grant crossed the Mississippi River. The trouble with regarding the campaign as beginning April 30th is, that it leaves out of consideration the preliminary movements that took place between April 1st and April 30th. As some of these movements have an important bearing on the campaign, it is thought best to treat it as beginning April 1st. Moreover, it was about April 1st that Grant decided to move by the southern route. After the two failures referred to, some months were spent in trying other routes to reach the great stronghold—one by way of Yazoo Pass, which seemed to be promising, but which, after an unsuccessful trial, was given up. Another route by way of Lake Providence was carefully investigated and given up, and the same fate fell to other routes.

In the early part of 1863 the Army of the Tennessee, consisting of three corps, was organized and Grant took the field in personal command. About April 1st this army had its advance forces at or near Millikens Bend, almost in sight of the goal. The avowed objective of this Army of the Tennessee was the capture of Vicksburg and the opening of the Mississippi River to navigation.

Between January and April all known routes of approach to Vicksburg were carefully investigated and studied. All were eliminated from further consideration except the route by way of the Mississippi-Central Railroad with Memphis as the base of operations, known as the northern route, and the one by way of Richmond, Perkins Plantation or New Carthage, from the vicinity of which a crossing into the State of Mississippi was to be made.

From a purely military standpoint the northern route had many advantages and comparatively few obstacles that could not be readily overcome so far as human foresight could determine. A railroad was already in existence and while it was not in first-class condition and lacked rolling stock, these disadvantages could be readily overcome. Moreover, once the army was in rear of Haynes Bluff, the defenses of that place would be taken in reverse and must be abandoned by the enemy. The long railroad line could then be abandoned and a short one by way of Yazoo River and Haynes Bluff could be opened. This was an important consideration and was equally so even if the southern route should be adopted. In fact, either the northern or southern route looked to the opening of a short line of communication by way of the Yazoo River if a siege had to be resorted to.

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The northern route avoided all the obstacles that were inherent in the southern, which were serious and not few in number. The fact that in December, 1862, Grant had been foiled in his attempt to reach Vicksburg by this same route, did not militate against it now. His former failure was due to the fact that he attempted it with too small a force and in consequence could not adequately protect his line of supply. With a much larger force he would be able to protect his long line of supplies until he opened the contemplated new one.

This northern route was advocated by his friend and military adviser, General Sherman, who commanded the 17th Army Corps. Sherman was regarded at the time as one of the ablest generals in the army and Grant shared in this high opinion of his friend and subordinate. The latter was so opposed to a southern route that he felt compelled to write a letter to his chief setting forth his objections, but at the same time stating that in case Grant decided in its favor, he would give it his most hearty support.

One of the most serious objections to the northern route was that it involved a retrograde movement of the army just at a time when our international relations with Great Britain and France were in a somewhat strained condition. Both these countries were almost ready to admit the Southern Confederacy as an entity in the Society of Nations. They had already acknowledged them as belligerents. Our crushing defeat at Fredericksburg, the doubtful victory of Murfreesboro, the slow progress made in recruiting the army, the great national debt that was piling up, and many other things of a political nature, had produced a most disturbing effect on the people of the North. To take away the Army of the Tennessee, now concentrated almost in sight of the goal it had set out to capture, without accomplishing anything, would have been looked upon as disastrous. It would have been hailed throughout the Confederacy as a Union defeat, encouraging the southern people to renewed efforts, and would have caused dismay among the Union people of the North. From a military standpoint the northern route appeared the safer and better one. From a political standpoint it was almost unthinkable.

The southern route was beset with difficulties. To transfer the army from Millikens Bend to Perkins Plantation or New Carthage, was no easy task. The whole country was inundated by the high water in the Mississippi River which had come through the cuts in the levees made by the enemy. There were numerous bayous to cross which could only be crossed by bridges, which bridges had to be constructed by our own soldiers with timber growing in the swamps. The few pontons we had, belonging to a short section of a ponton bridge train, had been impressed into the service of carrying provisions to the advanced part of our army.

After all the army, if moved to some point near Perkins Plantation, would be worse off than it was at Millikens Bend, unless it was also provided with the means of transporting it across the river. That meant that transports and barges must be brought there from above Vicksburg. There were more below. Could the ordinary river steamboat run past the Vicksburg batteries without being so damaged as to be useless as a transport? There were many officers who believed it could not be done. Suppose, however, that enough transports and barges could run by the batteries and come out in a serviceable condition. Could a landing be effected in the face of an army as large as our own? Could our army after crossing be supplied with food and ammunition over the precarious line of communication behind us? These were weighty considerations. The difficulties to be overcome were great, but Grant was a great man and he decided to face them. Grant believed that some of the transports would be lost in running the batteries but he thought enough would get by to serve his purpose.

It was determined to try an experiment on the night of April 16. Three transports and about a dozen barges were selected to make the trip. The crews at once deserted and the volunteers had to be secured from the army. Of the three sent, one was destroyed, the other two got by in a damaged condition. They were quickly repaired, however, and made ready for service. General Sherman was so anxious about the result of this experiment that he spent the whole night in a small boat waiting below Vicksburg to see the result.

Ten days later, another consignment of transports had better luck. Six transports and twelve barges loaded with coal for the Navy were fitted out and ran the batteries. One transport was totally destroyed and six of the barges were lost. Of the five transports that got by in safety, some were damaged, but not seriously. They were soon repaired and we now had seven transports, and about a dozen coal barges ready for service.

This settled the question of our ability to ferry the army across the river so far as transportation was concerned. The only doubtful question now was what would the enemy do to prevent our landing on the east side of the river?

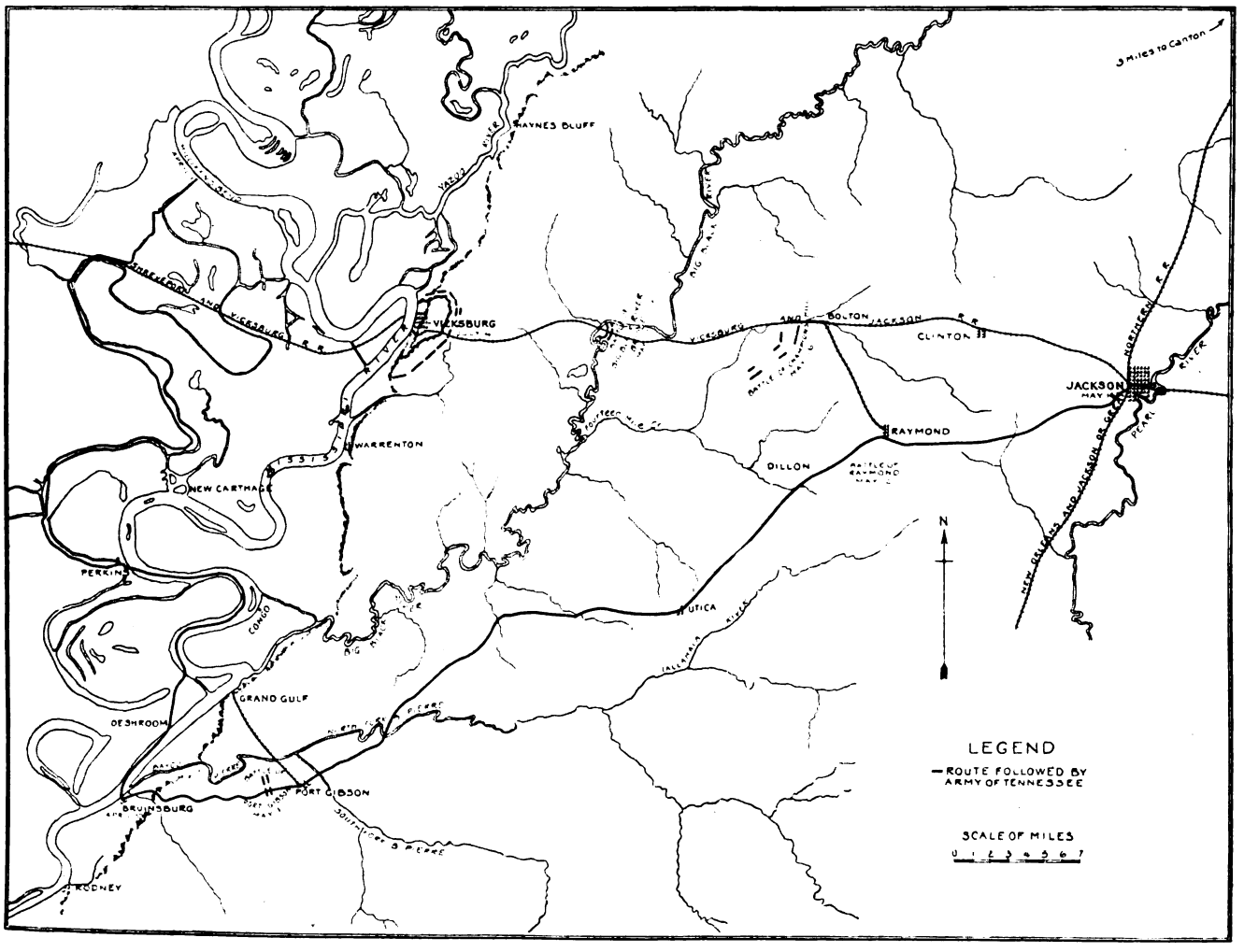
It is believed that the political conditions referred to above had something to do with Grant's determination to take the southern route. At that time he did not know the General in Chief of the Army. Halleck had no confidence in the plan of moving northward immediately after crossing the river. He had no objection to Grant's crossing the river, in fact, advised him to do so, but after doing so, to go south with about two-thirds of his army, and join Banks at Port Hudson. After reducing this place their united forces should go north and take Vicksburg. An order of Halleck forbidding the movement that Grant actually made was dated May 11th and sent by special messenger to him from Washington. It was delivered on the battlefield at Black River Bridge on the 18th, too late to be obeyed, and on the face of it an impolitic order, even if it had not been received too late. Halleck subsequently acknowledged that Grant was right and he himself was wrong.

The next thing was to find a suitable place to land on the Mississippi side of the river. Congo Landing, about 5 miles above Grand Gulf, was considered, but given up as unsuitable, as the bluffs were about five miles off, and the intervening ground low, flat, and only recently overflowed. Besides there was only one narrow road available and that unsuited to the movements of artillery.

General Grant and Admiral Porter held a conference on the question of landing, and it was decided to try to effect one on the water front of Grand Gulf itself. It was arranged that Porter, with his fleet of gunboats, would attack the batteries and silence the fire of the enemy's guns, while Grant would hold 10,000 men on transports and barges, ready to land as soon as the batteries were put out of action. It was thought that this could be done, as Porter had *81 guns*, nearly all of large caliber, to take into action, and it was known that the Confederates had only a few, and most of them of small caliber.

At 8 a. m. on the 29th of April, the gunboats went into

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Map of the country between Millikens Bend, La., and Jackson, Miss., showing route followed by the Army of the Tennessee

Taken from Atlas accompanying official records, Part VIII. Original map prepared under the direction of Lieutenant-Colonel J. H. Wilson, A. I. G., and First Lieutenant Engineers. Surveys by First Lieutenant P. C. Hains, U. S. Engineers

action, and kept up a steady bombardment for five hours, moving up and down in front of the batteries, while Grant held his men ready to land. At the end of this time, no visible impression having been made on the batteries, the gunboats, having lost heavily in men, and having been damaged, some seriously, withdrew out of range. After another conference between Porter and Grant, it was determined that it was not wise to resume the fight, though Admiral Porter expressed a willingness to do so. Herein Grant displayed that keen judgment for which he was so noted, for if an attempt had been made to land our troops on that shore front, we would surely have been repulsed.

In this fight the Navy lost 11 killed and 56 wounded—a total of 67. The Confederate loss was only 3 killed and 15 wounded, a total of 18. The damage to the gunboats was serious, that to the batteries was practically nothing. The navy had 81 guns in action, mostly large ones of 9 or 11-inch caliber. The Confederates had only 13 guns, mostly of small caliber, a 30-pounder parrot being the largest.

It was decided in an interview between Grant and Porter, after the engagement, that a landing must be found lower down the river.

We now had a sufficient number of transports and barges to ferry the army over the river with some rapidity. But we had no time to waste, for we could not expect our enemy was going to make no further resistance to our landing.

It was Grant's intention at first to go to Rodney, but during the night of the 29th he learned from reliable sources that the landing at Bruinsburg was a good one with a good road leading to Port Gibson, ten miles inland. He decided then to land at Bruinsburg, and at daylight on the 30th the ferrying began from *De Schrooms Landing, where the 13th Corps spent the night.

To cross a river of moderate size in the face of an alert and enterprising foe, of about equal strength, is as a rule, no easy proposition. The difficulties are not lessened if the river is very deep, very wide, and with a 5-mile current. Ordinarily your adversary would be watching you from his side and would be prepared to give you an enemy's welcome when you arrived. Of course we expected a royal welcome of this kind, but when we landed there was not a Confederate picket or patrol in sight. No one but a poor old negro, who was anxious to lead us to a corral where he said there were a number of horses. As very few of us had horses, this was welcome news and we proceeded to benefit by that information.

The 13th Army Corps was about 22,000 strong and after having had 3 days' rations distributed to it, was rapidly pushed out on the road toward Port Gibson. When we

(NOTE: This is spelled Deshroom on the map.—ED.)

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landed we had no idea of the piece of good luck that had fallen into our hands. The land was literally flowing with milk and honey. There was bacon and beef in abundance, corn meal and all the eatables that a hungry soldier, who had been floundering for six months in mud and swamps, could want. Not the least welcome of all things was good dry ground on which to sleep with no mosquitoes to keep us awake. The mosquitoes were so bad near Perkins Plantation that it is said two men were actually killed by them. The Army of the Tennessee actually had issued to it only five days' rations between April 30 and May 19. It lived practically on the country.

But where was the enemy? We had fought him only the day before at Grand Gulf only ten miles from Bruinsburg. Evidently the Confederate commander had been completely hoodwinked into the idea that Grant's main attack was to be on his right flank at Haynes Bluff, so he reinforced that flank and left the other to take care of itself. But why Bowen, who commanded the left wing, should have gone from Grand Gulf to Port Gibson to oppose our advance into the state, is incomprehensible from a military standpoint. He should have met us at Bruinsburg with all the force that could by any possibility have been spared from other places.

General Hovey's division, going out on the road leading to Port Gibson, came in contact with the Confederate pickets about four miles west of Port Gibson. The men on both sides rested on their arms until daylight. By the morning of May 1st, Grant had on the field or close up, five divisions, four of the 13th Corps and one of the 17th Corps. In all they amounted to about 27,000 men. Bowen had only 7,500; he himself says about 5,000. The result of the fight was, as might be expected, an overwhelming victory for the Union troops. That night Bowen fell back across Bayou Pierre and destroyed the bridge behind him. This delayed our pursuit, for as we had no ponton bridge train, the bridge had to be rebuilt of such material as could be hastily gathered together.

This first encounter was unfortunate for the Confederates as it dampened their courage and raised the spirits of our men. The battle also decided the fate of Grand Gulf which, after spiking the guns, was immediately abandoned by the enemy.

After taking possession of Grand Gulf, Grant had two lines of operations open to him, *first* the one he actually followed moving northeastward to Jackson, and *second,* the one due north, crossing the Big Black River at one or more of the ferries, from each of which fairly good roads led to Warrenton and the rear of Vicksburg. Warrenton once in our possession would have afforded a good line of operations. This line would have put our army on the weakest flank of the defenses of Vicksburg and we would have had the close co-operation of the Navy, but we would still have been under the necessity of keeping open the precarious line of supply from Millikens Bend to New Carthage or Perkins Plantation. The base that Grant was after was that at or near Haynes Bluff, which could be reached by his transports via Yazoo River.

Besides, it was important to capture Jackson and destroy its usefulness to the Confederates, and it was important to keep in view the probability of an attack from that direction after we had established our line of circumvallation around Vicksburg.

From May 1st to May 12th the time was utilized in converting Grand Gulf into a temporary base, and in getting together the fragments of our army which had become somewhat scattered. At the same time the biggest part of the army moved northeastward leisurely along the left bank of the Big Black to Fourteen Mile Creek. Grant had now gotten his troops well in hand. During this period Pemberton's army was apparently waiting for something to turn up, and it soon did. He was more fortunate than Micawber.

On May 12th McPherson, with two divisions of his corps en route to Jackson, encountered two Confederate brigades at Raymond, and after a spirited engagement lasting about two hours, drove them away toward Jackson. This was another unnecessary fight, in which we had a preponderance of three to one.

On May 14th Grant attacked Jackson, the capitol of the State of Mississippi, which was an important railroad center for the Confederates. His attack was made by two divisions of Sherman's Corps, and two divisions of McPherson's, in all about 22,000 men. The Confederate general, Joseph E. Johnston, who had just arrived and assumed command of all the forces in the vicinity, including Pemberton's command, had about 11,000 men. Jackson was supposed to be strongly fortified, but was not. The Confederates made no serious attempt to hold it and after a brief engagement hurriedly retreated northward toward Canton. The retreat was so precipitate that General Grant and his staff, who had gone to the right of our line to investigate conditions, found an unguarded road leading into the town, which they followed and were the first troops there.

McClernand had one division at Bolton, with two others in supporting distance. Grant had thrust the largest part of his army in between the two Confederate armies and the order of Johnston, that Pemberton join him via Clinton, could not be carried out. Pemberton made no attempt to carry it out. Instead, he notified Johnston that he would at once move his army southward and attack Grant's rear at or near Dillons Plantation. He started to carry out this design, but being delayed by heavy rains had only proceeded a few miles when he was overtaken by a second order from Johnston directing him to abandon Vicksburg and unite his army to that of Johnston then retreating towards Canton. Pemberton now started to comply with this last order, which was in reality a repetition of the first, when he came in contact with Hovey's Division of McClernand's Corps, which had been at Bolton and was now on the march westward toward Vicksburg. This meeting, wholly unexpected by Pemberton, brought on the battle of Champions Hill, in which the Confederates were disastrously defeated. Again it was a case of fine tactical maneuvering in which Grant brought on the field a preponderating force of not less than two to one. The Confederate loss was fully 8,000 men, including Loring's Division, which was cut off from the main body and went to Jackson. The rest of Pemberton's army fled in great disorder towards Vicksburg. Pemberton seems never to have given any serious consideration to the possible necessity of evacuating Vicksburg. Consequently when the necessity was forced on his consideration, he had made no preparation looking to that emergency and finally when he was ordered to do so, he could not obey the order.

The pursuit was taken up early on the morning of the 18th and a detachment of about 1,600 men was overtaken at Black River bridge where the detachment had been left to guard the crossing until Loring's division arrived. But Loring's division having been cut off, did not arrive. There were two bridges across the Big Black protected by a strong bridgehead, but the latter was carried by assault chiefly by Lawler's brigade of Carr's division. The

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bridges across the Big Black having been prematurely burned, the entire garrison was trapped by their own act and compelled to surrender. In this engagement our forces outnumbered the enemy at least five to one.

A bridge was hastily constructed out of the unburnt timbers of the old railroad trestle and from cotton gin buildings, before the morning of the 19th, and the 13th Army Corps immediately began to cross rapidly in pursuit of the flying enemy.

As the Confederates were supposed to be very demoralized as well as disorganized, an attempt was made on the 19th to carry the defenses of Vicksburg by assault before the enemy had time to recover their morale. It failed. After the enemy got behind their line of works they seemed to recover their spirits and made a good defense.

The 20th and 21st were spent in pushing our lines up close to their works and in getting our artillery in position.

On the morning of the 22nd after a severe bombardment of the enemy lasting two hours, from all the guns in position, about 200, aided by all the guns and mortars of Porter's fleet in the river, a fierce assault was made along the whole line, but this was also repulsed. The men who could not apparently fight in the open now fought like demons behind their fortifications. Some of our regiments succeeded in planting their colors on the parapets, but they could advance no further. That night after dark our troops were withdrawn to more secure positions and siege operations were ordered to begin at once. But we had no tools and had to wait for them to be sent from the North. The siege lasted just 42 days, only two over the number laid down in the books as allowable. On July 4th the Confederates stacked their arms just outside their works and we took possession of them. We found they had better rifles than we had, that they still had a small supply of ammunition, but they had nothing to eat. Soldiers cannot fight without somehing to eat, so they surrendered.

Pemberton was a fine looking soldier in steel gray uniform as he sat down at the table to sign the document of capitulation, but one looking at him at the time could not help pitying him. He was a broken man. He had staked everything on a policy of defense, which he doubtless realized too late was a mistake. He had now lost Vicksburg and his army as well.

Grant's Clearcut Project

When General Grant crossed the Mississippi River he had a well-defined project of operations in mind. He hoped and expected (1) to move his army northward, (2) to capture Jackson, the capital of the state, (3) to open for his own army a short line of supply via the Yazoo river, (4) to bring Pemberton, if possible, to battle in the open field, and (5) then to drive him into Vicksburg and lay siege to that place if he could not carry it by assault. If, however, this program could not be carried out, he was prepared to go south with a part or all of his army to aid Banks in the capture of Port Hudson and after capturing that place for their united armies to come up the river and capture Vicksburg.

The capture of Jackson was important because three railways, one from the north, one from the east and one from the south centered there. These roads were the main lines over which the supplies and reinforcements of the Confederate army were received. Besides, it was the left flank of the line of defense that it was supposed Pemberton would take up. To break through that line was essential to the opening of a short line of supplies for our own army. We might get along temporarily by means of the precarious line from Millikens Bend to Grand Gulf, but this was liable to be broken. The Yazoo line was safe and sure as soon as we could get possession of Haynes Bluff. Hence the haste with which Grant dispatched Sherman's Corps to that place on May 18th.

The magnitude of Grant's victory was amazing, even to ourselves. He totally destroyed an army almost as large as his own, captured 260 guns of all calibers, besides about 60,000 muskets, caused the surrender of Port Hudson with all its armament and about 6,000 more men, opened the Mississippi River to the navigation of the great northwest, broke the Confederacy into two pieces, destroyed almost absolutely all communication of the Confederacy with foreign nations, cut in two the lines of supply the Confederacy had established to Mexico, and carried dismay to the hearts of the southern people, many of whom saw in the fall of Vicksburg the downfall of the southern Confederacy. All these results were accomplished with a loss on the part of the Union forces of about 10,000 men.

To what was success due?

To what can the magnificent success of the campaign be attributed? Certainly not to overwhelming numbers in Grant's Army. The field army of the Tennessee was not greatly different from that of the Confederate Army of the Mississippi. There is an old saying that "figures do not lie," but it is well known that figures given by writers, of the numbers in contending armies, seldom agree. We can estimate, however, the number in the Confederate Army of the Mississippi, say on May 1st, which is a fair date of comparison, by working backward.

Total number of men and officers surrendered at Vicksburg on July 4th	31,600
Their loss during the siege is conservatively estimated at about	1,000
Prisoners taken at Black River Bridge, May 18th	1,600
Loring's Division (estimated) cut off in the battle of Champions Hill	5,000
Lost in the battle at Champions Hill	3,000
Lost in the battle at Jackson, May 14th	700
Lost in the battle at Raymond, May 12th	500
Lost in the battle at Port Gibson, May 1st	700
Total	44,100

(This number includes only the troops in the second or Vicksburg military district. It does not include those in the 1st, 3rd, 4th or 5th military districts. The troops in these excluded districts would have added something at least to Pemberton's total.)

The Army of the Tennessee

Number for duty as per muster rolls in the 13th Army Corps (4 divisions)	22,000
Total estimate in the 15th and 17th Corps, each consisting of 3 divisions	33,000
Total	55,000

It is to be stated, however, that there were no sick men in the Army of the Tennessee. The sick were all left behind when we crossed the river, but on the other hand the Confederate Army was on the defensive, and being on the defensive it had many advantages which the Army of the Tennessee did not have. All the intelligent people of the South were its friends and practically all were our enemies. Their means of getting information as to the numbers and organization of the opposing force were far above ours. Many of their people believed they were fighting a holy war against an invader who was stealing their property. The rank and file were practically on an equality in other respects, so that taking into consideration the conditions existing on both sides, it is fair to assume that

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the two armies were not materially different in strength.

To what then can we reasonably attribute the magnitude of the victory? First and foremost it was due to the fact not known to everybody at that time that the army of the Tennessee was commanded by one of the greatest generals in history, and had two of the best corps commanders that the Civil War produced. In all his maneuvers, both tactical and strategical, after May 1, Grant made no blunders and but few mistakes, whereas his adversary made few mistakes but many blunders. The Confederate commander may not have been in all cases responsible for the blunders, but blunders were made and they contributed in no small degree to our success.

Grant, in his "Memoirs," states that Providence dictated the Vicksburg campaign of the Army of the Tennessee. Grant was not a conspicuously religious man, nor was he an irreligious one. He possessed many Christian virtues that professing Christians did not, but for him to attribute to Providence what seems clearly to most of us as due to his own merits as a general looks as though he was overmodest in stating the case. The Army of the Tennessee, it is true, did the fighting, but he directed it. The army was the tool used. The mechanic who handled the tool was Grant. Does any one believe that if the campaign had been a failure Grant would have sought to put the blame on Providence? Not a bit of it. He would, with his inherent magnanimity have taken the whole responsibility on his own shoulders. Shall he not then have the credit for success?

To sum up in a few words, the success of the campaign was due, first, to Grant's ability as a general, second, to the valor of his army, and third, to the blunders of his adversary.

One conspicuous blunder made by our adversaries was in failing to make any provision whatever for an attack from the south. The problem for the Confederate Army was to prevent the crossing of the Mississippi River by the Union forces in such numbers as would threaten the capture of Vicksburg or the destruction of the Confederate Army protecting it.

It is obvious that if the crossing of the river could be prevented the object of the Confederate Army of the Mississippi would be achieved. The first thing, therefore, was to prevent, if possible, the crossing of the river. There was no place between Vicksburg and Grand Gulf where the river could be safely crossed, and roads found by which the army could proceed inland and attack Vicksburg. Consequently, the crossing would be made, if at all, at or below Grand Gulf. If made below Grand Gulf the army would in all probability proceed north by some of the numerous roads that existed in that section. The problem then was to prevent the crossing, and, failing that, to meet Grant's army in the field before it could be concentrated for attack. Pemberton made no effort to prevent our crossing the river, nor did he make any effort to attack us. He merely waited, apparently, to see what Grant would do.

The waiting policy is well known to military men to be dangerous, and is only justified when *it is known* that one's forces are greatly inferior in numbers or morale to those of one's antagonists. The Confederate force was not greatly inferior to ours in numbers or morale. Field fortifications constructed at important points should not then be omitted if there is a possibility that they might be needed. The importance of this is seen in the repulse of Grant's army on May 19 and 22. Field fortifications cost little and sometimes prove to be invaluable.

It must be assumed that Pemberton did not believe that Grant would land at Bruinsburg. If he had so thought he should have made some disposition to meet him. If Grant had not landed at Bruinsburg, he would have landed at some other point farther south, as Rodney. There were good roads leading from both places into the interior.

As to the possibility of attack via the Yazoo River, it was unreasonable to expect that to be repeated so soon after Sherman's disastrous failure. It was hardly probable that Grant would try that route again until the floods in the Mississippi River, which were an important factor in causing Sherman's failure, had subsided.

As to the probability of an attack from the north via the Mississippi Central Railroad, Pemberton must have known that if Grant moved his army back to Memphis it would be regarded as an acknowledgment of failure, that it would, in any case, take considerable time to do it, and that it could not be done without his knowing it. An attack by way of the Yazoo or Memphis being improbable, there was only one other route, and that led from the south. There was a probability that Grant might go south and join Banks in reducing Port Hudson. After taking which, the two armies, united, would come north to invest Vicksburg. This project would take time, but was a safe one for Grant, and it is almost certain that Grant would have taken advantage of it had his project of turning north from Grand Gulf failed.

The idea that Vicksburg was designed to protect a field army, and the field army was to protect Vicksburg, are incompatible. These duties were not dependent upon each other. If there was a field army, its place was in the field, not around Vicksburg. The army of the Mississippi was a field army, or, at least, it was used as such, and yet it was a garrison army as well. As a field army it was too small. As a garrison army it was too large.

Vicksburg, itself, was of no special value to the Confederacy except insofar as the guns mounted on the river front closed the river to navigation. How, then, were these guns to be protected? The answer to that question depends on the answer to the further question, By what would their destruction be threatened? Certainly not by a cavalry raid nor by the navy alone operating from the river. The menace could only come from a field army, and the menacing army must be met by an opposing field army. The batteries could not be protected by chaining the army to the guns, but by giving it mobility.

History abounds in records of armies that have taken refuge in fortresses where there was a large civil population. Such civil population is a great hindrance to the defense. It is an aggravated hindrance when supplies from the outside are in danger of being cut off. In that case the fortress generally falls a victim of starvation, if not to the superior force of the enemy.

It is not claimed that an army may not take *temporary* refuge in a fortress liable to investment, but the commanding general who takes his army into such a place must have the most positive assurance that it will not be left there to take care of itself. Vicksburg when once invested was completely cut off from all supplies and from all communications with the outside world. Its only hope thereafter was in a relieving army. Failing that, its doom was sealed.

It is easy to criticize, but not always easy to suggest a course that would forestall criticism. In this case, however, certain things were obvious at the time. For instance, a strongly entrenched camp should have been established from which a mobile army could operate on the front, flank or rear of an invading army from the south.

The next thing in order was the creation of a field army out of whatever forces were in the Department of the Mississippi or could be brought there. For this purpose every place of minor importance should have been alto-

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gether abandoned. If not abandoned, they should have been temporarily occupied by detachments only, made from the field army. The idea should have been inculcated and fostered that the defense of Vicksburg was dependent on a field army and not on a garrison stationed behind the forts around the town.

The field army concentrated in an entrenched camp midway between Vicksburg and Jackson would have protected Vicksburg on one flank and Jackson on the other. Haynes Bluff could be quickly reinforced from there, if necessary. The entrenched camp should have been formed by strong *enclosed* redoubts connected in whole or in part by light infantry parapets. Redoubts open in rear are liable to be taken in reverse when a part of the weaker infantry parapet is broken through, as was the case at Jackson. The lines of circumvallation at Vicksburg were about twelve miles long. They could have been reduced under these circumstances to three or four. No army could seriously threaten Vicksburg from the rear if a field army was camped at Bolton or thereabouts.

The railroad connecting Vicksburg and Jackson would have afforded the means of rapid movement of forces and made the line between the two cities a strong one for defense; beside the railroad there were several good wagon roads to supplement the railroad in the rapid concentration of troops on either flank.

Jackson was not only an important railroad center, but it had several factories where war material was manufactured for the Confederate Army. Besides, all reinforcements for the Confederate Army must naturally come by way of one of the railroads that centered at Jackson. Consequently Jackson should have been adequately fortified. The elaborate works at Black River Bridge would have been unnecessary.

Beside the above, Raymond being at an important intersection of roads, should have had a strong enclosed redoubt to be occupied when danger seemed imminent. Willow Springs should also have been fortified. Bruinsburg and Rodney should both have had advanced field works. The bluffs at both places afforded excellent sites for defensive works.

If ever a defensive campaign was fought where a force of cavalry would have had telling effect, it was the Vicksburg Campaign. When Grant crossed the Mississippi River, he did not have a single squadron of cavalry with him. Indeed, he had none to speak of at any time during the campaign. The official returns show that Pemberton had in his Department of the Mississippi on April 1, the following cavalry organizations:

Gallelyn's Mississippi Cavalry, Second Tennessee Cavalry, Martin's Cavalry Company, Johnson's Cavalry Company, Van Dyke's Cavalry, Smith's Partisan Rangers, Adams' Cavalry, First Arkansas Cavalry, First Missouri Cavalry (dismounted), Third Missouri Cavalry (dismounted), First Tennessee Cavalry, Ninth Tennessee Cavalry, Ninth Louisiana Cavalry, Bolen's Cavalry Company, Gant's Cavalry, Teny's Cavalry Company, Garland's Cavalry, First Mississippi Rangers, Miller's Cavalry.

From the above formidable list of organizations, even though some may have been mere skeletons, it would seem that a respectable cavalry force could have been organized. An insignificant force of cavalry patrolling the shore from Vicksburg to Rodney could have kept Pemberton advised of the position of Grant's force, the number of transports, the position of Porter's fleet, and other items of information of value to a commanding general. A good brigade of cavalry under a competent officer could have delayed Grant at the landing until the whole of Bowen's Division could have been deployed along the bluff.

Another blunder was made when Pemberton, on May 14, undertook to cut off Grant's communications with his base at Grand Gulf, when he ought to have known that the only one he then had was a movable one of about two hundred (200) wagons loaded principally with ammunition. Grant's Army was actually living on the country.

But the train was absolutely vital to Grant's army unti a new base could be established at Haynes Bluff.

From the Confederate standpoint the battle of Port Gibson was a blunder. If fought at all, it should have been fought at Bruinsburg, while Grant's army was being landed from the transports. Moreover, the Confederates should have had at least 20,000 men to oppose Grant at the landing, and if that number was not available it would have been better not to have fought any battle at all.

When we consider how good a fight the enemy put up at Port Gibson on May 1st and at Grand Gulf on April 29th, it is probable that a good temporary defense might have been made at Bruinsburg, even with 7,500 men. The bluffs there, being about three miles back from the river, were beyond the range of the guns of Porter's fleet.

When the map is studied, one is naturally inclined to ask what did Bowen go to Port Gibson for? The place was of no particular value to the Confederates nor to us. Under some conditions it might have been useful as a position from which Grant's line of operations from Grand Gulf, if he had kept it, could be menaced, but Grant never intended to hold Grand Gulf as a base. The paltry 7,500 men sent to Port Gibson were not capable of accomplishing anything of value.

It was a serious blunder when on April 29th, Pemberton mistook the demonstration against his right flank, made by Sherman, for a real attack and the real one on his left flank made by Grant for a feint. There was no sufficient reason for this blunder. Of course, Pemberton did not know how many men Sherman had with him in his demonstration at Haynes Bluff, nor how many men Grant had on the other flank, but it is one of the tricks of the trade to fool your adversary if possible and the adversary if he is wide awake must see to it that he is not easily fooled.

It is not claimed that Pemberton might have found out exactly how many men were in each column. But he ought to have been able to determine approximately the number Sherman had. Sherman went up the Yazoo River on transports. This river was a narrow crooked stream, heavily timbered on each side. The most incompetent secret service department ought to have been able to count the number of transports and estimate approximately the number of men on each. If Pemberton did not have any such department one should have been organized. In default of an organization, some of his soldiers could have done it with little risk.

On May 1st Sherman, having accomplished his work of frightening Pemberton into the idea that he was going to attack in force, withdrew from the Yazoo and joined Grant at Grand Gulf a few days later without fighting at all and without the loss of a single man.

The conditions at Haynes Bluff on April 29th were precisely what they were on January 1st, four months prior. At the latter time Sherman attacked that place with 35,000 men and was defeated. Was it reasonable to suppose he was about to repeat that attack with a smaller force?

Did Grant make any blunders? In the light of all the information now available, and which was not available at

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the time, it must be conceded that Grant made no blunders. Some mistakes of judgment he made, but they were few. It is believed his worst mistake was made when on May 22d he ordered an assault along the entire line in an effort to carry the enemy's works by storm. However, he had good reasons for it at the time. It was a case of assault or siege. If an assault succeeded a siege would be avoided. If it did not, a siege would follow as a matter of course.

The Army of the Tennessee was not prepared for a siege. It had no entrenching tools whatever and they could not be had in much less than ten days or two weeks from the North. There were no engineer troops in his army. Hot weather was coming on and with it would come much sickness. We were liable to be attacked in the rear by an army that it was known was being formed under Johnston for Pemberton's relief, and it was possible the relieving army might be larger than Grant could cope with in addition to that of Pemberton. Moreover, the men themselves were averse to settling down to the hard labors of a siege until after a trial had been made to take the place by storm. The men felt after the successful assaults on the works at Jackson and Black River Bridge that they were well nigh invincible. These reasons, it is believed, were sufficient to justify the order.

While we believe Grant was justified in ordering the assault, it is believed he made a tactical error in ordering it made simultaneously along the whole line. It is a military maxim that one man behind good field works is equal to three or more in the open. As the number in Grant's army at that time and place did not exceed Pemberton's by more than about 30 per cent at the most, it is easy to see that he was taking risks—that theoretically the advantage would be with the enemy. Moreover, we had been repulsed in a similar but less intense assault on the 19th when Pemberton's army was supposed to be demoralized from its recent defeats in the field.

It is believed that it would have been a better tactical arrangement to have massed, say four divisions, on some one point and have made it the assaulting column. Between the right of McClernand's Corps and the left of McPherson's, there was a far weaker place than most of the other parts of the line. A large deep ravine existed in rear of this part of the line and gave advantages for massing such a force during the night. These four divisions could have been taken, say two from McClernand's Corps and one each from McPherson's and Sherman's. Of course, an attack would have been kept up along the whole line at the same time, but not with the fierceness with which it was made under the orders received. It is not claimed that this form of attack would have succeeded, because the Confederate works were generally strong, but it is certain that the chances of success would have been better.

The Siege

The siege of Vicksburg officially began on May 23rd, the day after the unsuccessful assault. In reality it did not begin until about June 1st, as up to that time there were not tools to work with. The ground for the most part on the hills around Vicksburg was dry and hard, having almost the tenacity of indurated clay. Picks were essential as well as shovels, and it is believed there were not 100 picks in the whole army.

The deep dry bayous that intersected the neighborhood of Vicksburg afforded excellent means of approach to the near vicinity of the fortifications but in many places they formed almost impassable obstacles. They afforded us sufficient cover, however, to lay out the first parallel at an average distance of about 600 yards.

The Confederate works consisted of a series of redoubts, irregular in shape and generally open in the rear, connected by light trenches for infantry. The redoubts had a strong profile with dry ditches about 6 to 7 feet deep and from 6 to 10 feet wide. The infantry parapets had no ditches and were constructed by throwing the dirt from the trenches up in front of them. It is curious to note that the works, even for the more important redoubts, seldom provided flanking defenses for the ditches, so that when our men got into the ditch of a redoubt they were generally comparatively safe, except from lighted shells which could be rolled over the parapets from the inside. Lighted shells were used as hand grenades but there were no hand grenades at first in either army. We got some from the navy later on, but in the early stages of the siege no hand grenades were used.

The redoubts were generally built on spurs that projected out from the main line and these redoubts invariably attracted the storming parties. The redoubts were the most prominent parts of the work and the most severe fire came from them. To avoid being taken in flank the men naturally swerved toward the point from which the fiercest fire came. In that way the attacks of each division were made on the strongest points—just where the Confederates wanted them made.

By reason of the lack of engineer troops and the almost total lack of tools, progress was very slow. The fact is, the siege was carried to a successful issue by main strength and awkwardness. The men in the ranks for the most part were intelligent farmer boys who learned quickly how to handle entrenching tools, as they already knew how to handle a rifle, but it took time for them to learn. If the siege had began about the 1st of July instead of the 22nd of May, a much better showing would have been made as to speed.

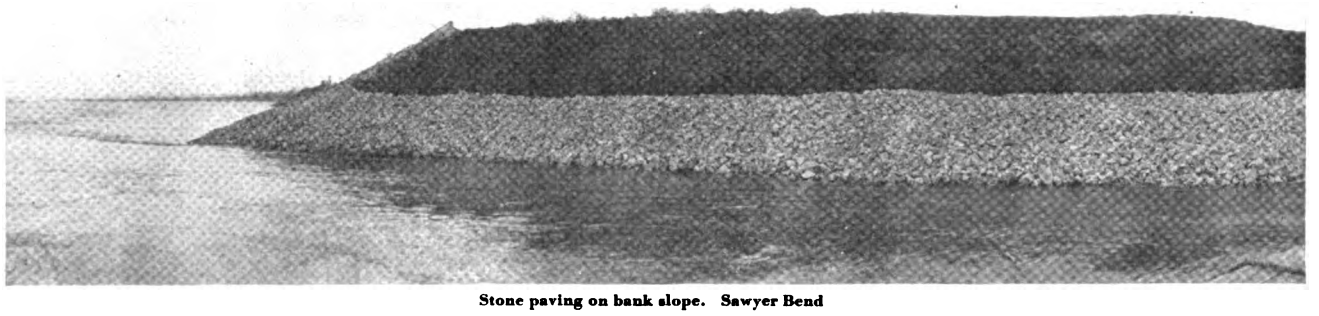
In the early days of the siege there were only two officers of Engineers serving in their professional capacity as engineers, Captain Fred Irvine and the writer. Two others were in the Army of the Tennessee, Major General McPherson, commanding the 17th Army Corps, and Lieutenant Colonel James H. Wilson, who was Grant's Inspector General. Captains Comstock, McAllister and J. M. Wilson arrived after the siege was half over.

The unscientific way in which some of the siege work was carried on is illustrated in the establishment of the second parallel in front of the 13th Corps. Lawler's Brigade, composed chiefly of Iowa troops, occupied a part of the line just where a wide deep ravine existed in front of them. The crest of the near side of this ravine was occupied by our people and that of the farther side by the Confederates. The two sets of pickets being close enough to engage in conversation (they were not more than 50 feet apart) soon became sociable and made an agreement not to fire on each other without giving warning. The Confederate picket line was exactly on the ground that we wanted for a part of the second parallel. The writer notified General Lawler that he wished to occupy that ground and requested him to advance his pickets when the two lines took their places for the night.

On the evening of June the 20th, the two picket guards deployed and started forward from their works at a double-quick on the sounding of retreat, each trying to get as far forward as possible. In this double advance the two picket lines met and then passed each other before they could be

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Stone paving on bank slope. Sawyer Bend

Regulation of Middle Mississippi River

By

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Major, Corps of Engineers — Formerly Major, 12th Engineers

[*Note.* An air of romance has clung to our great river, since the days of the aborigines, through the times when it silently witnessed the exploits of the daring explorers, La Salle and De Soto, the pioneer period immortalized in song and story by Mark Twain, Tom Sawyer and Jim Bludsoe, who are real characters in the minds of many American boys.

The Mississippi, with its great tributaries, is the largest navigable river system in the world. Millions of people live in its broad valley, and every one of them is interested in its problems. Not a few have their own solutions of these problems, as indicated by the many suggestions received by the Mississippi River Commission as to how to control "the Father of waters."

The methods employed in the regulation of the Mississippi River, in the interests of navigation and flood abatement, are based upon experience extending over many years. Major Jones has described them in most entertaining fashion in the article which follows.—ED.]

General Description and History

Geography. The "Middle Mississippi" comprises that section of the Mississippi River included between the mouths of the Mississippi and the Ohio Rivers. Considered just above the mouth of the Ohio, near Cairo, Ill., the Middle Mississippi drains an area of 707,000 square miles. It forms a central link of the great system of navigable waterways which may eventually connect the Great Lakes with the Gulf of Mexico.

Physical Characteristics. The Middle Mississippi flows through alluvial "bottoms" composed of sand and silt with occasional deposits of gravel and limited in width by lines of rocky bluffs from 3 to 7 miles apart. Above Commerce, Mo., these bluffs impose strict limits upon the lateral movements of the stream. At Commerce, however, they diverge almost at right angles to the direction of the stream and below this point exercise no restraining influence.

The river bottoms, in their natural state, are largely subject to overflow in times of flood, and are covered with heavy growths, principally of willows in the newer deposits and of mixed timber in the older. The lands are extremely fertile and have in large part been protected by levees and put into cultivation.

The bottoms contain a number of lakes and dry lakes formed by cut-offs of the stream, or the closing of chutes or minor river channels, or, in some cases, by the river having completely forsaken one bed for another. The channel of the stream was divided and obstructed by many islands, "towheads" and shifting sandbars. "Towhead" is the colloquial name given to a more or less permanent small island.

The distance from the mouth of the Missouri to the mouth of the Ohio, measured along the present river channel, is 200 miles. Measured along the line midway between the limiting bluffs, this distance is 160 miles.

Low water at the mouth of the Missouri is 395 feet above mean gulf level, and at the mouth of the Ohio 275 feet. The slope of the valley is therefore .75 foot per mile, while the mean slope of the river is about .6 foot per mile.

The banks of the stream are stationary only at points where they are artificially fixed. In general, the concave sides of the bends are marked by caving banks, while the convex sides are being built up by accretion. The river channel is constantly changing position. The river as a whole moves from side to side and the bends and straight reaches move downstream. The stream at long intervals completely abandons some section of its bed, and adopts a new channel opposite this section.

In addition to the movement of the stream bed as a whole, there is a continual shifting of the navigable channel within the bed itself. This movement is due to the changing slope of the banks and bottom of the stream, and to fluctuations in water stage, all of which influence the currents which maintain the channel.

A longitudinal section of the river shows a succession of pools and bars. The bars move downstream at varying rates with respect to the shore. Their crests rise as the water stage increases and are cut through by the current as the water falls. In general, the crest of a bar will rise about two-fifths as much as the increase in the water stage. A gradual fall of the river allows time for the crest of the bar to be washed off into the pool below, but a rapid fall leaves these crests near the surface, formerly in the unimproved river, reducing the navigable depth over some of the bars to 3¼ or 4 feet. A continued low water stage allows time for the current to deepen the channel across the bars.

In general, the pools are formed in the narrow portions of the river and in the concave bends where the current exercises a concentrated scouring action. The bars occur in the broad stretches of the river, and at points where the current is deflected diagonally across the stream from one concave bank to another.

Upon the Middle Mississippi there are about sixty of these bars, any one of which may become obstructive at

*District Engineer, St. Louis Engineer District. †Assistant Engineer, St. Louis Engineer District.

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low water stages. Many of these potential obstructions lie dormant and give no concern during a long succession of years, while a few are chronic trouble makers. At present it may be said that from eight to sixteen of these bars may be expected to rise to within 8 feet of the water surface at some period during each low-water season and to require engineering treatment in order that an 8-foot channel may be maintained. The combined length of these shallow stretches is insignificant, probably not exceeding three miles even at the lowest stages. The *average* low water depth of the main channel of the Middle Mississippi is about 18 feet. The low water discharge is about 40,000 cubic feet per second. Even at the lowest stages there is ample *water* for all purposes of navigation. The problem is to control the *sand* so as to prevent its piling up on the crests of the bars. The finer material normally carried in suspension is an important factor where shore deposits are concerned, but is relatively unimportant in its effect upon the sand bars.

Engineering problems presented

The principal engineering problems presented by the Middle Mississippi are:

(*a*) *Flood control.* The oscillation between the average annual high and low water stages is 25 feet. The extreme recorded differences are 44 feet at St. Louis and 56 feet at Cairo. The control of floods and the protection of land from overflow is in charge of The Mississippi River Commission, acting under The Chief of Engineers and The Secretary of War.

(*b*) *Protection of land against erosion—Reclamation—Irrigation.* The Middle Mississippi presents possibilities for such works, but the Federal Government has never undertaken them. Works designed primarily for flood control or channel improvement have, in many cases, the secondary result of protecting land from erosion by the current. Although riparian interests are constantly striving to secure governmental action in saving private property from destruction by the river, such work has never been recognized as of such national importance as to warrant independent Federal action.

(*c*) *Water-power development.* Possibilities exist for power development on the Middle Mississippi, but definite projects have not as yet advanced beyond preliminary investigations.

(*d*) *Terminal facilities.* Terminal and unloading facilities have been constructed and maintained by municipalities and private interests. The Federal Government, in connection with channel improvement, has protected these facilities and provided a proper channel to give access to them.

The usual river landing or "levee" consists of a paved ramp, or incline, extending along a section of the river from high to low water limits. Recent municipal and private installations at St. Louis include pile docks extending to deep water and carrying freight handling machinery and a concrete dock with vertical wall to deep water and carrying modern machinery and freight houses. Within the past year the Federal Government has undertaken to construct certain terminal facilities at St. Louis.

(*e*) *Channel improvement and maintenance.* Channel improvement and maintenance is the duty of the District Engineer of the St. Louis Engineer District of the Engineer Department at Large, acting under the Division Engineer Western Division, The Chief of Engineers, and The Secretary of War.

Generally speaking, the work consists in stabilizing the river bed and the main river currents as far as possible, so as to prevent the formation of obstructive bars and to decrease the difficulty to navigators of knowing and following the channel, the prompt removal of bars when formed, and the removal of snags, wrecks, and other obstructions to navigation. Maintenance of river lights and other aids to navigation is a function of the Lighthouse service. The Engineer Department supplements this work by marking with buoys all dredged channels and difficult crossings. A crossing, as the term is here used, means a stretch in which vessels pass from a navigable channel on one side of the river to that on the other; usually this will be a reach between two bends in opposite directions.

District organization

In order to accomplish the improvement of the Middle Mississippi River, the St. Louis Engineer District is organized into an office force, a field force, and an engineer depot.

Office organization—

The District office comprises:

(*a*) *An engineering section* which develops plans, for channel improvement in accordance with approved projects, recommends the adoption of sub-projects and the distribution of available funds, designs the necessary engineering works, organizes the field forces and supervises the actual construction of the engineering work.

(*b*) *A clerical and accounts section* which handles all money accounts, disbursements, civil service and general records, property accounts and miscellaneous business.

(*c*) *A drafting and map section* which directs the necessary surveys, prepares maps, supervises gage readings and keeps the necessary records.

Field organization—

The field forces vary in strength and composition, each party being organized and equipped to perform its own definite duty as described in detail hereafter.

Engineer depot—

The depot is maintained at St. Louis, Mo., and consists of the various shops necessary to maintain the river fleet, machinery and equipment, a subsistence section to handle rations for the working forces, a property section to handle property and the purchases of fuel and supplies, and a force of watchmen and shipkeepers to protect the fleet.

Improvement projects

Original condition of channel—

In its natural condition, the channel of the Middle Mississippi was obstructed by many snags. The stream was divided at many places, even at low water stages, into several separate channels or chutes, and the sand bars reduced the navigable low water channel depths in places to as low as 3½ or 4 feet. The constantly shifting channel required skillful piloting for navigation and the great fluctuation of water stage made construction of loading and transfer facilities difficult. Despite these adverse channel conditions, the rapid development of the Mississippi Valley, the absence of railroads, the development of the steamboat, and the imperative demand for transportation facilities produced a great and thriving river traffic. As early as 1836, the Federal Government provided small amounts of money for the improvement of St. Louis harbor. At this time, the annual river traffic at St. Louis approached 500,000 tons. With the rapid growth of commerce upon the river, the Federal Government, in a small way, under-

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took to make navigation less dangerous by the removal of snags and wrecks from the channel. It was not, however, until 1872 that a Board of Engineers presented a definite project for the improvement of any part of the Middle Mississippi. Curiously enough, this year marks approximately the peak of the curve showing annual river traffic at St. Louis. At this time the annual average of freight handled by water at St. Louis approached 2,000,000 tons Since 1872, the river channel has been steadily improved, but river traffic, due to causes other than channel conditions (chiefly railroad development), has steadily declined until at our entrance into the World War it amounted at St. Louis to less than 150,000 tons annually. During the past three years Government activity in water transportation has greatly stimulated the river traffic.

The project of 1872—

This project was concerned with the improvement of the river in the immediate vicinity of St. Louis and included recommendation for a survey of the river as far south as Cairo.

The theory of the original and all later projects is that the stream bed must be fixed by means of bank revetments, walls or dikes, that the channel width must be reduced where excessive, and that the low water flow must be forced into the main channel by the closing of the chutes and secondary channels. The purpose is to maintain a gently winding course rather than to shorten or straighten the channel. It is folly for man to violently oppose nature on the Great River.

The true object to be attained is the regulation of the movement of the *shifting river sands.* The current is the great regulating power, the engineering devices being but the harness used to apply the power of the current. Experience and experiment have changed the details of engineering construction, but the current remained the sole moving power until 1896 when it was supplemented by the hydraulic dredge.

About $1,500,000 was expended under the original project. Dikes, training walls and revetments were constructed in the vicinity of St. Louis, and the survey was completed to Cairo.

Existing project, 1881—

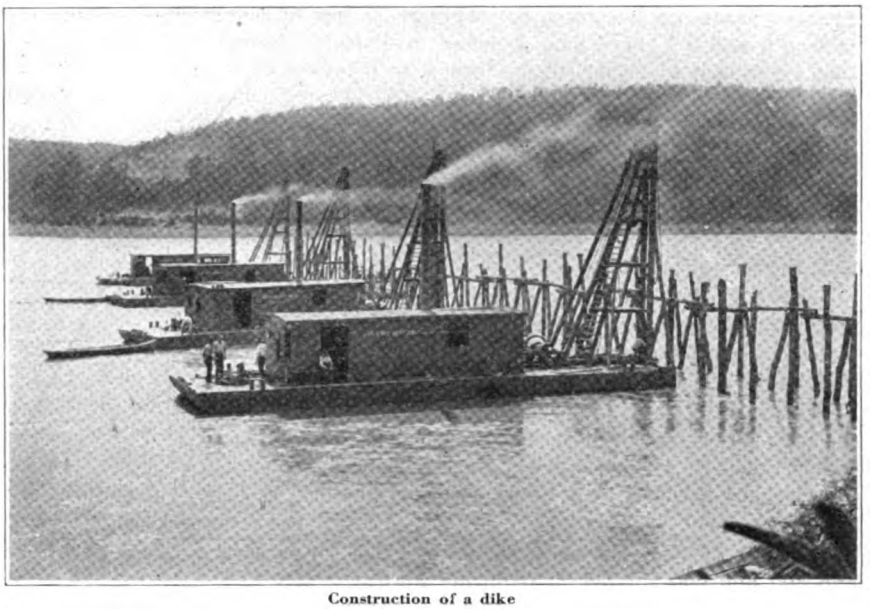
The existing project, as originally submitted in 1881, was to make the improvement continuous, working downstream from St. Louis. The banks were to be stabilized by revetments; the widths, where excessive, to be reduced to 2,500 feet by dikes; the side channels were to be closed by dikes or dams. By these means, it was intended to maintain a low water channel depth of at least 8 feet.

This project was interrupted and practically abrogated by acts of Congress in later years, but was restored by the Rivers and Harbors Act of 1910, which also provided for maintenance by dredging which had been employed upon the Middle Mississippi since 1896. The revised project contemplated a minimum low water channel width of 200 feet and a low water depth of 8 feet from St. Louis to the mouth of the Ohio and of 6 feet from St. Louis to the mouth of the Missouri. The project was to be completed in a period of 12 years at an estimated cost of $21,000,000 in addition to the $13,000,000 already expended. After completion of the project maintenance costs would, according to estimates, be $400,000 per year.

Work upon the revised project, amounting to about $1,000,000 annually, was pushed forward until 1914 when appropriations were cut to about $300,000 per year—a sum sufficient for maintenance and dredging only. Since 1914, no new work has been done except where necessary as a step in maintenance of existing works. At present, the project is about one-third completed. The present day cost of completion is estimated at $25,000,000 to $30,000,000.

Location and works of improvement

Each section requiring improvement must be studied carefully in connection with the proposed works above and below the section, and conclusions must be reached as to the character and exact location of the regulating works required in the section to insure that the general scheme of improvement will be maintained. In general, experience has shown that mattress and stone bank revetments have proved successful in the concave bends, and that permeable dikes or hurdles have been successful on convex banks where it is desired to hold or build up the shore, and in chutes and side channels to be closed. Revetments on convex banks are superfluous and hurdles or dikes placed in concave bends are ineffective. The general plan of fixing or contracting a channel is to fix the concave side of the bend by revetting the bank, and if contraction be required, to accomplish it by construction of hurdles on the convex shore approximately at right angles to the current. Detailed descriptions of the construction of the engineering works used on the Middle Mississippi are given below:



Construction of a dike

Materials of construction

The principal materials used in construction of hurdles and bank revetments are piles, brush or lumber for mattress construction, stone and spalls for revetments and ballasting, wire and nails. These are generally found within the district, and are procured either by hired labor or by purchase.

Piles are delivered by contractors to designated localities

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as required, or are loaded on Government barges and towed by Government steamers. Two general classes of piles are used. Piles of the first class are cypress or white oak, not less than 10 inches in diameter at the small end, exclusive of bark, nor more than 20 inches in diameter at the large end. Lengths range from 36 feet to 65 feet. Piles of the second class are cottonwood, cypress, oak, hickory, elm, pecan or sycamore, not less than 8 inches in diameter at the small end, exclusive of bark, nor more than 18 inches in diameter at the large end. Lengths range from 30 feet to 65 feet.

Willow brush or cull lumber, depending on the available supply of willows and the cost of lumber, is used in construction of subaqueous mattress for hurdles and bank revetment. The supply of willows depends on the rate of use as well as the extent of bar formation which is promoted by hurdle construction. The increased cost of lumber has of late years considerably decreased its use. Desirable willows are live fresh cut saplings 30 feet or more in length and not more than 4 inches in diameter, except that 5 per cent of larger brush, from 4 to 6 inches in diameter, may be used.

Mattress lumber must be of sound live timber, cut not more than three months before being sawed, free from large knots, shakes, brittleness and other defects rendering it unfit for use. The boards are 1 inch in thickness, not less than 12 feet in length and 4 inches in width, nor more than 6 inches in width.

Stone and spalls must be of such kind and quality of rock as will not deteriorate under action of the elements, and stone must be in pieces weighing not more than 100 pounds nor less than 20 pounds.

Wire is soft steel, annealed, usually about 0.08-inch in diameter. It is made into lashings of four wires or twisted into strands of sixteen wires. Approximately 3 pounds of wire are used to each linear foot of standard width mattress.

Nails are of steel wire in sizes 10d and 20d for lumber, and 20d and 60d for brush, requiring approximately one-half pound per linear foot of mattress. Square steel boat spikes, ¼ inch by 6 inches, are used for clamping wire strands in mattress construction and in clumping piles.

Permeable dikes or hurdles

A hurdle, as the term is here used, is a silt-arresting device, consisting essentially of a row or parallel rows of piles, driven usually in clumps, forming a permeable dike through which the silt-laden current can pass, but with greatly diminished velocity, resulting in deposits of silt above and below the hurdle, which are soon overgrown with willows. Hurdle lines have generally been built normal to the direction of river flow or slightly inclined upstream therefrom.

A hurdle construction plant includes a number of pile-drivers, usually four to eight, each with its crew, small flatboats, at least two to each pile-driver, a derrick-boat for transferring piles from barges to flatboats, one or more steam tenders or small steamboats, a complete mattress construction outfit, including bank paving force, one or more quarterboats for quartering and subsisting men, field office, blacksmith shop, store boat, etc., the total force varying from less than one hundred to two hundred or more men, depending upon the amount of work to be done.

A broad flexible mattress is first sunk on the hurdle line to prevent loss of the piles by scour and through this mattress the piles are driven. In order to provide an apron to catch the overfall due to the head, about two-thirds of the mattress width is placed below the piling line. At the shore end, the bank is protected against scouring or caving by a revetment about 300 feet in length, of which two-thirds is placed below the hurdle. Mattress and revetment for hurdles are very similar to those described under bank revetment.

For many years hurdles have been constructed of clumps of piles, generally three, though sometimes four piles to a clump. The clumps are grouped in rows of one, two or three to a hurdle. The piles are driven so that when their upper ends are drawn together by means of a wire rope they form a sort of pyramidal structure, the horizontal distance of the piles from each other at the surface of the river bed being 8 to 10 feet, depending mainly on the depth of the water. About one pile to the linear foot of hurdle is required.

The tops of the piles are generally at an elevation of 20 feet above extreme low water, except that in the upstream row, the top of one pile in each clump is at an elevation of about 25 feet above that stage in order to intercept drift at high stages and prevent it from crossing the line of hurdle and dragging the top of the latter with it.

Since 1913, outer ends of hurdles have been sloped down to an elevation lower than the remainder of the hurdle. This is done to conform to the bank slope of the ideal cross-section, to diminish the resistance to the current, and to lessen the cost. These outer heights have varied from the 17-foot to the 14-foot stage, depending on the stage of the river at the time of construction.

Previous to the World War the usual cost of hurdles did not exceed $25.00 per linear foot. Repairs varied from $10.00 to $20.00 per linear foot, according to circumstances. With the general rise in wages and in costs of materials of all kinds, construction and repair costs have practically doubled.

A hurdle, as at present constructed, is subject to attack by scouring action at its outer end, breaching during high stages and the action of ice. The scouring action is set up by the increase in current and depth, and the eddy which tends to form below the hurdle, due to the side contraction of the channel, and becomes less violent with the enlargement of the narrower but deeper channel. Scouring and loss of piling, etc., are prevented by building a section of mattress and hurdles at the outer end at right angles to the general line of hurdle (parallel with the bank) forming a T-head, and by liberal use of stone ballast.

Breaching may occur at any point, particularly at the shore end, where it may be avoided by careful attention to the bank paving. Accumulations of drift may cause breaches through scour induced underneath or around the shore end. Drift may be sunk by overlaying it with a light mattress of brush, lumber or of woven wire, and ballasting with stone. When sunk it solidifies and strengthens the hurdle.

When in large fields and passing at rather high stages, ice is destructive to hurdles in deep water. It is preferable to construct hurdles during the spring season, when the fill from succeeding rises will generally reduce the depth so that ice of the following winter will be harmless. Loss at the outer end is minimized by extending the hurdle to fairly deep water and by constructing substantial buttresses of stone.

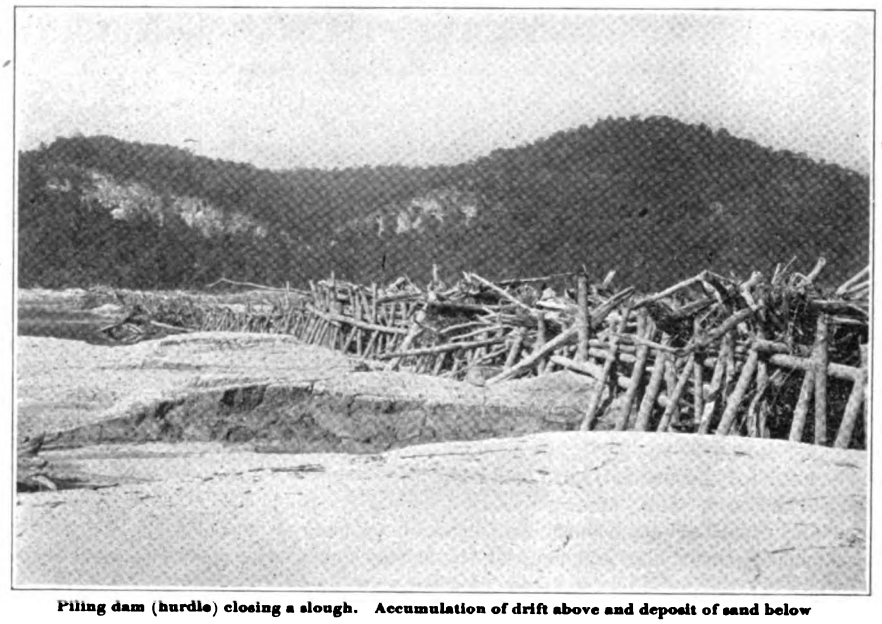
The earliest form of channel construction devices were stone dikes, which were built at a number of localities from 1872 to 1879. They were constructed on foundations of brush held in place by piles, the brush being placed in

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layers alternately parallel to and across the current and with the greater part of the width downstream from the crest of the structure to protect the bottom against scour by overfall. Stone was dumped on this foundation and allowed to take its natural slope until the crest had reached the required height, usually 10 to 15 feet above extreme low water. These structures gave increased channel depths locally, but, being difficult to maintain on account of the overfall, they were abandoned in favor of permeable dikes, which build up new dikes and thereby, in a measure, protect themselves.

Permeable dikes, or hurdles, as first used in 1879, were spaced about 300 feet apart, and consisted of a brush mattress foundation with a single row of piles driven 5 feet apart. The length of the hurdles and their distances apart were determined by local conditions, such as currents, velocities, and depths. These permeable dikes gave results much more satisfactory than the solid dikes and secured thick deposits of sediment, but being frail and low in height, did not build up new banks high enough for revetments.

Hurdles were gradually made stronger, first by driving the piles in two rows and bracing the upper row against the lower by means of diagonals and later by grouping the piles in clumps of three or four, driving two or three rows of clumps, depending on the depth of water. The diagonal braces were omitted, but horizontal stringers (piles) were placed between the rows, binding and bracing all clumps together and equalizing the strains thereon. This distance between dike lines has been increased from 300 feet to 1,000 feet, using approximately the same number of piles in one hurdle as were formerly used in three. The penetration of piles, which at first was sometimes as little as 5 feet, has been increased to 20 feet by the use of the water jet and improved pile-driving machinery. At first, for greater ease in pile driving, the foundation mattress was placed around the piles after they were driven, but it was found that scouring of the river bottom, induced by the piling, often proceeded so rapidly as to endanger the structure and prevent placing the mattress. The method was changed and, at the present time, the foundation mattress is always placed first and the piles are sharpened and driven through it, butts down.



Piling dam (hurdle) closing a slough. Accumulation of drift above and deposit of sand below

Portable jetties

Experiments were formerly made with cheap devices, designed to concentrate the water at shoal places and by increasing its velocity to induce sufficient scour to give a channel depth sufficient for the pressing needs of navigation. These devices were to be removed as soon as they had effected their object or the river had risen.

The system may be briefly described as follows: Having determined upon a direction that should be given to the jetty in order to produce the best results and admit of the easiest possible construction, piles are driven along this line at intervals varying from 10 to 20 feet, depending upon the depth of water and the strength of current. In extreme cases, instead of single piles, clumps of two or three may be driven. Along these piles, at a proper distance above the water surface, other piles are made fast longitudinally by wire or rope. These stringers are to support the upper ends of corrugated sheet-metal panels, the lower ends of which are to rest upon the bottom of the river. Each panel is 10 feet in width, measured in the direction of the jetty, and from 10 to 20 feet long, depending upon the depth of the water in which it is to be used. It is made of No. 14 U. S. standard corrugated sheet metal, riveted to three 5-inch I-beams, 12.5 pounds per foot. Suitable links or clevises are provided for handling the panels. To prevent scour taking place along the lower edge of the panels, and thus permitting them to swing through between the piles, a mattress 8 to 10 feet wide is made by placing small fascines side by side. This is tied to the lower edge of the panels and sunk with stone.

At the end of the low-water season the jetties are removed. The panels are taken up, cleaned, painted and stored. The piles are also removed, to be used in future work.

The total cost was $3.00 to $4.00 per linear foot.

The results of this device, though positive, were meager. Since a gain in depth exceeding 1 to 2 feet was rarely attained, this form of improvement was abandoned in 1899, coincident with the development of dredging, which gives better and quicker results.

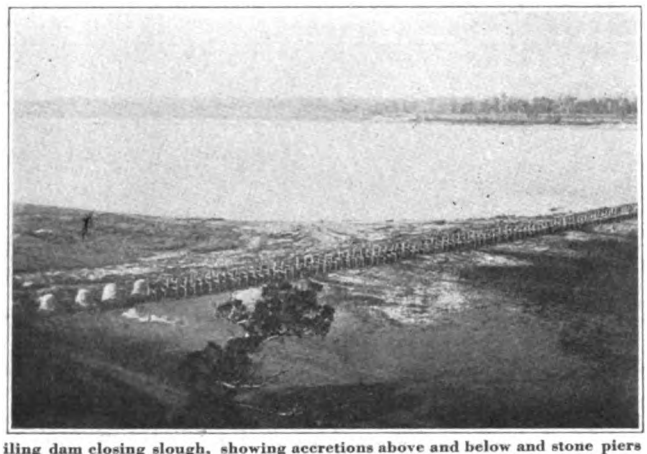
Bank revetment

The protection of caving banks in this reach of the Mississippi was commenced at Sawyers Bend, in the northern harbor of St. Louis, Mo. The project for this work contemplated a continuous foot-wall or dike of brush and stone placed at and below low water for the support of a continuous revetment of stone extending from low water to the top of the bank on a slope of 2 horizontal to 1 vertical. Construction under this project was begun in 1872 and continued to 1875, with minor repairs in 1877 and 1878, since which last date no work has been done in this locality.

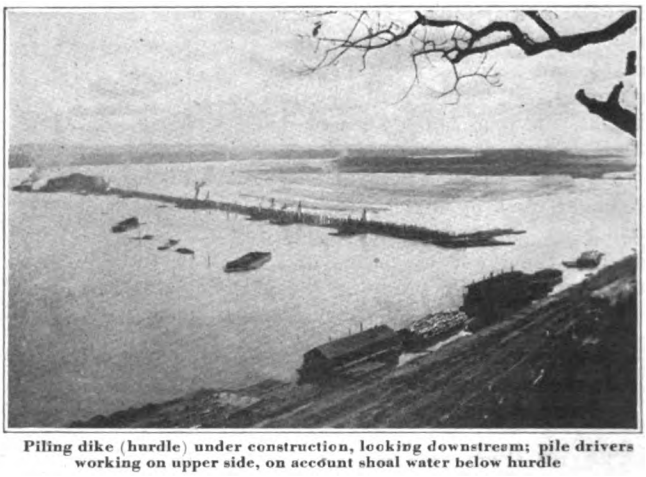
The above-water section of the work was proposed of the form then and now in common use. The subaqueous protection was one of the earliest attempts to prevent deep-water erosion upon the Mississippi River in its alluvial sec-

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tions. At the foot of the sloping bank a longitudinal trench was excavated by a dredge to a depth of 8 feet below lowest water. A loose mass of brush was placed in the trench with its top extending outward into the stream in order to protect the base from scour. Upon the brush was piled stone to a height of 6 feet above lowest water, giving the structure a height of 14 feet. 4,745 linear feet of this wall or dike was built, and for 1,118 feet of its lower end a continuous revetment of stone was carried from the top of the dike to the top of the bank. For the temporary protection of a part of the bank at the close of the working season a number of stone cross dikes 6 feet high and 50 feet long were built upon the sloping bank at intervals of 120 feet. The cross dikes served the purpose so well and proved so much more economical than the continuous revetment that they



iling dam closing slough, showing accretions above and below and stone piers (shore end) over rock ledge



Piling dike (hurdle) under construction, looking downstream; pile drivers working on upper side, on account shoal water below hurdle

were used for the protection of the remaining 3,627 feet of the above-water bank. This protection served its purpose well and is still in good condition, although untouched for twenty-two years. The efficiency of the subaqueous section of the work is probably due to the relatively stable character of the bank and small depth of water, which was only about 18 feet in 1872, and is from 20 to 25 feet at low water at the present time. With a depth of 40 feet, such as is commonly found in front of caving banks between St. Louis and Cairo, it seems hardly probable that such a form of construction would have withstood undermining. Its cost, $21.50 per linear foot, was also high.

From 1875 to 1881 subaqueous protection was sought by rafts of brush that were built upon the water surface on a grillage of poles spaced about 6 feet in each direction, and upon which were placed two layers of brush held in place by cross poles and securely bound together. The total width of the protection afforded thereby varied from 40 to 70 feet, dependent upon the length of the brush, the tops of which extended outward into the stream. The rafts were built in sections, which attained, in 1881, a length of 700 feet and were designated mattresses or mats. In relatively shoal water this protection was effective, but in deep, swift water, with active bottom erosion, they failed to hold the bank. Their failure was, no doubt, due to insufficient width, with undercutting on the stream edge, such as would occur with any form of construction that did not reach the foot of the eroding slope.

In 1881 the form of subaqueous protection was adopted that has since remained in use, with changes only as to details. For a time, lumber was substituted for brush in this construction. Briefly stated, this protection consists of a woven or wattled mattress of willow or cottonwood brush, preferably the former, on account of its greater flexibility. Having but one thickness of brush, woven upon poles, this mattress is thin and flexible. Sufficient strength during construction and sinking is secured by ample fastenings of nails, spikes, wire and cables. In form and handling it does not differ materially from the lumber mattress hereafter described in detail.

The standard width for these mattresses is 125 feet, and they ordinarily are made continuous for each locality, any break in continuity being due to external or unforeseen causes. Lengths of from 5,000 to 10,000 feet have been built, launched and sunk in ordinary work. When firmly settled and held upon the bottom with sufficient stone ballast, they have furnished permanent protection to underwater slopes reaching to the normal and full depth of 40 feet. The few known failures have been due to undercutting of the outer edges of mattresses laid in shoal water which was subsequently greatly deepened by changes of regimen. The protected banks include all classes of material from tough clay to alluvium and nearly clear sand.

Location, limits and references. The location of each bank protection is determined in advance and plainly marked in 100-foot sections with substantial stakes.

The District Engineer determines the widths of mattresses and paving at each locality, and the lengths and lap of mattresses if built in sections. In swift current or very deep water, mattresses sometimes may be made and sunk in 500 to 1,000-foot sections, but ordinarily mattress is made downstream in one continuous section, and of such width as will cover a bank zone at least one hundred and twenty-five (125) feet wide below standard low water.

The inner or shore edge of the mattress is placed as near standard low water as practicable and consistent with expeditious work. If placed at a higher stage, the required width of mattress may be more than 125 feet.

Paving is continuous on a slope of 2½ horizontal and 1 vertical, from the inner edge of the mattress to the top of the river bank, or to such lower level as may be determined upon.

Time when work may be carried on. As a rule, mattress work is done only when the river is below the mean stage (12.6 feet St. Louis gauge), which, on an average, obtains from July to March. Usually the river falls gradually from about the mean stage, in the early part of August, to extreme low water caused by ice, in December. It is during this period, about 125 fair working days, that bank protection can be carried on to the best advantage.

After the mattress is placed, bank paving may be car-

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ried on at any time when the bank to be paved is not submerged.

Preparation of site. All logs, snags, stumps, trees and other obstructions, that will prevent the mattress from lying evenly and in contact with the river bed, are removed. The mattress is then constructed of lumber as described below, or of brush.

Brush mattress is very similar to lumber, except that laps or splices are made about 50 per cent longer when brush is used.

Lumber mattress. Construction is begun by laying across the foot of launching ways, mounted on flat boats or weaving barge, three thicknesses of boards, breaking joints not less than three feet, and thoroughly nailed and wired together to form the bottom half of a header, or clamp, at the upstream end of the mattress.

On the bottom half of the header and at right angles thereto, selected boards, called weavers, are laid in double thickness and spaced about 4 feet apart, depending upon the pliability of the boards to be woven; the ends of these weavers are securely wired and spiked to the bottom half of the header. As a rule, each weaver is made continuous throughout the length of the mattress by lap splicing not less than 3 feet, and is nailed along the lap and lashed with wire at each end thereof.



U. S. Dredge "Fort Chartres" (No. 6) laid up in winter harbor

The lumber in the main body of the mattress is woven parallel to the header, under and over the ends of the system of weavers, and is then shoved down along the weavers in courses spaced not more than 4 inches apart. Weaving progresses simultaneously from the inner and outer edges of the mattress toward the middle. Wherever a board fails to reach a weaver, the next board in that course laps back to the last weaver caught. In weaving, one gang of laborers is employed on each side of the mattress, with one or more additional gangs in the middle, depending on the width of the mattress.

In each successive course, the boards are passed under and over those weavers that the preceding course passed over and under, respectively, and the board ends are shifted to break joints from one to three weavers to avoid continuous lines of splices.

All ends of boards are left above the weavers, except at inmost and outmost weavers, where every fourth or fifth end is woven underneath, all woven boards are securely nailed to each weaver passed over.

Top planks, or longitudinal binders, are laid on top of the woven boards directly over the weavers, breaking joints with them and with adjacent top planks, are lap-spliced not less than 3 feet, and are securely spiked and wired to the weaver at intervals of about 5 feet.

The top half of the header, similar to the bottom half, is placed on the ends of the top planks directly over the bottom half and breaking joints with it. The whole is thoroughly spiked and wired together to form a strong clamp for the ends of the top planks and weavers across the upstream end of the mattress. To give suitable connection for head lines to anchorages, a second clamp, similar to the header, is generally constructed 5 to 10 feet therefrom, and a similar but lighter clamp completes the downstream end of each section of mattress.

To act as cross binders, double or triple thicknesses of boards, as needed, spaced about 25 feet apart or at every launch of mattress from the ways, are laid across the top planks for the entire width of the mattress, are lap-spliced at least 3 feet, and are spiked and wired to weavers and top planks.

When mattress is to be sunk along steep, submerged banks or in swift current, cribs of sufficient depth to hold the sinking stone in place are formed, along either or both edges or over the entire mattress, as may be required, by increasing the thickness or ordinary top planks and cross binders, and, in special cases, by adding intermediate cross binders, all of the required thickness, thoroughly spiked and wired in position.

From ten to twenty wire strands are fastened to the header and weavers, and usually are made continuous throughout the mattress, each strand is twined around its weaver and top plank, is drawn taut with blocks and tackle, or capstan, and clamped at each turn with ¼-inch by 6-inch spikes. The number of strands used varies with velocity of current and depth of water. Usually one strand is placed on each of the first four to six outer weavers, and the spacing then increases toward the inner edges of the mattress. In gentle current, strands are omitted on the two to six inner weavers. After the mattress is launched off the ways, all wire lashings are tightened and all weavers, top planks, cross binders and woven lumber that may have been broken in launching are repaired.

Sinking of mattress. The mattress is held in position ready for sinking with the necessary complement of head lines and body lines made fast ashore and under equal strains, and a barge load of stone is moored at the water upstream corner of the mattress.

The upstream end of the mattress is supported by 10 to 15 slip lines from a mooring barge, or flat boats, and is ballasted for a length of about 10 feet with as much stone as the slip lines and stiffness of mattress will allow. Slip lines from flat boats are also used when needed to support the mattress along its outer edge and middle portion. The ballasting is then gradually extended downstream and carried over a length of 150 to 300 feet with just enough stone to take the buoyancy from the mattress. The first 150 feet is sunk deep enough to permit swinging the now partly unloaded stone barge across it, stone is rapidly thrown from each side of the barge as it is swung across, and, by slackening the slip lines, the head of the mattress is steadily lowered to the river bottom.

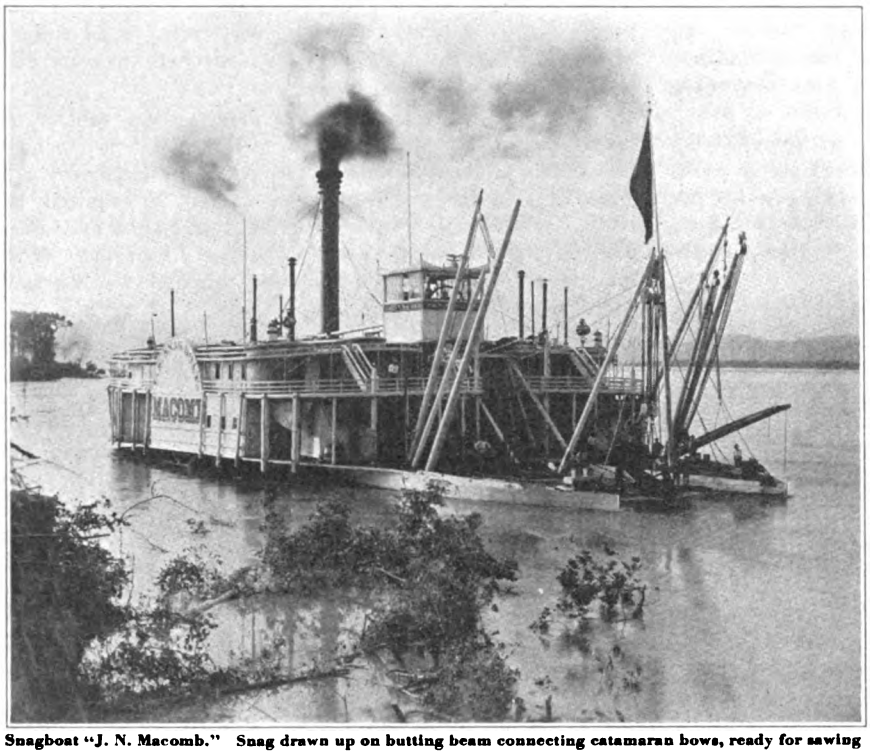
After the head of the mattress is sunk, sinking the remainder proceeds more slowly, and usually without prior ballasting. The stone barge is dropped broadside over the mattress and about as much mattress is sunk each day as is made.

When mattress is built and sunk in sections, an entire section is ballasted before sinking.

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All stone placed on mattress must be evenly distributed and not dropped or thrown with sufficient force to break or injure the mattress.

The mattress, when completed, requires on each 10,000 square feet not less than 50 cubic yards of stone evenly distributed. An additional 50 to 100 cubic yards more than necessary for sinking is required on the upstream of 10,000 square feet of each section of mattress.



Snagboat "J. N. Macomb." Snag drawn up on butting beam connecting catamaran bows, ready for sawing

More stone is used if needed to shape the mattress to the river bed and secure close contact therewith.

Irregular bank and broken mattress. In bays or other indentations in the shore line, to which it is not practicable to fit the main section of mattress, a "pocket" mattress is placed, generally after sinking the main section, to make substantial connection between the inner edge of main mattress and the shore. Should mattress be broken in sinking, the break is covered with a second overlying mattress.

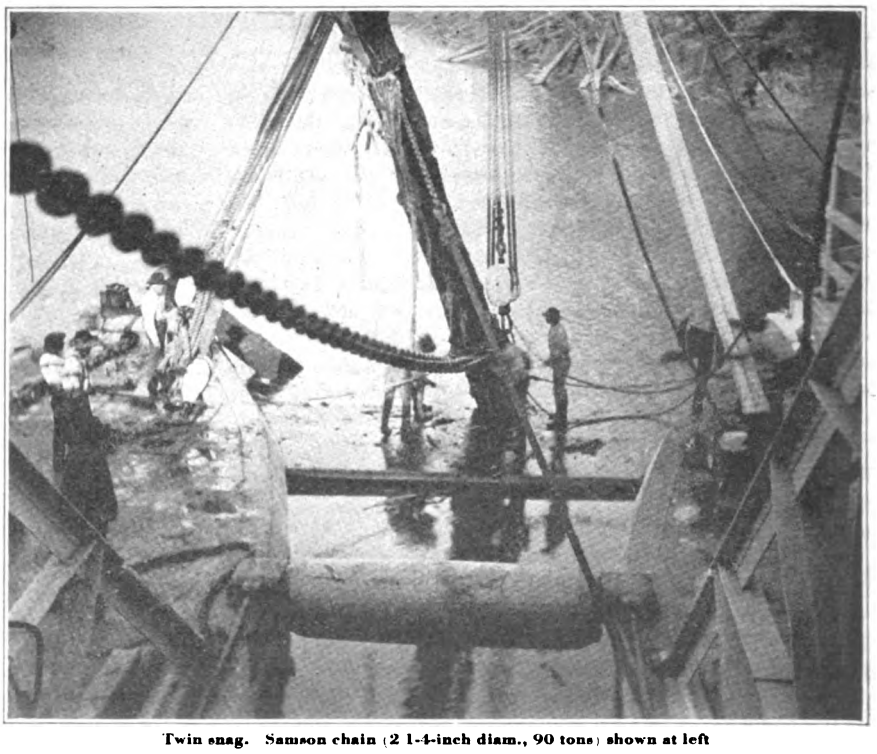
Grading. The bank above the inner edge of the mattress is graded on a regular slope 2½ horizontal to 1 vertical to such height as may be required. All logs, trees, snags, stumps and other obstructions are removed and the slope, when finished, presents a neat, even surface.

If grading is done with a water jet after the mattress has been sunk, a thick coat of spalls may be required along the inner edge of the mattress to prevent gullies being washed thereunder. No filling, unless of spalls or water-tamped earth, is permitted in making the required bank slope.

Paving. Paving is riprap stone compactly and evenly laid in a single layer 12 to 14 inches thick and extended from the inner edge of the mattress up to the graded bank slope to the required height, each stone being placed by hand, in contact and breaking joints with the preceding course and without jutting markedly above the general top surface. One cubic yard of stone covers about twenty-five (25) square feet of bank slope. Spalls are used, as needed, along the inner edge of the mattress to fill holes, furnish a footing for and filling between paving stone and form a good connection between mattress and paving. The total quantity of spalls used does not exceed 25 per cent of the total quantity of riprap stone.

Working force. The force required for mattress construction is about 86 men, in addition to the boarding crew of about 10 men, and is composed of the following classes of labor: 1 overseer, 3 foremen, 1 shipkeeper, 6 boatmen and linesmen, 75 laborers divided as follows: 9 wire cutters, twisters and cable makers; 18 unloading and passing lumber; 18 weaving; 18 nailing, repairing, tightening cables, etc.; 12 sinking.

The cost of subaqueous mattress of standard width, and of standard bank paving, was, prior to the war, about $5.00 per linear foot each. At present the cost is fully 100 per cent greater.



Twin snag. Samson chain (2 1-4-inch diam., 90 tons) shown at left

The first use of a hydraulic dredge to aid navigation on the Middle Mississippi was made near Cape Girardeau, Mo., in the fall of 1894, with an experimental dredge built by the Mississippi River Commission about one year earlier. This

(Continued on Page 272)

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The Officers' Reserve Corps and the Organized Reserves

Their Place in Our Policy of Defense

By

William G. Haan

Major General, U. S. Army

Director of the War Plans Division, General Staff, U. S. A.

[*Note.*—Measured by the march of events, rather than by the flight of time, the engineering profession has long been interested in the Reserve Corps. The echoes of the first shock of arms in 1914 had scarcely ceased to sound before some of the leaders visualized in some degree the role of engineering science in modern warfare. Within six months after the first battle of the Marne a small group of farseeing men met in New York to discuss means and methods whereby the engineers in civil life might prepare for service in the war which they so truly anticipated was bound to come.

This little group of pioneers decided that, given proper legislation, the engineers could and would organize a Reserve Corps to be called into active military service when the hour should strike. Committees were formed to lay the matter before the War Department and the issue resulted not merely in an Engineer Section of the Reserve Corps, but sections for all arms of the service as well. The plans of the committee were embodied in the National Defense Act of June 5, 1916. Under this Act we entered the World War, and the part played therein by the officers of the Engineer Reserves is now a matter of history.

Actual experience in war developed a few weaknesses in the organic act, and after exhaustive studies Congress amended the statute by the so-called Army Reorganization Act of June 4, 1920. This was eighteen months after the signing of the Armistice, and another ten months have passed during which committees of the General Staff, comprising in their membership officers of the Reserve Corps itself, have been engaged in formulating plans and regulations for the reorganization, administration, training and mobilization of this major component of the Army of the United States.

Following the passage of the Act of June 4, 1920, appointments in the Reserve Corps were wholly suspended until October 4, 1920, and pending the publication of definite information as to the rights, duties and privileges of Reserve Officers, there has been a marked decrease in the strength of the Reserve Corps as a whole. This has been a matter of grave concern, not only to the War Department, whose duty it is to provide for the defense of the country, but also to those in civil life who have at heart the best interests of the nation and who believe in the obligations of a democratic citizen-soldiery. We, therefore, take particular pleasure in publishing the following article prepared by Maj. Gen. Haan, who has taken a very prominent part in formulating the plans and regulations which will undoubtedly govern the Organized Reserves for some considerable time to come.—ED.]

UNDER the military policy provided for by Congress in the National Defense Act as amended by the Act of June 4, 1920, the Organized Reserves are the principal war component of the Army of the United States, and are raised, supported, and employed by the United States under the powers granted to Congress by the Constitution. The Organized Reserves are, therefore, a purely Federal force with a well-defined mission, and in a war of any magnitude will constitute the major component of the Army of the United States. The War Department is now engaged in the development of this component in accordance with the approved policies and plans for the organization of the peace establishment so as to permit of an immediate mobilization in the event of an emergency declared by Congress, as required by Section 3, National Defense Act, as amended.

Under the approved plans above referred to, the reorganization of the Regular Army component of the Army of the United States has been effected within the limitations prescribed by Congress, and a program has been prepared and accepted by the States which provides for the development of the National Guard component up to its prescribed strength by June 30, 1924. These two components will provide within themselves the essential elements of three field armies, and may be employed separately or together in minor or major emergencies. In the event of mobilization, all deficiencies in the Regular Army and National Guard components will be made good by units organized from the reserves for this special purpose. In addition to the above, there will be organized in the Organized Reserves, three field armies complete in every respect, and the Communications Zone and Zone of the Interior troops required in a mobilization involving the maximum effort.

The initiation of the organization of units in the Organized Reserves has been held in abeyance pending the preparation of necessary regulations and allotment tables, and in order to give the National Guard a reasonable period for reorganization. The War Department is now prepared to proceed with the organization of units of the Organized Reserves and, with this object in view, the following important actions have been or are about to be taken:

First, the promulgation of Special Regulations No. 46, General Policies and Regulations for the Organized Reserves, approved February 16, 1921. These regulations are general in nature and are designed to set forth in a comprehensive manner the basic plan for the organization of units in the Organized Reserves. The regulations consist of three parts. Part I is a statement of general policies, including the mission and affecting the organization, administration, training, and mobilization of the Organized Reserves. Part II consists of provisional regulations affecting matters relating to the composition of units, the officers and enlisted personnel and their assignment to units, the administration, the training and the mobilization of the Organized Reserves. Part III consists of extracts from existing law and notes on organization methods. The latter are arranged in narrative form and cover the various steps from the organization of a divisional area to the organization of a company.

Second, regulations for the Officers' Reserve Corps, which are now in the process of publication. These regulations are of special interest to all reserve officers, as they cover all matters relating to the appointment, assignment, promotion, transfer, and discharge of reserve officers. Under these regulations all reserve officers are arranged into classes for assignment after appointment as follows:

(*a*) For duty with the Regular Army.

(*b*) For duty with the National Guard.

(*c*) For duty with the Organized Reserves.

(*d*) For special duties and activities exclusively controlled by the War Department or its branches.

Under these regulations the qualifications of reserve of-

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ficers are now being determined and lists are being prepared for the information of corps area and other commanders. It is proposed to give every reserve officer a definite war assignment and to train him for such assignment. For example, Major Brown, Ordnance Reserve Corps, of Boston, is assigned to duty as Assistant Commandant, Watertown Arsenal. Upon mobilization, or when called to duty for the annual training period, Major Brown goes to Watertown Arsenal and performs duties in accordance with his war assignment. On the other hand, Captain Dowd, Infantry Reserve Corps, of York, Pennsylvania, is assigned to command Company C, 316th Infantry. He is called to active duty for training and is mobilized with his company.

Third, regulations for the Enlisted Reserve Corps have been prepared and are in process of publication. These regulations cover all matters affecting the enlistment, assignment, promotion, transfer, discharge, etc., of the reserve enlisted personnel.

It is of interest to note here that all regulations affecting the reserve component are formulated and proposed by committees of the War Department General Staff, of which at least one-half of the members are reserve officers.

Fourth, allotment tables showing the units of the Organized Reserves to be organized in each corps area have been published for the information and guidance of all concerned. Based upon these tables, studies are being made in each corps area and the localization of units is being considered by local boards, the majority of which are reserve officers.

As stated above, Appendix II, Part III, Special Regulations No. 46, is designed to visualize the various steps in organization of a division and subordinate units thereof. It should be understood that this is purely a hypothetical study and is intended to illustrate in a general manner the methods to be employed in the organization of units. In view of the fact that advance copies only of these regulations have been distributed and that it will be some time before all reserve officers can be furnished with copies, some pertinent extracts which are typical are given here:

Establishing Divisional Areas. Among the organizations of the Organized Reserves allotted to the Third Corps area by the War Department, are three Infantry divisions. Designations of World War divisions placed at the disposal of the Commanding General of the Third Corps area are the 79th and 80th. In establishing divisional areas the first consideration is the distribution of the military population throughout the area. In this corps area it is divided as follows:

Pennsylvania	1,573,496
Virginia	245,675
Maryland	192,995
District of Columbia	53,425

Distribution as follows:

(*a*) 1 division to the eastern half of Pennsylvania.

(*b*) 1 division to the western half of Pennsylvania, and

(*c*) 1 division to Maryland, Virginia and the District of Columbia, would be sufficiently equitable on this basis, as the distribution of corps and army troops throughout the entire area would readily balance the inequalities. These areas are the most symmetrical that could be arranged. The two States and the District of Columbia forming the area (*c*) are contiguous. It would be impossible to divide the corps area in such a manner that either of the World War divisions, the 79th or the 80th, could be exactly reconstituted. After consideration of the foregoing, the corps area commander establishes the divisional areas as stated. Headquarters of these divisions are to be established at Philadelphia, Pittsburgh and Richmond, respectively.

Designation of Divisions. The 79th Division was composed of men from Maryland and Eastern Pennsylvania, and the 80th Division of men from Virginia, West Virginia, and part of Western Pennsylvania. Eastern Pennsylvania furnished a large majority of the men of the 79th Division. The corps area commander, therefore, decides that the division in the eastern half of Pennsylvania will be designated the 79th Division. The State of Virginia furnished a large portion of the men in the 80th Division and this division was organized and trained at Camp Lee, Virginia. The division in the area comprising Virginia, Maryland and the District of Columbia is, therefore, designated the 80th Division. The other division in the corps area is assigned a new number.

Localization and Designation of Subordinate Units. The 79th divisional area being wholly contained within a single State, the location and designation of the subordinate units thereof are functions of the board provided for in Section 3a of the National Defense Act, as amended by the act of June 4, 1920. Specific instructions for the formation and functioning of these boards have been issued by the War Department. The corps area commander submits to the Board for the State of Pennsylvania the question of localizing and designating the units of the 79th Division, advising them of the names and numbers available for their use. This board localizes and designates the units of the 79th Division, locating the 316th Infantry in southeastern Pennsylvania.

Organization of a Division. The War Department has made available to the corps area commander certain officers and enlisted men of the Regular Army for assignment to organizations of the Organized Reserves in his area. From their number the corps area commander designates Colonel Adams to organize the 79th Division and places at his disposal for this purpose eleven other officers of the Regular Army and twelve enlisted men. Colonel Adams is also furnished with a list of the reserve officers available for assignment to this division residing in the divisional area, with such information regarding their qualifications as is necessary, in order to enable him to recommend their assignment intelligently. Colonel Adams is ordered to take station at Philadelphia, and having arrived there he establishes divisional headquarters. In proceeding with the organization of the 316th Infantry in southeastern Pennsylvania he assigns Captain Ball and one enlisted man of the Regular Army to this regiment, and directs them to proceed with the organization. Colonel Adams and his staff, from examination of the records of the available officers, determine that Colonel Crew of the Infantry Reserve Corps, residing at Lancaster, Pennsylvania, is the most available officer to command the 316th Infantry, and Colonel Adams recommends that the corps area commander assign him to command that regiment. This assignment having been made, Captain Ball and his enlisted assistant report to Colonel Crew. He explains thoroughly the plan of organization. As Colonel Crew resides in Lancaster, this city is designated as regimental headquarters of the 316th Infantry. Colonel Crew and Captain Ball carefully consider the officers available within their area and recommend assignments based on records and Colonel Crew's personal acquaintance with these officers. These assignments are made by the corps area commander. While the organization of the 316th Infantry is thus initiated, similar action is being taken with the other regiments of the division and with the special units. Certain qualified reserve officers are also assigned to the Division Staff. While the officer personnel is not complete, the distribution throughout the divisional area is such that practically all units have had assigned to them at least one officer. The first stage in organizing the division has, therefore, been accomplished.

Organization of the Regiment. Authority is now given to recruit all units to an enlisted strength, which, for the purposes of this study, will be assumed to be one-third their number of non-commissioned officers and specialists, and organization commanders are directed to recruit this strength and to complete their commissioned personnel as soon as possible.

Colonel Crew and Captain Ball after numerous conferences, which included other officers assigned to the 316th Infantry, have developed a working plan for the further organization of this regiment. Residing in the City of York, Pennsylvania, are Captain Dowd, First Lieutenant Elwell and Second Lieutenant Ford, all holding commissions in the Officers' Reserve Corps, Infantry Section. These officers have been assigned to Company C, 316th Infantry, which was localized at York. Captain Ball proceeds to York for a conference with the officers assigned to Company C. He explains in detail the plan of organization. Captain Dowd and his lieutenants invite into this conference Mr. Gray and Mr. Hall, both of whom served as Infantry lieutenants in the Army during the World War. They are urged to apply for commissions in the Officers' Reserve Corps, which they do. In forwarding their applications, Captain Dowd requests that they be assigned to Company C. Captain Dowd and his officers then call a meeting of ex-service men. Captain Ball is introduced, and plans for the organization of the Organized Reserves and the requirements of membership in the Enlisted Reserve Corps are presented. Those present are told of their local officers who have been assigned to this company. A number of these present served under Captain Dowd in the Army and are desirous of perpetuating their old company. With the impetus to recruiting given by this meeting, Captain

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Dowd and his officers are able to enlist the fifteen men which their present order authorizes. The number enlisted includes men who served in the following grades:

1 first sergeant,
1 mess sergeant,
8 sergeants and
5 corporals.

These men are given their warrants in due course, and Lieutenants Gray and Hall receive their commissions and are assigned to this company. The first stage in the organization of Company C has been accomplished.

Captain Ball works along the same lines in the other cities which have been given companies in the 316th Infantry. He holds frequent conferences with Colonel Crew. During the progress of the organization, Colonel Crew designates the officers for his regimental staff, who are properly assigned thereto. Captain Ball is assigned as Adjutant of the Regiment. Battalion commanders and their staffs are assigned.

Organization of Auxiliary Arms. Colonel Adams is confronted with a somewhat different problem in the special arms, as for instance the Artillery, yet he succeeds in placing the divisional artillery in fairly compact and regular districts. In doing this he finds that he requires complete co-ordination with the State committee under section 3a, National Defense Act, as amended by the Act of June 4, 1920, to the end that the Artillery contingent of both division and higher units is equitably distributed over the whole area. He frequently finds places for technical units, such as Medical and Signal Services, in connection with hospitals and colleges located within the divisional area.

Training a Company on Inactive Status. Captain Dowd finds that all of his officers and men will agree to devote one evening a month to instruction. He arranges with Captain Ball to conduct conferences a designated evening each month, and secures the use of an available meeting place for this purpose. Throughout the winter and spring these assemblies are continued, while Captain Dowd and his officers are given additional instruction whenever Captain Ball's time will permit.

Lieutenant Elwell applies for admission and is sent to Camp Benning for a special course of one month at the Infantry School.

Several afternoons during the spring the members of the company go out for tactical problems, which are conducted by Captain Dowd.

The interest of the officers and men increases and all look forward to their annual field training.

A reading of the foregoing will indicate that throughout these regulations runs the policy of giving reserve officers assignments as near their homes as possible, usually in their home town. This should stimulate local interest and make it possible to interest the community to the extent frequently of assisting in securing suitable meeting places and possibly other assistance of a material nature—not to speak of the intangible support that will be given to local organizations by the fact that they constitute in a sense a representation of the community.

The extent and nature of the training that is proposed for individuals and organizations of the Organized Reserves is dependent upon the funds appropriated by Congress for this purpose. It is recognized that while the annual training period of 15 days affords the principal means for the training of the Organized Reserves, it must be supplemented by voluntary training to the greatest practicable extent. In the exercise by the War Department of the authority granted by law to require 15 days of active duty in each year, due consideration will be given to the occupation or other civil duties and responsibilities of the reserve officers and enlisted men. When practicable, divisions will be called for training as units and all organizations and all members of the divisions will be called at the same time. When so called, the chain of command and the duties and responsibilities of all commanders of reserve units insofar as the administration, training and supply are concerned, will be the same as prescribed for the Regular Army. As a general rule, it will not be practicable to train all of the divisions and corps and army troops in any corps area in any one year. Officers and enlisted men of units not called for training with their organizations will be given such individual and special training as funds available will permit.

In this connection it should be noted that reserve officers and enlisted men may attend the General and Special Service Schools where special courses are arranged for their instruction and training. The number of officers and enlisted men who may be designated to attend these schools depends again upon availability of funds and upon accommodations at the schools. The War Department has made strong representations to Congress as to the necessity for funds for these purposes. Unless adequate funds are appropriated and made available, the best intentions and efforts of the War Department and of the reserve personnel will be able to accomplish but little in the practical development of the Organized Reserves. The funds that will probably be available during the fiscal year beginning July 1, 1921, will not permit of the training of units and it is proposed that the maximum number of officers be assembled in each corps area for instruction and training in basic policies and organizational methods. These assemblies should be most useful in establishing a basic doctrine and in insuring uniformity of methods to the end that the initial steps in the organization of units in the Organized Reserves will result in the successful development of this component of the Army of the United States.

Deaths of Prominent Engineer Officers

Maj. Gen. Alexander Mackenzie

IT was with keen regret that his wide circle of friends learned of the death on February 21, 1921, of Maj. Gen. Alexander Mackenzie, who was the Chief of Engineers, United States Army, from January 23, 1904, to May 25, 1908. Alexander Mackenzie was born in Wisconsin on May 25, 1844, and was appointed to the United States Military Academy from Illinois, entering on September 1, 1860, and graduating on June 13, 1864, sufficiently before the close of the Civil War to permit him to render gallant and meritorious service, especially in the Department of Arkansas, for which he was brevetted captain. Commissioned first lieutenant in the Corps of Engineers on graduation, he was successively promoted to captain on March 7, 1867; major, April 5, 1882; lieutenant colonel, February 3, 1895, and colonel, May 3, 1901. As noted above, he became Chief of Engineers, with the rank of brigadier general, on January 23, 1904, and, in accordance with the provision of law especially applicable to certain officers who had Civil War service, he was promoted to be major general on retirement on May 25, 1908.

During his forty-four years of active service his experience was naturally a broad one. He first served on the lower Mississippi River, and thereafter, for a brief period, on the Great Lakes; following this, from 1866 to 1874, he commanded a company of engineer troops at Willets Point, N. Y. From June, 1874, to the time of his retirement his entire service was either in connection with works of river

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and harbor improvement or in the office of the Chief of Engineers at Washington. While, for about six years, between 1874 and 1880, he was connected in turn with the improvement of the Ohio River, and with the construction of harbor works and lighthouses on the Great Lakes, it is the period between 1880 and 1895 that is the most notable in his career as an engineer engaged in actual construction.

Between 1880 and 1895 General Mackenzie was in charge of the improvement of the Mississippi River between St. Paul and the mouth of the Missouri, and during these fifteen years the work, which at the time he assumed charge of it was in an elementary and formative stage, developed into what, in all probability, is the most successful example of river regulation known to engineers. River regulation is probably as difficult a problem as engineers have to cope with. The variable factors are numerous and are sometimes hard to identify, their influence is frequently obscure and dependent upon circumstances and conditions that may originate at points far distant from that which is under treatment; no two seasons are at all alike, and, all told, the problem of attempting to convert a seemingly lawless, alluvial stream into one that shall have a smooth, regular channel flowing in gentle curves with adequate depth is one whose solution has usually defied the efforts and patience of engineers of all climes and countries. General Mackenzie's mind was, however, peculiarly adapted to the handling of a problem of this kind, and under his careful and patient direction there came into being standardized plans and methods for treating this stream which have left it today, although the project is even now not entirely completed, with a channel of enormously greater capacity for navigation than it had in 1880, when operations under General Mackenzie were begun. Within the limits of an article of this sort, it would be superfluous to attempt to describe in detail what were the methods pursued, but it is fitting to say that when he came to the upper Mississippi River it virtually had no really useful channel at low-water stages. Such a channel as existed permitted navigation with a draft of not to exceed 1½ feet as far as LaCrosse, while above that point, during low-water periods, nothing was possible in the way of navigating the river upon a practical scale, although, of course, logs and rafts could be floated. To-day the river is navigable to the Falls of Saint Anthony for boats which, at extreme low water, can always safely draw as much as 4 feet, while at ordinary low water considerably deeper channels may be counted on.

It was while he was on duty on the upper Mississippi River that General Mackenzie became best known among engineers and to the people of the Central Valleys, where his kindly, congenial manner, his patient consideration for others, and his shrewd practical judgment won him the confidence, respect and affection of all who knew him.

In June, 1895, General Mackenzie was called to Washington to become the principal assistant in the office of the Chief of Engineers, where he remained in charge of all matters relating to river and harbor improvements until on January 23, 1904, he was promoted to be Chief of Engineers. During his service in Washington he was brought into intimate contact with Congress, with members of the Cabinet, and with Presidents, all of whom learned to admire him and to respect his judgment and integrity. On his retirement on May 25, 1908, he took up his residence in Washington and remained there without active occupation until he was recalled to active duty on May 11, 1917. At that time, at the age of 73, he was still physically quite active and, although no longer very strong, he responded cheerfully to the call of the emergency. With singular appropriateness, his duty took him back to the upper Mississippi River, where he had spent the happiest and most fruitful years of his service, and where he was hailed with joy by the large number of old friends who still survived. He continued on active service for two years, until 1919, but during this time he found the strain of the work greater than he had anticipated, and here, no doubt, germinated the seeds of the organic disease that led to his sudden death. He was, however, singularly devoted to the discharge of his duty and determined to do everything that one man could do to help in carrying the burden of the Nation, so that, in spite of several warnings that other men would have taken more seriously, he persisted in remaining on duty when it was evident that his health was hardly adequate to the task. On his return to Washington his many friends were with regret forced to admit that he had noticeably failed during his absence, but his sudden death was a shock and great grief to all.

It is difficult to summarize in a few words the character of any man, but it seems fitting to say that General Mackenzie was distinguished among men by unaffected simplicity and kindliness of manner, by approachability, and by unassuming but hard-headed common sense that enabled him early in his career to be a successful executive and later in life to be, first, a shrewd and far-sighted assistant, and later a Chief of Engineers whose career was marked by the success with which he handled the difficult problems of administration constantly besetting the head of a busy governmental bureau. With his passing the world has lost a most lovable character and the engineers of the country a wise and generous friend and adviser.

Colonel McDonough

Lieut. Col. M. J. McDonough, Corps of Engineers, died at the Fitzsimmons General Hospital, Denver, Colo., on February 13, 1921. His death was due to tuberculosis, brought on by the strain incident to the World War.

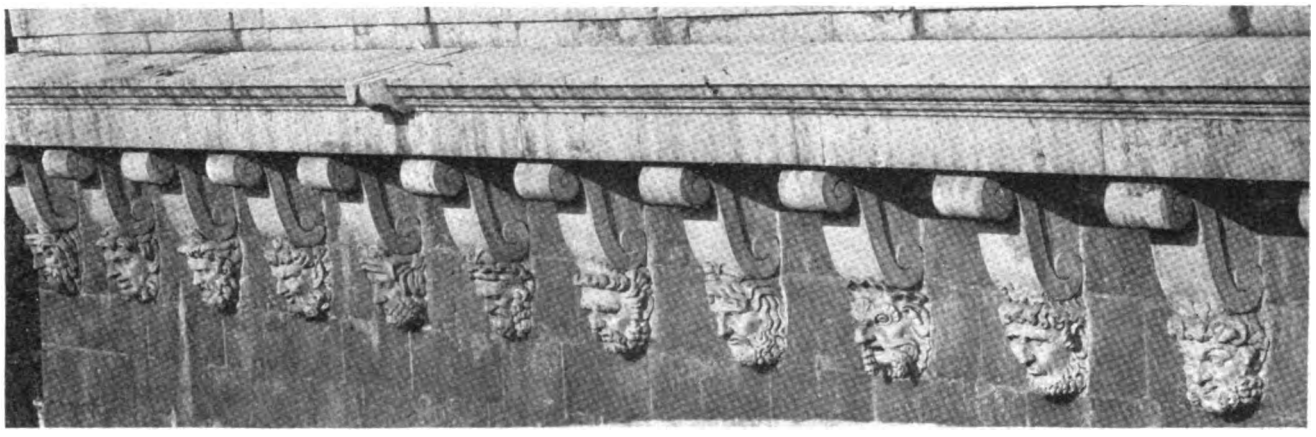
Our issue of July-August, 1920 (Vol. XII, No. 64) contained a brief account of Colonel McDonough's life and services, with his portrait. He was retired from active duty for physical disability May 11, 1920, and in spite of every care his health continued to decline.

Colonel McDonough was in all respects splendidly representative of the highest development of the American army officer. In him were combined an intellect of the highest order and greatest versatility, a positive, forceful and rigidly upright character, and a wonderful ability for winning friends, whom he numbered by thousands and in every walk of life. His expert knowledge of everything connected with his profession, his great talent for achieving practical results, and the unvarying cheerfulness and helpfulness which nothing could discourage or abate, won for him the respect and affection of his equals in rank and the loyalty and devotion of his subordinates.

That so positive and energetic a personality should have been without an enemy in the world, is a remarkable fact and a tribute to a remarkable character. His life and services were a source of inspiration and guidance to all who were so fortunate as to enjoy the friendship and helpfulness which he so generously dispensed. Here was truly a man amongst men.

Colonel McDonough leaves a widow, a son, Robert, and a daughter, Alice. Mrs. McDonough was Miss Alice Kinzie, daughter of Gen. D. H. Kinzie, a prominent officer of the Regular Army and a veteran of the Civil War.

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Carvings on the Pont Neuf

The Bridges of Paris

By

Carl L. Rimmele

Formerly First Lieutenant, Engineers

[*Note.* As Victor Hugo says, the early history of his beloved Paris is written in stone. In their architecture we may read the history of nations. In her monuments and bridges Paris has recorded the great events of her history and expressed her ideals, her hopes, her dreams.

We are grateful to the author for this very complete and beautifully illustrated history and description of the bridges of Paris. It is interesting from an historical, an artistic and an engineering point of view. In no other place in the world can be found such a complete historical and technical exhibit of the development of municipal bridge construction. For no other great city affords so favorable an opportunity. Paris is built upon the convolutions of the Seine. And as it is a narrow and insignificant stream, according to our American ideas, and as the traffic of the city is very great, there is every inducement to construct bridges, which can be built at a comparatively low cost.

The author traces the design, the development of types, the details of construction, and the cost of the Bridges of Paris over a relatively long period. Most of the early bridges are still in existence, and may be compared with the more recent types.

The multiple arch municipal bridge is common enough in our own country, but the multiple span suspension bridge, so common in France, is unknown in the United States, it being, of course, an uneconomical type. Curiously enough, it is also absent in Paris, but for a different reason. It appears that at least two such structures were erected, but they were evidently regarded as not sufficiently artistic in appearance for beautiful Paris, and have been replaced by the arch type.

Another notable fact is the absence of reinforced concrete arch types. Although the French were the originators of concrete, they employ it very sparingly. The most recent of the bridges described by the author, the Pont Alexandre, is of the single span segmented steel arch type. It was completed in 1900.

The development of types, the relative costs, and the curious expedients employed in construction, will be of interest to all lovers of bridges. American engineers will probably wonder at the apparently very careless foundations so frequently employed. And it is to be remarked that these inadequate foundations on several occasions made necessary very expensive reconstruction.

The most striking thing in connection with the bridges of Paris is the proof they afford that a bridge may be at once useful and beautiful.—Ed.]

THERE is no record of when the first bridges were built in what is now the City of Paris. However, it is known that during the Roman occupation under Julius Cæsar, as well as under the Emperor Julian in the 4th century, there were only two bridges over the Seine. One was called the Grand Pont (Great Bridge), on the site of the present Pont au Change, and the other was known as the Petit Pont (Little Bridge), located on the site of the present bridge of that name.

It was not until many years later, under Charles V, that the third bridge was built. It was called the Pont Notre Dame, as is the present bridge on its site. This bridge was replaced during the reign of Louis XII, the new bridge remaining in use until 1853.

The fourth bridge was constructed under Louis XIII, on the site of the present Pont Michel and was known by that name.

Until the end of the 16th century, then, the Ile de la Cite, or what was then the city of Paris, had only four bridges, making two complete crossings over the two channels of the Seine, the Petit Pont and Pont Notre Dame making one, and the Grand Pont and Pont St. Michel the other.

In 1578 Henry III ordered the construction of the Pont Neuf, or New Bridge, which is still in use to-day.

At the present time there are 32 bridges over the River Seine within the city limits of Paris, making 24 complete crossings; one crossing requiring 3 bridges, six requiring 2 bridges, while 17 are single bridges. Twenty of these bridges are masonry arches and 12 are metallic arches.

The descriptions which follow are arranged in the chronological order in which the bridges were constructed, except that all masonry structures are described first, the metallic bridges following.

It may be interesting to note that until the end of the 18th century all masonry bridges in Paris were built with semi-circular or almost semi-circular arches; from 1787 to 1852 all had segmented arches and after that time, beginning with the new Pont Notre Dame, all had elliptical arches.

The information given concerning the bridges of Paris was obtained through the kindness of M. Restraint, Chief Engineer of Bridges, and from "Annales des Ponts et Chaussees," 1835 to 1916.

[*Note.* For the benefit of our readers who may wish to locate the bridges described, there is reproduced herewith a plan of the City of Paris and a table showing the locality of the various bridges. We regret that a better plan was not available, but with the aid of a magnifying glass it will be found quite readable.—Ed.]

The Pont Neuf

Quite the opposite of what its name implies, the "New Bridge" is the oldest bridge in Paris and the best known. It is the patriarch of the Seine bridges.

The first stone was laid by Henry III himself in May, 1578, and the work was carried on until the piers were

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well above the water. At that time, however, owing to the Civil Wars, operations were suspended and were not resumed until several years later, when Henry IV (Henry of Navarre) ascended the throne. The bridge was finally completed in 1604.

This bridge is 232.88 meters long and divided into two sections, one over the main branch of the Seine composed of seven masonry arches, the other separated from the first by the extreme western end of the Ile de la Cite, composed of five arches.

The arches are very nearly semi-circular, built of cut stone, and are slightly skewed. The spans vary from 14 meters to 17.55 meters. The depth of the arches at the keystone is 0.75 meter. They are 20.65 meters long between faces in the northern or main branch section, and 20.35 meters long in the southern section. The deck is 20.30 meters wide between parapets, accommodating an 11.30-meter roadway and two 4.5-meter sidewalks.

The piers rest on timber platforms, which, although laid directly upon the sand, were, when the bridge was constructed, about 3 meters below the river bed. These platforms consist of 0.40 by 0.40 by 7.0-meter sleepers parallel to the center line of the bridge, spaced 1 meter center to center, covered with a floor of 16 centimeters (6″) oak planks.

This bridge, completed in 1604, was in constant use until the middle of the last century without any repairs having been made. In 1848, however, the bridge was found to be badly in need of repairs; in fact, many of the arch stones had become loosened and fallen out. The work started that year included the reconstruction of seven of the arches, lowering the roadway and constructing galleries for water lines. Care was taken that the original appearance of the bridge should not be altered and sculpturing which could not be restored was replaced with accurate copies, for Paris has a tender affection for the old Pont Neuf. This entire work was carried on under traffic, half the roadway being kept open at a time, and covered a period of four years.

In 1885 one of the piers settled to such an extent that longitudinal fissues over a half meter wide appeared in the roadway. Investigation showed that the upstream half of the pier had been undermined, and that, since the construction of the bridge, the bed of the river had been lowered more than 3 meters, so that in some places it was below the pier footings. The repairs, which were started immediately, included the rebuilding of half the pier and half the adjoining arches.

The new footing was built in a caisson sunk to a depth of 4 meters below the old footing. Around the rest of the pier narrow caissons, 2 meters wide, were sunk to the same level and filled with masonry, completely surrounding that half of the pier. Over the new halves of the reconstructed arches spandrel walls were used instead of the filling as in the old part.

After this work had been completed, sheet piling was driven around the other piers, as well as around the abutment footings, and capped with masonry. Cement grout was then pumped in under the old footings to partly consolidate the sand.

The total expenditures charged to this famous bridge during its more than 300 years of service, have been less than 3,000,000 francs.

Pont Marie

Ten years after the completion of Pont Neuf a bridge was started connecting the north bank of the Seine with the Ile St. Louis. This bridge was designed and its construction begun by Cristophe Marie, whose name it bears, but was later taken over and completed by Delagrange, in 1635.

The Pont Marie is 92.27 meters long between abutments and consists of five nearly semi-circular arches of cut stone. The largest arch has a span of 17.65 meters, and the smallest, 13.76 meters. The width between faces is 23.60 meters. The keystone depth is 1.75 meters.

The foundations are masonry footings placed directly upon the gravel of the river bed.

In 1658 two arches were washed out and were replaced six years later. Except for this, there is no record of any expenditures during 300 years of use.

Pont Tournelle

In 1654 the Pont Tournelle was constructed over the southern channel, opposite the Ile St. Louis, which, with the Pont Marie, completed the crossing at that point.

The bridge, as originally built, consisted of six semi-circular arches of cut stone; the largest of these was 17.58 meters between piers and the smallest 15.57 meters. The total length of the bridge between abutments was 117.88 meters, and its width between faces was 13.80 meters. The piers are 3.95 meters thick, and rest on piles.

In 1845 it became necessary to widen the deck. This was accomplished by utilizing practically the entire width of the original structure for the roadway, raising the pier heads to the level of the sidewalks and carrying the sidewalks on metallic arches.

These arches are semi-circular. Each rib consists of five cast iron sections bolted together. In cross section they are channels 450 by 135 by 50 millimeters, and are the same depth throughout the entire length of the arch. The spandrel work was cast in six sections, and is bolted to the arch ribs.

Pont Royal

The Pont Royal was completed in 1689 and is composed of five semi-circular masonry arches; the center arch has a span of 23 meters, the adjacent arches 22.60 meters, and the shore spans 20.58 meters. The arches are 17.0 meters long between faces and carry a roadway of 10.4 meters and two 3-meter sidewalks.

The entire bridge is constructed of cut stone and rests on pile foundations. The depth of the arches at the keystone is 1.42 meters. The piers are 4.86 meters thick.

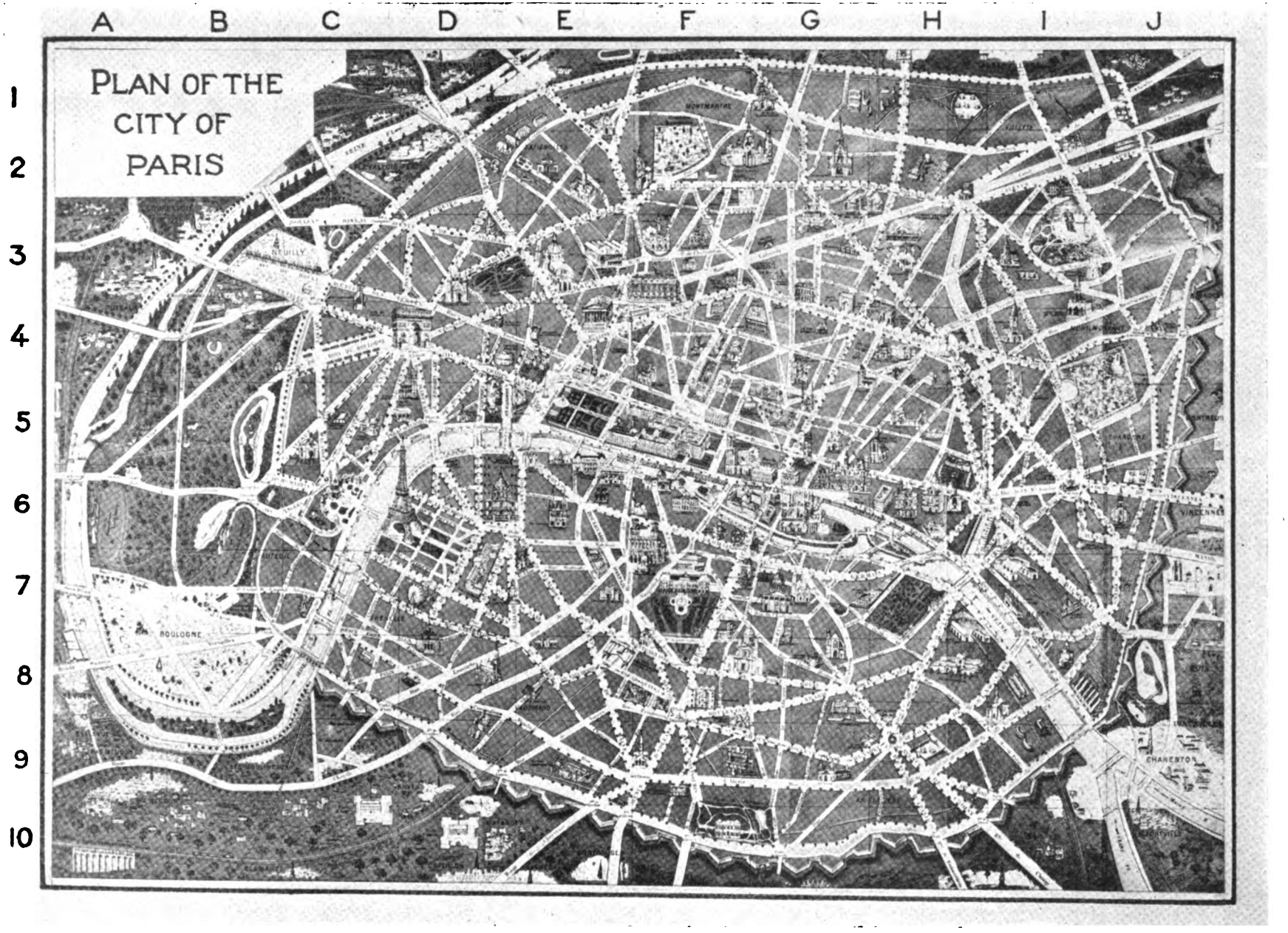
Pont de la Concorde

With the construction of the Pont de la Concorde, in 1787, a new type of bridge was inaugurated, the segmental arch, which type was employed exclusively until the middle of the next century.

The Pont de la Concorde was designed and constructed by M. Peronet, Chief Engineer of Bridges and Highways under Louis XVI. It is composed of five segmental circular arches of masonry resting on four 2.92-meter piers and two 15.59-meter abutments. The pier footings are stepped out to a width of 6.82 meters and rest on timber platforms on piles.

The bridge is 15.59 meters wide between faces, accommodating a roadway 8.75 meters wide and two 3-meter sidewalks. The central arch has a span of 31.18 meters with a rise of 3.97 meters; the adjacent arches span 28.25 meters and have a rise of 3.69 meters; the shore spans are 25.33 meters long with a rise of 2.98 meters. The keystone depths are, for the middle, adjacent and shore arches, 1.09, 1.01 and 0.88 meters, respectively.

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LOCATION OF BRIDGES ON THE PLAN OF PARIS

Alma ----------5 D	Alexandre III---5 D	Bercy ----------8 I	Grenelle -------7 C	Mirabeau ------7 C	Petit ----------6 G	St. Michel -----6 G
Archevéché ----6 G	Au Change------6 G	Carrousel ------5 F	Iena ----------6 C	National -------9 I	Royal ----------5 E	Sully ----------7 H
Arcole ----------6 G	Austerlitz ------7 H	Concorde ------5 E	Invalides ------5 D	Neuf ----------6 F	Solferino ------5 E	Tolbiac --------8 I
Arts ----------6 F	Auteuil --------8 C	Double --------6 G	Louis-Philippe --6 H	Notre Dame-----6 G	St. Louis-------6 G	Tournelle ------6 H
			Marie ----------6 H			

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Pont d'Austerlitz

The original Austerlitz bridge was begun in 1801 and completed in 1805, the year of the victory of Napoleon over the Austrians at Austerlitz, from which it received its name. It consisted of five cast-iron arches of 32.36 meters span each, and resting on masonry piers set on pile foundations. The width of the deck was 12.74 meters.

This bridge was in use until 1854, but by that time traffic had increased to such an extent that a wider bridge was necessary.

The cast-iron arches were removed, and were later replaced with masonry. The piers were lengthened by driving piles at each end, capping with concrete, and new stone masonry carried up and joined to the old. The piers were then joined by segmental masonry arches of cut stone, having a rise of about ⅛ meter. The deck of the reconstructed bridge was 18 meters wide.

This additional width, however, was not great enough to accommodate the ever-increasing traffic, so, in 1884, the bridge was again widened. This time the piers were lengthened equal amounts upstream and downstream, as before, but independent footings were poured in caissons sunk to rock and about 2 meters below the old. The stone masonry was joined to the old just below the water line. The width of the deck after the extension was 30.4 meters.

The original cost of this bridge was about 2,500,000 francs. The reconstruction in 1854 cost 950,000 francs, and the extension in 1884, 1,450,000 francs.

Pont d'Iena

The Pont d'Iena is composed of 5 masonry arches, circular arcs having a chord of 28 meters and a rise of 3.42 meters. The depth of the arches at the keystone is 1.44 meters.

The piers are 3 meters thick and the abutments 15 meters. The left bank abutment and 3 piers were constructed in caissons set on piles; the other pier and abutment rest on timber platforms.

The length of the arches between faces is 14 meters and the width of the deck between parapets 13.70 meters. The bridge has an 8.7-meter roadway and two 2.5-meter sidewalks.

Construction was started in 1806, the year of the French victory over Prussia at Iena-Auerstadt, and the bridge opened to traffic in 1814. There is no accurate information on the cost of the work.

Pont de l'Archeveche

This bridge is composed of three segmental masonry arches. The central arch has a span of 17 meters with a rise of 2.31 meters, and the others have spans of 15 meters and a rise of 1.91 meters. The depths at the keystone are 1.07 meters and 0.96 meter, respectively.

The piers are 2.30 meters thick and the abutments 9 meters. The right bank abutment is built on a timber platform directly upon the soil. The other abutment and the piers are on pile foundations.

The arches are 11 meters long between faces and carry a roadway 7 meters wide, with two 2-meter sidewalks.

Construction was begun in April, 1828, and the bridge completed the following November.

The cost was approximately 380,000 francs.

Petit Pont

There have been bridges on this site since the days of the Romans. The bridge just preceding the present structure was built in 1719 and consisted of three masonry arches. In 1852 this bridge was demolished and replaced with the single arch in use to-day.

This arch is a circular segment with a rise of about 1/10 of the chord. The upstream chord is 31.0 meters, while the downstream chord is 32.5 meters long. This difference was caused by the alignment of the quays.

The arch is constructed of cut stone set in cement mortar and has a depth at the keystone of 1.35 meters.

The old abutments were utilized, the only change being to widen them slightly.

The cost of this bridge was 385,000 francs.

Pont National

The Pont National, known until the fall of the Empire as Pont Napoleon III, was constructed by the Terminal Railways of Paris in 1852-3.

It is composed of five segmental masonry arches of 34.5 meters span and 4.6 meters rise, not including two 12-meter arches, one on each bank, over streets.

The bridge is 16.10 meters wide, divided between 7.74 meters for the railway (double track) and 7.8 meters for the highway.

The arches are constructed of course rubble and have a keystone depth of 1.20 meters. They rest on piers carried on piles. The piers are 4 meters thick and the abutments 12.5 meters.

The original cost of the bridge was 2,237,000 francs.

The work was carried on under the supervision of M. Couche, Chief Engineer.

Pont Notre Dame

The present Notre Dame bridge replaced a 6-arch structure built in 1499-1507 by the Joconde Brothers, an Italian religious organization. The type of foundation used in this bridge was the same as that employed later for the Pont Neuf, as heretofore described.

They are timber platforms laid directly upon the sand, but, unlike those of Pont Neuf, they were immediately enclosed in sheet-piling walls and further protected by loose rock dumped at the upstream ends.

In 1852 it became necessary to lower the roadway some three or four meters to conform to the new level of the streets approaching it, so it was decided to completely wreck the old superstructure and rebuild the bridge on the old foundations. Accordingly, the superstructure was demolished to a point slightly above the water line, and the piers rebuilt with a thickness of 3.5 meters. They were connected with five elliptical arches, varying in span from 18.76 meters for the largest to 17.40 meters for the smallest The central arch has a rise of 7.5 meters and the shore spans 7.25 meters. The depth of the arches at the keystone is 0.88 meter.

The sixth arch of the old bridge had been built to span the head of a canal which was no longer in existence.

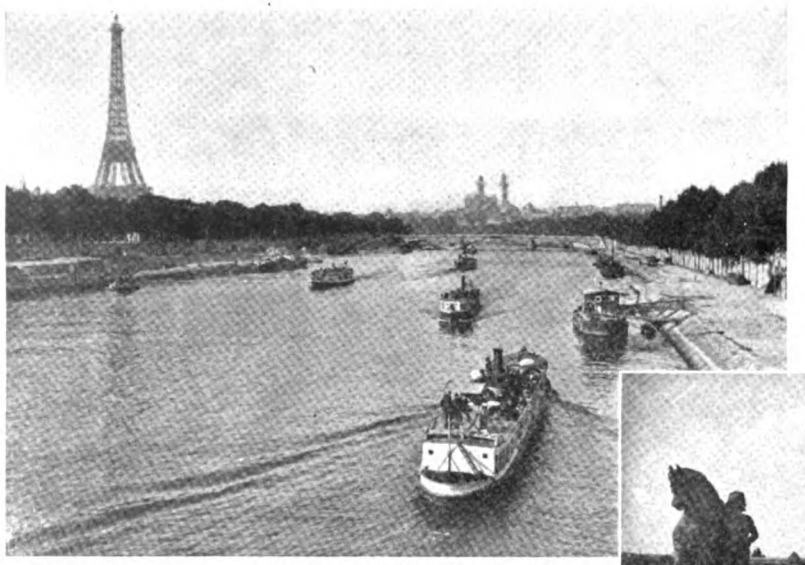
The length of the arches between faces is 21 meters, and the width of the deck 20 meters between parapets. The bridge has a 12-meter roadway and two 4-meter sidewalks.

For the greater part, stone from the old bridge was used, set in natural (Vassy) cement mortar.

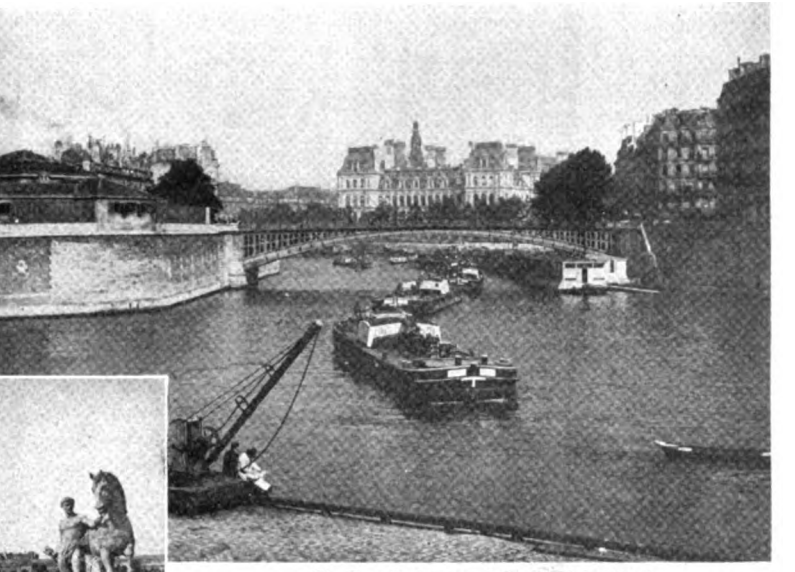
The reconstruction required approximately one year and cost 713,000 francs.

These were the first elliptical arches used, beginning another new era in bridge construction. During the next ten years, six more bridges of this type were built.

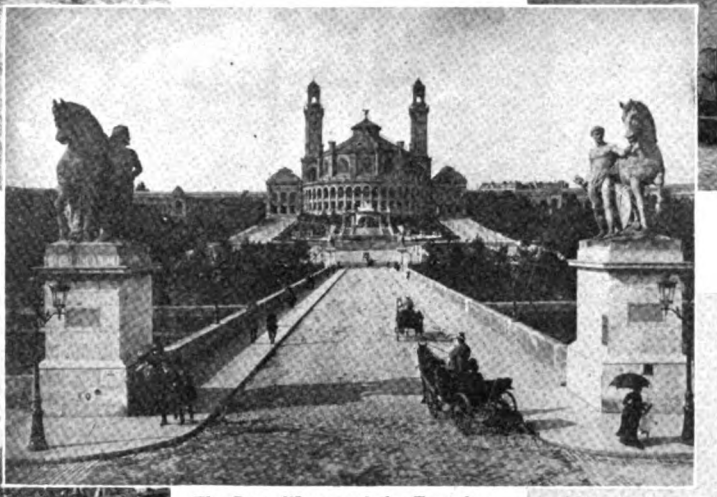
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View on the Seine from the Pont des Invalides, the Pont l'Alma, Eiffel Tower and Trocadero in background



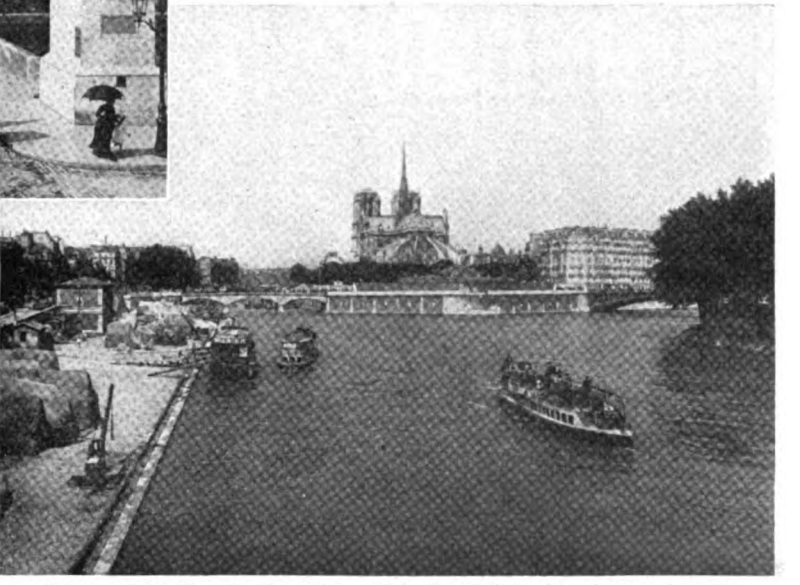
The Pont St. Louis and the Hotel de Ville



The Pont d'Iena and the Trocadero



The Pont des Arts and the Palais de l'Institut



The Pont de l'Archeveche, Notre Dame and the Pont St. Louis from the Pont Tournelle

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Pont des Invalides

The first two bridges on this site were both suspension bridges, erected in 1824 and 1829.

The bridge of 1829 had three spans, the piers resting on pile foundations. The central span was 67.78 meters long and the shore spans each 24.68 meters.

In 1854, at the time of the Exposition, it was decided, for æsthetic reasons, to replace this bridge with a masonry arch structure, using, as far as possible, the old piers and abutments.

The new bridge is composed of four segmental arches; the shore spans are 31.87 meters, with a rise of 3.10 meters, and the central spans are 31.69 meters each, with a rise of 4.10 meters. All arches are 1.2 meters deep at the keystone and 1.8 meters at the skewbacks.

The central pier is the only one entirely new. It rests on piles capped with concrete. The old piers were lengthened and the abutments increased to 11 meters thickness.

The roadway is carried on seven arched spandrel walls.

The estimated cost of the reconstruction was 800,000 francs, but, owing to a change in the plans after the work had been started, changing the width of the proposed bridge from 14 to 16 meters, the actual cost was about 990,000 francs.

Repairs in 1876 consisted of replacing some broken skewbacks and arch stones, at a cost of 156,000 francs.

In 1878 some movement was noticed in the right-bank arch and was traced to the shifting of the first pier. It was discovered that some of the piles in the foundation were shattered and others displaced to such an extent that the caisson in which the footing was built did not rest squarely upon the heads of the remaining piles. In addition to this the ice flow during the winter of 1879-80 did so much damage that it was necessary to reconstruct practically the entire bridge. The central pier and the pier next the left bank, which had just been replaced, were the only exceptions.

The reconstruction did not change the appearance of the bridge, although the arches are slightly lower.

The cost of reconstruction from 1878 to 1881 was 1,396,000 francs.

Pont l'Alma

In 1854, when news of the victory of Alma was brought from the Crimea, it was decided to construct a bridge commemorating the battle.

Work was begun immediately and pushed as rapidly as possible, since it was desired to open the bridge to traffic the first day of the International Exposition, the year following.

This bridge is composed of three elliptical masonry arches of cut stone, set in cement mortar, the center arch having a span of 43.38 meters, with a rise of 8.6 meters, and the shore spans 38.88 meters, with a rise of 7.70 meters each. The depth at the keystone of all the arches is 1.50 meters.

The deck is 20 meters wide between parapets and accommodates a 12-meter roadway and two sidewalks.

The piers are 5 meters and the abutments 8 meters thick. The left bank abutment rests directly upon the soil and less than 1 foot below the water level; the other abutments and piers are built on pile foundations.

The figures on the pier heads represent four types of French soldiers.

Work was begun at the end of 1854, and the bridge completed about the middle of 1855.

The cost was 1,620,000 francs.

Pont St. Michel

The present St. Michel bridge was constructed in 1857, and is composed of three elliptical masonry arches, 17.20 meters span, with a rise of 6.50 meters. The arches rest on two 3-meter piers and two abutments 6 meters thick.

The arches are of cut stone taken from the old bridge on this site, set in Portland cement mortar. The depth at the keystone is 0.70 meter.

The width of the bridge between arch faces is 31 meters, and between parapets 30 meters. It carries an 18-meter roadway and two sidewalks.

The pier foundations were built in caissons.

Construction was started in May, 1857, and the bridge completed in December of the same year.

The total cost was 552,000 francs.

Pont au Change

It might be of interest to note that there have been bridges on this site since before the beginning of the Christian Era.

At the time the Boulevard Sebastopol was opened the bridge then on the site did not exactly line up with the streets. The old bridge, a 6-arch masonry structure, was demolished and the present bridge erected in 1858-60.

The present structure is composed of three elliptical arches of 31.60 meters span each, with a rise of 7.22 meters, resting on two 4-meter piers and two abutments. The width of the bridge between parapets is 30 meters, accommodating an 18-meter roadway and two 6-meter sidewalks. The keystone depth is 1.0 meter.

The piers rest on concrete footings 2.72 meters thick, poured in caissons. The abutments rest on stone masonry footings.

The arches are built of stone taken from the old bridge; the spandrels are Chateau-Landon rock. All stone is set in hydraulic lime mortar.

The demolition of the old structure was begun in 1858 and the new bridge opened in 1860. The work of demolishing the old bridge required more than a year.

The total cost, including the wrecking of the old structure, was 1,272,000 francs.

Pont Louis-Philippe

This bridge is composed of three elliptical masonry arches; the center arch has a span of 32.0 meters, with a rise of 8.25 meters, and the shore spans 30 meters, with a rise of 7.73 meters. The depth at the keystone is 1.00 meter and at the skewbacks 1.50 meters.

The piers are 4 meters wide and set on concrete footings 3.6 meters thick. The right bank abutment rests directly upon the gravel of the bank, and the other partly on the soil and partly on the piles of an old quay.

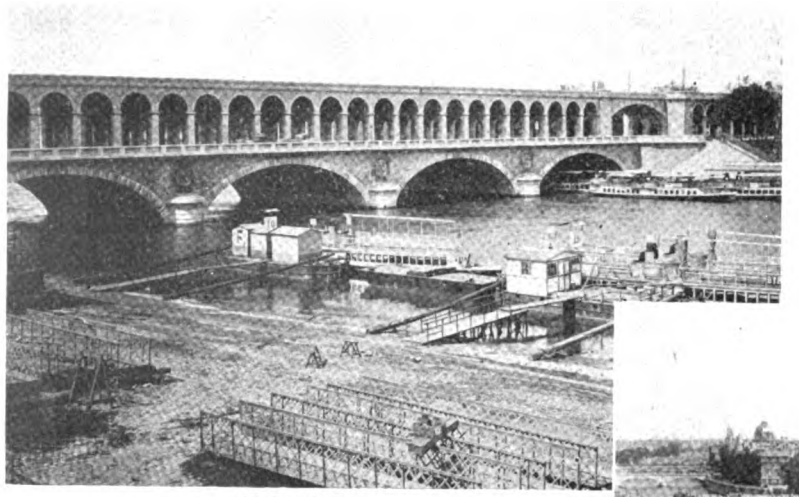
The work was begun in 1860 and completed in 1862. The total cost was 785,000 francs.

Pont de Bercy

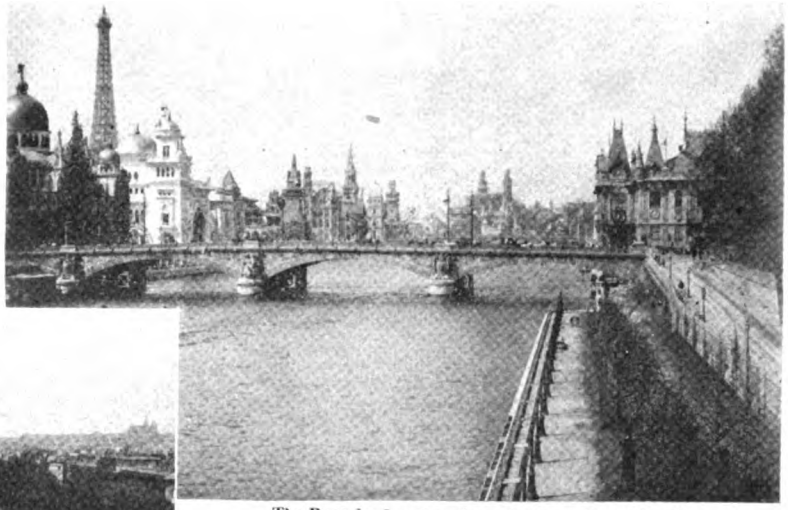
The Pont de Bercy is composed of five elliptical arches of 29.0 meters span and 7.44 meters rise. The intrados of the central arch is 9.25 meters above low-water level; that of the two adjacent arches 8.75 meters, and the shore spans 8.25 meters. The depth of the arches at the keystone is 0.90 meter.

The abutments are 7.5 meters thick, and the one on the right bank rests on a timber platform on 30 by 30 by 8.5 meter piles. The left bank abutment rests directly upon the soil.

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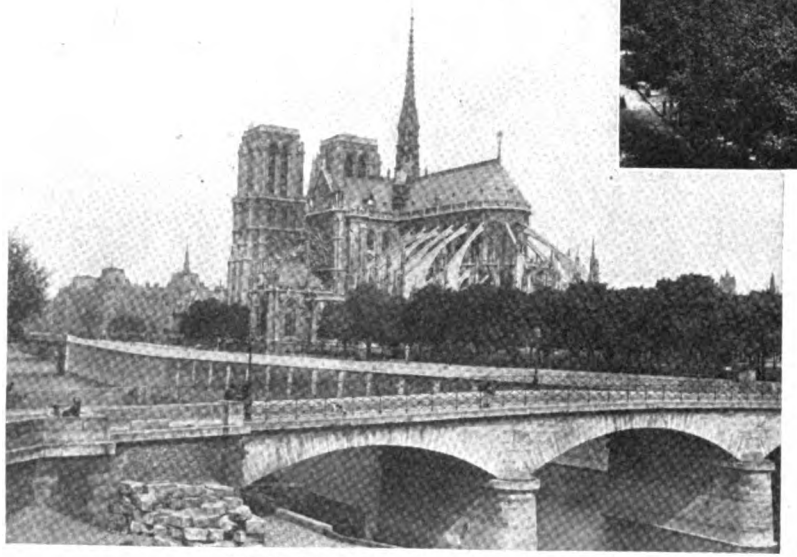
Viaduct de Passy
(The Viaduct d'Auteuil is very similar to this)



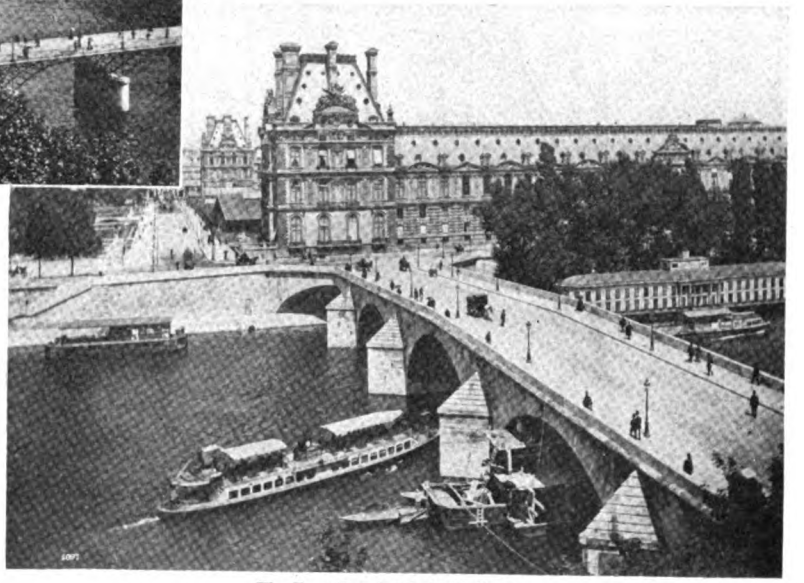
The Pont des Invalides from the Pont Alexandre III



View of "la Cite" (the island on which stands Notre Dame Cathedral) the Pont Neuf. and the Pont des Arts (from the Louvre). Note movable dam in right-hand channel



The Pont de l'Archeveche and Notre Dame



The Pont Royal and the Tuileries

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The piers are 4 meters thick and set on concrete footings poured in caissons sunk to a depth of 4.5 meters below normal water level.

The width of the bridge between parapets is 19.12 meters, with a 10-meter roadway and two sidewalks.

The total cost was approximately 1.000.000 francs. Construction was begun in 1863 and the bridge completed the year following.

Viaduct d'Auteuil

The highway bridge is 30 meters wide between parapets, and in the center is carried a double-track railway viaduct of masonry.

The total length of the bridge between abutments is 174.85 meters.

It is composed of five elliptical masonry arches of 30.25 meters span and 9 meters rise; four 4.72-meter piers and two abutments 7.5 meters thick at the ends, carried out to 13.0 meters under the railway viaduct. The deck is carried on seven spandrel walls.

Those portions of the arches under the roadways have a depth of 1 meter at the keystone and 1.75 meters at the skewbacks; under the viaduct, a section 11 meters wide, they are 1.6 meters deep at the keystone and 2.8 meters at the skewbacks. The reinforced belt in the center terminates in straight cut-stone joints, dividing each arch into three nearly equal sections.

The piers rest on concrete footings on chalk rock; the right bank abutment rests on piles driven into the chalk and the left bank abutment rests directly on the bank gravel and is enclosed with sheet piling.

The railway viaduct is 9 meters wide between faces and 10 meters high, measured from the roadway to the top of rail. It is composed of 31 semi-circular arches, with a 4.8-meter span on the bridge itself and two 20-meter segmental arches, one on each bank over the highways. Each large elliptical arch of the bridge carries 6 viaduct arches, the axis of every third arch coinciding with the axis of either a large arch or a pier. The depth of the arches is 45 centimeters at the keystone and 65 centimeters at the skewbacks.

The viaduct occupies 9.20 meters in the center of the bridge, on either side of which is a roadway 7.25 meters wide and a 2.3-meter sidewalk. Each viaduct pier has two 2.25 meters wide arched openings, which, while cutting down the weights of the superstructure considerably, also permit pedestrians to use the center of the bridge.

The bridge and viaduct are constructed of cut stone set in hydraulic lime mortar.

The work was begun in 1863 and finished in 1865. The total cost was approximately 2,864,000 francs.

The structure was erected under the supervision of MM. Bassompierre-Suvrin and Villers-du-Tenage.

Pont de Tolbiac

This bridge was constructed in 1879-82 and is composed of five elliptical arches whose springing lines are 1.36 meters above normal water level. The spans diminish from the center toward either bank, being 35.20, 32.15, and 29.10 meters, respectively, with rises of 8.18, 7.61, and 7.09 meters. The depth of the keystone is 1.0 meter.

The abutments are 7.50 meters thick, and that on the right bank rests on piles, the masonry footing dropping 1 meter below the cut-offs, while the left bank abutment rests directly upon the soil with the bottom of the footing about 1 meter below the water level.

The piers are 4.10 meters thick at the springing lines, and their concrete footings rest directly on the gravel.

The width of the bridge between parapets is 20 meters, with a 12-meter roadway.

The cost of construction was 1,500,000 francs.

Pont des Arts

The Pont des Arts is a foot-bridge designed by Cesart & Dillon and constructed in 1804.

It was originally composed of nine cast-iron arches, each having a span of 17 meters.

In 1852 the docks on the left were widened, necessitating the removal of one span and one pier. The second arch was replaced by a steel arch having a span of 23.7 meters.

The original cost of the bridge was 780,000 francs.

Pont du Carrousel

This bridge is composed of three circular metallic arches with spans of 47 meters and a rise of 1/10. The arches are carried on piers and abutments resting on piles capped with concrete and enclosed with wood sheet-piling.

Each arch is made up of five ribs spaced 2.8 meters c. to c. The ribs are made of wood and enclosed in cast-iron. These wooden ribs, which, in cross-section, are nearly elliptical, with a major axis of 60 centimeters and a minor axis of 32 centimeters, are composed of eleven thicknesses of 2-inch material with surfaces and joints tarred, and are securely held together by their cast-iron casing. The casing is 37 millimeters thick and cast in two sections, bolted together by flanges at the top and bottom. All joints are sealed with tar. The ends of each rib are closed with cast-iron caps. The depth of the ribs, from top to bottom of the casting, is 89 centimeters, uniform throughout their length.

The spandrels are cast-iron circles, decreasing in diameter from the piers toward the center of the arches.

The deck is carried on timber stringers, ten 8 inch by 12 inch, and covered with plank, on which the paving is laid.

The hand-rails are cast-iron.

The bridge is 12 meters wide between hand-rails and has a 7-meter roadway and two sidewalks.

This bridge, begun in 1831, was completed in 1834.

Pont d'Arcole

In 1828 a suspension foot-bridge was erected on the site of the present Pont d'Arcole and was known, first, as the Passerelle de la Greve, and later as the Passerelle d'Arcole. By 1854 traffic had increased in this section to such an extent that it was decided to replace the foot-bridge with a highway bridge.

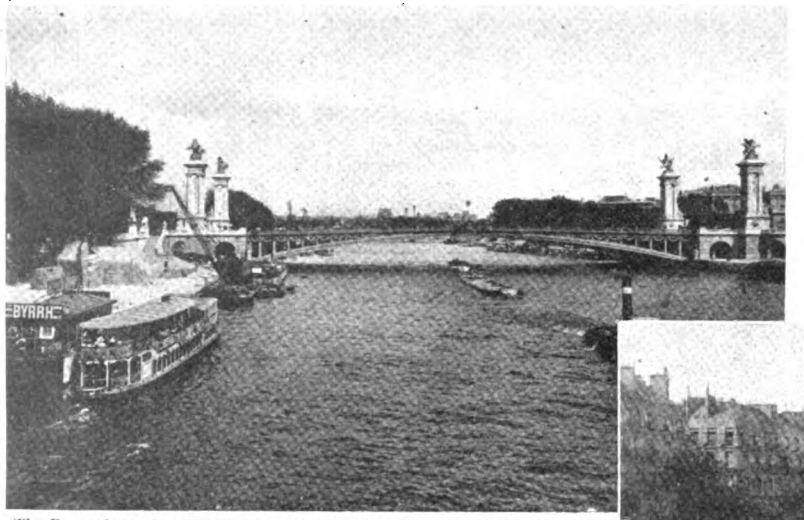
The plans prepared by the bridge department provided for a triple-arch masonry structure, but M. Oudry, then Chief Engineer of Bridges and Highways, presented, in the name of a local company, a proposition to cross the river with a single wrought-iron arch having a span of 80 meters. This plan had so many advantages that it was immediately accepted.

The arch is a circular segmental arc with a rise of 1/13, or 6.12 meters, over a clear span of 80 meters between abutments. The crown of the arch is 9.25 meters above normal water level.

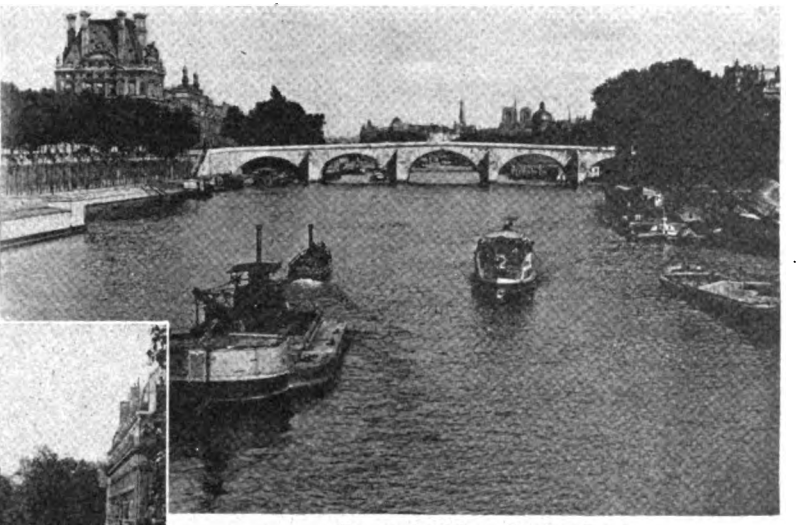
It is composed of twelve fabricated wrought-iron ribs, each 1.33 meters deep at the abutments and 0.33 meter at the crown. The ribs are spaced 1.33 meters c. to c. under the roadway, with one rib under each sidewalk. They are tied and braced with wrought-iron T's riveted every 2.5 meters along the intrados.

The ribs are fabricated in I-section; the web plate is 10 millimeters thick, the angles 100 by 90 by 10 millimeters, and

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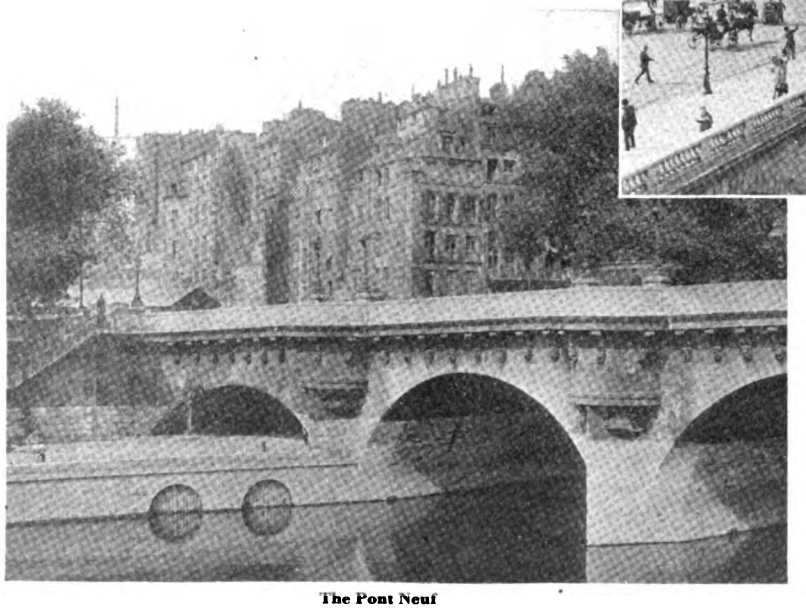
The Pont Alexandre III, the most magnificent of the Bridges of Paris, from the Pont des Invalides



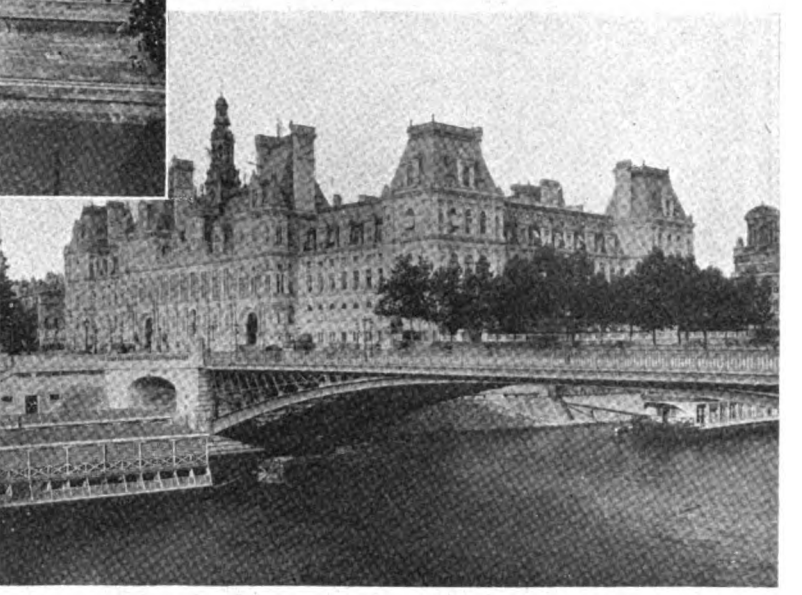
View on the Seine. The Pont Royal



The Pont and Place St. Michel



The Pont Neuf



The Pont d'Arcole and the Hotel de Ville

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View of the Quartier de l'Etoile from the Eiffel Tower, the Pont l'Alma on the right

the four cover plates, top and bottom, each 530 by 10 millimeters. T-stiffeners, 200 by 100 by 12 millimeters, are riveted every 1.25 meters along their entire length.

The deck is entirely of iron and carried on wrought-iron spandrels. It is 20 meters wide between hand-rails, which are of cast-iron, and carries a 12-meter roadway and two sidewalks.

The abutments are of stone masonry on pile foundations.

The original cost was 1,143,000 francs.

This structure was designed and erected by the "Campagnie des Ponts en Fer," under the supervision of M. Oudry.

Pont de Solferino

This bridge was begun in 1858 and completed in 1859, shortly after the victory of Solferino, from which it received its name.

It is composed of three metallic circular arches of 40 meters span each, which rest on two piers 3.35 meters thick and two 9-meter abutments. The central arch has a rise of 4.0 meters and the others 3.55 meters.

The left bank abutment rests on a masonry footing directly upon the soil, the bottom of which is at the water level. The right bank abutment has a concrete footing, also directly upon the soil, but about 1.5 meters below the water line. Both piers have concrete footings.

Each arch is made up of nine cast-iron ribs having a double I-section 1.20 meters deep at the origin and 80 centimeters deep at the crown, spaced 2.5 meters c. to c. Each rib is cast in 15 sections with flanged connections, bolted together; the end sections are bolted to bearing plates set in the masonry. The ribs are tied together by 20 equally spaced cast members. The deck, of cast-iron I-beams, with brick arches between, is carried on cast-iron spandrels.

The original cost was 1,090,000 francs.

Pont au Double

The Pont au Double consists of a single circular metallic arch of 35.42 meters span and 2.94 meters rise, resting on two abutments of coursed rubble masonry set in Portland cement mortar. The bridge is 20 meters wide between hand rails, with a 12-meter roadway and two sidewalks.

The abutments are built directly upon the soil with the bottom of the footings about 2.5 meters below the normal water line. The right bank abutment is protected by sheet-piling, and the other by the retaining wall of the quay.

The arch is composed of eleven cast iron ribs, spaced 2 meters c. to c. The ribs are 80 centimeters deep at the origin and 50 centimeters at the crown, with the exception of the outside ribs, under the sidewalks, which are 60 centimeters at the crown. They are cast in 9 flanged I-beam sections and bolted together. The lateral bracing is also cast iron. They rest on steel wedges on cast iron bearing plates sunk in the masonry. The deck is carried on cast-iron I-beams 500 by 280 by 30 on cast spandrels.

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Pont St. Louis

The present Pont St. Louis was constructed in 1861 and consists of a single circular metallic arch of 64 meters span and 5.85 meters rise on masonry abutments.

The arch is composed of 9 cast-iron ribs spaced 2 meters c. to c., which carry the deck of brick arches on cast-iron spandrels. The ribs have an I-beam cross-section with a web thickness varying from 52 millimeters at the abutments to 38 millimeters at the crown. Each rib is cast in eleven sections, bolted together. The depth is 1.8 meters at abutments and 1.20 at the crown. All joints are rigid.

The abutments are 10 meters thick and are built of rubble masonry in Portland cement mortar, with cut-stone facing. The left bank abutment rests on piles, and at the other directly upon the soil.

The bridge is 16 meters wide and has a 10-meter roadway.

The total cost was 656,000 francs.

Ponts Sully

These bridges span the main and lesser channels of the Seine at the extreme upstream end of the Ile St. Louis. They are 20 meters wide and carry a 12-meter roadway and two sidewalks.

The abutments and piles of the bridge over the main channel are skewed to an angle of 51° 10′, with the center line of the bridge, and those of the other bridge, to an angle of 66° 26′.

The bridge over the main channel is composed of three cast-iron circular segmental arches; the central arch has a span of 49.56 meters and a rise of 5.66 meters, and the remaining arches have spans of 46.35 meters with a rise of 4.88 meters.

The bridge over the lesser channel is composed of one circular cast-iron arch with a span of 42.28 meters and a rise of 5.45 meters, and two semi-circular masonry arches, one at each end, having a diameter of 15.35 meters.

On the main channel bridge the left bank abutment is built directly upon the sand; the piers are on concrete footings on rock, about 4 meters below the water level, and the right bank abutment rests on piles. The abutments of the smaller bridge rest directly upon the sand.

Each metallic arch is composed of eleven cast-iron ribs spaced 2.0 meters c. to c. In cross-section they are I's, with a web thickness varying from 30 to 52 centimeters. They are 60 centimeters deep at the crown and 90 centimeters at the abutments. They are cast in sections of equal length, measured along the intrados—11 in the arches of the main bridge and 9 in the other. The joints are planed and the sections bolted together. The arches are braced laterally on top of the spandrels by 8-inch cast-iron I-beams, which also carry the brick arches of the deck.

The cost of the bridge over the main channel was 516,000 francs for the masonry and 682,000 francs for the metal; the smaller bridge cost 481,000 francs for the masonry and 193,000 francs for the metallic parts.

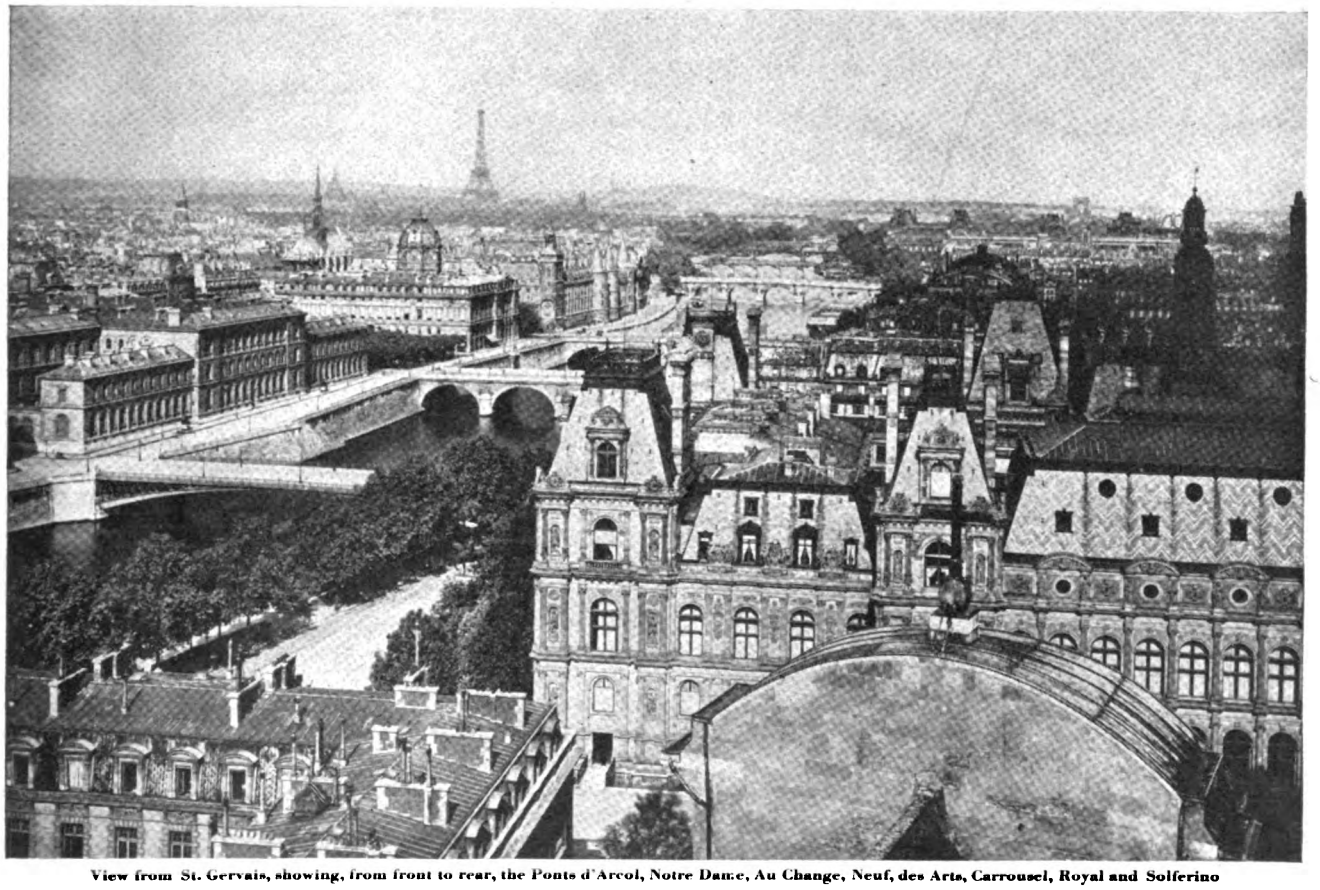
Work was begun in 1874 and completed in 1876.

Passerelle de Debilly

This foot-bridge is separated into two parts by the Ile de Cygnes, the one part being 120 meters long between abutments and the other 89.80 meters. Both sections are composed of two structural steel-deck cantilever trusses. The piers are two steel cylinders, filled with concrete.

The central span of the larger section is 44.20 meters long and that of the smaller 32.20 meters.

The depth of the trusses is 50 centimeters at the connecting pin and 3.5 meters over the piers.



View from St. Gervais, showing, from front to rear, the Ponts d'Arcol, Notre Dame, Au Change, Neuf, des Arts, Carrousel, Royal and Solferino

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The bridge was constructed in 1878 and cost 420,000 francs.

Pont de Grenelle

In 1825 a bridge of six framed arches on masonry piers was constructed, as was also the dike separating the Grenelle basin from the river proper, and which divides the bridge into two equal sections. It became necessary to rebuild the superstructure in 1875, and cast-iron arches replaced those of timber.

The old masonry work was built on pile foundations and was still in good condition. The piers were used without any change, but the abutments were increased in thickness to approximately 6.4 meters.

The new arches are composed of five cast-iron ribs each, spaced 25 meters c. to c. The ribs have I cross-sections and are 70 centimeters deep throughout their entire length. The thickness of the metal is 24 millimeters for the interior ribs and 18 millimeters for the two outside.

The lateral bracing is also cast-iron, bolted to flanges on the ribs.

The work was done during 1874 and 1875 and cost approximately 375,000 francs.

Pont Mirabeau

The Pont Mirabeau is composed of two deck cantilever trusses on two pier abutments. The central span is 93.20 meters and the two shore spans each 32.42 meters between pier faces.

The piers are built in caissons sunk to solid rock, about 10 meters below the river bed. The two end abutments rest on piles. The piers are built entirely of Cherbourg granite in Portland cement mortar, and the abutments are limestone in hydraulic lime mortar.

The bridge is 20 meters wide between hand-rails and has a 12-meter roadway.

Each cantilever is composed of seven structural steel trusses spaced 3 meters c. to c. under the roadway and 3.72 meters for the two outside trusses. The two halves of the bridge are symmetrical, resting on cast-steel rockers on the piers, and pinned together in the center. The shore ends are anchored to the abutments by means of vertical rods set in the masonry.

The channel arm of each cantilever is 49.67 meters long, measured from center line of rocker to center line of connecting pin; the other arm is 37.30 meters from center line of rocker to the end.

The top chords of the trusses are horizontal, the bottom chords take the form of parabolic curves.



The Pont Alexandre III and the Grand Palais

The depth of the trusses is 84 centimeters at the central joint, 50 centimeters at the shore ends, and 53.5 centimeters over the piers.

The deck is carried on brick arches between transversal I-beams spaced 2.0 meters c. to c.

The bridge was designed by M. Resal, and cost 728,000 francs for the masonry, 1,221,000 francs for the steel, and 141,000 francs for the bronze decorative figures.

Pont Alexandre III

The Pont Alexandre III, the most ornate and elaborate of the bridges of Paris, is a single metallic arch with three pin connections, having a clear span of 109 meters between abutments. The end pins set out from the abutment in their bearings 75 centimeters, making the span of the metallic arch itself 107.5 meters c. to c. of pins. The arch has a rise of 6.28 meters, 1/17 approximately.

The approaches on the quays are masonry arches. The

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bridge is 40 meters wide between hand-rails, with a 20-meter roadway and two 10-meter sidewalks.

The arch is composed of 15 ribs equally spaced. The arch ribs are cast-steel and the spandrels structural steel. The decorative work is cast-iron.

The abutment footings are 44 by 33.5 by 3.5 meters, poured in caissons sunk to approximately 6 meters below the river bed. They are built of coursed rubble masonry to a point about 1 meter below the water level, and from that point up of cut granite. All stone is set in Portland cement mortar. In back of the bearing plates the rock is laid in courses approximately 45° to the horizontal and well toward the center of the abutment.

The arch ribs are cast in 30 voussoirs and 4 joint sections. The interior ribs have I cross-sections, and the two outside ones are decorated channels. The sections are approximately 3.5 meters long and have flanged connections bolted together. The depth of the ribs vary from 1.03 meters at the abutments, 1.52 meters at section No. 7 to 90 centimeters at the central joint. The web thickness is 5 centimeters (2″).

Work on the foundations was begun in April, 1897, and the bridge completed just three years later.

The total cost of the structure was 6,585,000 francs, of which 1,000,000 francs were for decoration.

The bridge was designed and constructed by MM. Resal & Alby.

Viaduct de Passy

The Viaduct de Passy is composed of four structural steel deck cantilever trusses. Over the main branch the central span is 54 meters and the shore spans each 29 meters; over the other branches they are 42 meters and 23 meters, respectively. The width of the deck is 24.70 meters and has an 8.7-meter central promenade, two 6-meter roadways, and two 2-meter sidewalks.

In the center of the bridge is the railway viaduct, 7.3 meters wide and 7.5 meters above the roadway. The viaduct consists of deck-plate girders supported on cast-iron columns.

Work was started in 1903 and the viaduct completed in 1906. The total cost was 5,500,000 francs.

The Secret of Universally Good Roads in France

By

Perry K. Miller
Captain, Engineer Reserve Corps

THE difference in the method of road repair between the French and the American is a true indication of the difference in the natures of the two nationalities. It is inherent in the American to get a fair or good result in the shortest time while with the French it is to get the best possible result irrespective of time.

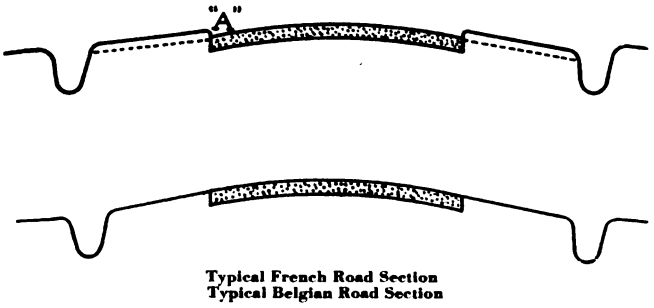
To compare our American roads to French roads is unfair to our engineers unless several important differences in existing circumstances are taken into consideration. One must make due allowances, especially for the following: Our severer climate with frost going from three to five feet, the enormous truck loads and the high speed of most of our traffic.

After the armistice was signed, the American army set out on the tremendous work of putting into shape the thousands of miles of French roads which had been either severely damaged or practically destroyed. Never has there been such an enormous road repair work attempted or accomplished in so short a time. Just how did the army measure up to this work? It is an absolute fact that some if not nearly all of the French Departmental Road Engineers, who correspond to our State Highway Engineers, have, after observing our methods and results, begged that the American army would only distribute road material along the sides of the road and leave all repair work to be done by the French cantonnier (caretaker of from two to five kilometers of road). Here again there must be one more condition taken into consideration. The American soldier in the ranks was not interested in the rebuilding of French roads. He was home-sick and craved for the time when he would embark for home.

Were the French and the Americans to work under conditions most favorable to themselves, the French would far excel in road repair. The secret of it is the patience of the man which keeps him constantly at his endless task.

Many engineers say that road drainage is over fifty per cent of road repair or construction. The French drainage systems are marvelous in their design, construction and upkeep. However, were we as skilled in this part of the road repair we would still have far poorer roads because the reckless haste of our impatient natures would prevent us from giving to the road surface the care which French roads receive.

The Frenchman's thrift presents itself in the design of the roadway proper. His repair practice is the last word in road maintenance. The typical French road section is shown in the figure. The typical Belgian road section has a continuous road wearing surface drainage plan and it is also shown in the figure.



Typical French Road Section
Typical Belgian Road Section

The Belgian road section makes it possible to totally eliminate the standing water troubles often experienced in the use of the other type, particularly on flat grades. The French type, with well attended lateral drains, drains the roads properly and accomplishes the important work of holding at "A" most of the worn particles of the road surface, which play so important a part in the continuous French road repair.

The cantonnier starts out for his work with a two-wheel cart in which he has a stone fork, a shovel, a pick, a rake and above all his improvised brush road broom.

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The road metal is always seen very neatly piled at frequent intervals along the road side. The binder he brushes from "A." Very rarely does he require new material for binding the road metal.

It is the every-day attention that keeps the French road in the state of perfection that we always find it. After rains or showers the cantonniers are particularly active. Every meter of road is worked at intervals of from one to five days. Every piece of road metal finally is brushed into its proper place and there becomes fixed. It is not unusual to see French road workers make several steps to brush single pieces of stone into some particular spot.

It is patience, untiring patience, that is the true secret of the excellence of French roads.

What and Why is a General Staff?

By

Donald H. Connolly

Major General Staff, Engineers

[*Note.* Major Connolly, the author of this article, by reason of his present position as a member of the General Staff at Washington, D. C., and his experience as a staff officer, is exceptionally qualified to speak with authority on the subject of the General Staff.

Moreover, in the preparation of this article, Major Connolly has consulted with many members of the General Staff, and their views are also embodied herein.

We are able to say, therefore, that this article presents a consensus of opinion of experienced General Staff officers as to what a general staff should be and how it should function. It must, therefore, command interest and respectful attention.—ED.]

IN the November-December issue of THE MILITARY ENGINEER there appeared an article by Maj. J. C. H. Lee on Staff Organization. As engineers we are all vitally interested in this subject, with special reference to where and how the engineers fit into the scheme. Maj. Lee's article, read in connection with Maj. G. R. Young's article in the same issue and the comments on both of them, has helped greatly in clarifying the subject. However, there were two points made which are open to argument:

First. That the main duties of the General Staff are in connection with supply questions and the actual command of staff and staff troops.

Second. That the General Staff should be organized on the basis of actual command of certain other staff units rather than along functional lines.

Let us examine the first idea expressed above. Major Lee's conception appears to be that the division commander has four principal assistants; that the three brigadiers are his principal tactical assistants and are held responsible for tactical details; that the Chief of Staff commands the staff and all the staff troops in his own person just as the brigadier generals command their brigades, and that he is responsible for all staff details. The concept appears to be that the staff units virtually form a fourth brigade under the direct command of the Chief of Staff. The article is not clear as to the exact relation of the Chief of Staff to the tactical details connected with the division. Major Lee's contention that the three brigadier generals are the division commander's principal tactical assistants was objected to by several commentators and in his final summing-up the author admits that the Chief of Staff and G-3 are the division commander's tactical advisors. However, from the fact that the Chief of Staff holds direct command of all the staff troops, which the author himself says is fully as responsible a position as commanding a brigade, it seems fairly clear that he probably would not have any more time to devote to tactical details of the work of the division as a whole than an infantry brigadier would have, after attending to the details of his brigade. It seems quite evident that the author considers the tactical work as a secondary mission of the General Staff, as he states: "In other words, the true mission of the General Staff, not only for the division but for any military body, is the duty of fitting the military activities of supply (material and otherwise) into a soundly organized system for control by the superior commander."

In discussing this point, let us first try to answer the question, What and Why is a General Staff?

In his hearing before the Senate Committee on Military Affairs when it had under consideration the provisions to be included in the last amendment of the National Defense Act (Act of June 4, 1920), Col. John McA. Palmer* stated: "I am perfectly satisfied that one of the principal causes of the confusion of thought in regard to a General Staff is that very few people know what a General Staff is. That is true in civil life; it is true in the Army; and it is also true in the General Staff itself."

The Origin of the General Staff

Let us consider what was the origin of the General Staff system, and what is the fundamental idea in foreign armies as to its mission.

The first traces of the General Staff are found about 1655 in the Brandenburg Army which preceded the Prussian Army. Incidentally, for over one and one-half centuries there was a very close connection between the engineers and what later became the General Staff. However, it was Frederick the Great, who as the result of experience in the Seven Years' War, started the system of taking *junior* officers and training their tactical judgment with a view to using them to assist general officers along tactical lines.

Carlyle, in his history of Frederick the Great, describes how Frederick, recognizing that the question of troop leadership on the battlefield was a question of action and not one of merely theoretical knowledge, started to develop in himself a practical sense of tactical judgment. Frederick, while riding through the country, constantly put to himself practical problems as to what orders he would issue were he commanding troops on this or that particular piece of ground, assuming that the enemy did this, or that, or the other thing. Later, Frederick de-

*Colonel Palmer was selected by General Pershing for detail on his staff as his First Chief of Operations, American Expeditionary Forces, and served as such during the initial days until his health broke down. At the time of his hearing before the Senate Committee referred to here, he was Chief of the War Plans Branch of the War Plans Division, War Department General Staff.

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veloped this idea still further on the theory that what had benefited him would also benefit others. At the close of the Seven Years' War he started a school for improving the tactical judgment of officers through this method of making them solve concrete problems. His plan was to select men with tactical aptitude and give them the precise training in higher troop leading and other matters in which the general officer should be expert.

Note the following in reference to his original General Staff system:

(1) That the training given an officer for General Staff duty was precisely the same as that given for high command of line troops.

(2) That after a command reached a certain size the commanding officer needed assistants in his control of the line troops, in addition to those he already had in using the staff troops.

(3) That Prussia had created a body of officers trained in this system of troop leadership and had had a General Staff with troops for over half a century before the Great General Staff at Berlin was established.

The Germans adhered to these original ideas throughout their development of the General Staff system. For instance, consider the type of problems given by Von Moltke to captains and lieutenants in the War Academy as candidates for the General Staff. In some of these problems these officers were required to state what arrangements they would make in a given tactical situation if they were in command of a given army corps or a given division. Von Moltke was not giving these junior officers this training and these tests to demonstrate their ability along these lines because he had any idea of employing men of this rank to command divisions or army corps, but because he expected to use them as assistants to generals who would train and lead these units.

Education for the General Staff or Etat-Major in France proceeds along similar general tactical lines. All candidates for the General Staff attend the Ecole-de-Guerre. Men like Foch and Petain are products of the French system.

The British have the same general idea that education for the General Staff must be along tactical lines.

The Japanese have the same idea that a General Staff officer is a specialist in troop leading and tactics. Of course they borrow their ideas direct from Germany, but they had considerable experience themselves in applying this system during the Russo-Japanese War. They went to what we would consider extreme lengths in applying the idea that the commanding general should keep his mind clear for the big decisions and turn over to his Chief of Staff the issuing of the tactical orders necessary to carry these decisions into effect.

All of these nations have had a chance since the adoption of the General Staff system to try it out in time of war, and the fact that they have retained it still organized on the same basic ideas, shows that their experience in war has given them no reason to make fundamental changes. The main point to be noted in all this is that, to quote Colonel Palmer: "A General Staff officer in that sense is primarily a trained troop leader; he is a man who is trained in tactical values; and when he comes to co-ordinate other agencies or other services it is purely in that direction that he ought to influence them. He should not do their business for them."

Under the French and German systems the tactical faculty has been determined and developed in the General Staff officer, and that is the primary reason why he is on the General Staff. He may be in the G-4 Branch (a supply branch) and deal with something other than tactics, but he is always dealing with it from the tactical point of view. The trained General Staff officer in G-4 will inform the supply services as to what they ought to supply in order to conform to the tactical plans. If you put a quartermaster or an engineer in there who is not trained along General Staff lines, he will feel, of course, that he is put there to do something, and not knowing exactly what, he may be inclined to take over complete control of the quartermaster or engineer activities. Some instances of this occurred in our own army during the World War.

The origin of the General Staff system and its development abroad may be summed up somewhat as follows:

When armies were small and the maneuvering, quartering and fighting formations were prescribed by rigid regulations, the general in command could personally work out what few details his orders necessitated, and often conducted the battle from what he personally knew about the terrain, the enemy, his own troops, and what he himself could observe as to the progress of the battle.

As details became more numerous and could no longer be governed by fixed rules, a commander in the field shifted more and more of the details of supply questions to the shoulders of subordinates in order to keep his own attention more clearly on his main job, which was to maneuver his fighting units in such a way as to accomplish the defeat of the enemy. Thus was developed the supply staff. As armies grew still larger and tactics changed and developed with the improvement in weapons, a point was finally reached where the need was felt for a distinct group of staff officers to relieve the commanding general of some of the details connected with the tactical handling of the fighting units. In most armies this group of staff officers is called the "General Staff." The General Staff group of the entire staff necessarily became charged with the duty of keeping the supply services and other specialist staff officers in touch with the needs of the tactical and strategical situation.

Colonel Palmer summed this up very concisely when he said that originally the General Staff was organized to perform staff functions that previously had not been performed at all except possibly by the commander in his own person, and was not organized merely as a new agency to perform functions already being performed by assistants to the commander.

This was the reason for the establishment of the General Staff system, and after the test of war it is still regarded as its mission in most important foreign armies.

The Creation of Our Own General Staff

Let us examine briefly the conditions under which the General Staff was established in the United States Army, how we started out, and the subsequent developments.

The basic fact is that we started from the top down instead of from the bottom up, as the Germans, French and British did.

The Germans had a General Staff with troops over fifty years before they had a Great General Staff in Berlin, just as we had our Army Quartermasters and a proper conception of what a quartermaster should be long before we had a Quartermaster General in Washington. On the other hand, we had what would correspond to the present War Department General Staff before we had what would correspond to the present General Staff with troops. In fact, at the time that the General Staff was first organized, we did not have organized bodies of troops large enough

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to utilize a General Staff or, in other words, we did not have any organized bodies of troops large enough for the commander to need assistants in his own peculiar function of command. Few, if any, of the original members of the General Staff Corps had training or experience as General Staff officers, on which to base their conception of what a General Staff officer should be and do; consequently they looked to Germany where the system had been in operation since about 1760, but they did not look very closely. To some people words are of more consequence than ideas. We borrowed the words, but missed a large part of the fundamental idea back of them.

We took the term "General Staff" from the German term "Generalstab." However, the ordinary English meaning of the words "General Staff" is quite different from the German idea expressed by the word "Generalstab." Because of this faulty translation, many people, looking merely at the words and not at the idea, have assumed that a General Staff officer is an officer whose activities are of a *general* character in that they extend over all matters that concern more than one special branch of the service. In other words, that his duties are of a general nature rather than of a special nature.

The German and the French idea are both to the effect that he is a specialist of the most restricted type. Even the British, who started their General Staff a year after we did ours, avoided making our mistake. In the discussions of 1904, which preceded the organization of their General Staff, it was particularly pointed out that this warping of the original meaning should be avoided. It was suggested that a better name than General Staff would be to call it the "Military Operations Staff," in order to make its mission clearer. It was pointed out that one of the first duties of the General Staff was to establish an educational system and standards of eligibility for the General Staff with accompanying lists of officers who came up to those standards.

The literal translation of the idea expressed by the words "Generalstab" is the "General's Staff" or the "Generalship Staff" or "Military Operations Staff." As confirmatory evidence that the Germans understand it this way, consider the fact that although the Army General Staff had been developed during many years before the German Navy had progressed to the point where they required an agency for the Navy corresponding to the General Staff of the Army, the Navy did not call this new agency the "Naval General Staff." They called it the "Admiralstab" or the "Admiral's Staff." The German idea was that just as a general officer needed an Engineer Staff to advise him on engineering matters, a Medical Staff to advise him on matters concerning the health of his command, so also he needed a Generalship Staff to assist him in the performance of his own peculiar functions of leading troops in battle.

To Mr. Elihu Root (while Secretary of War), more than any other one man, belongs the credit for establishing a General Staff Corps in the United States Army. In his report for 1903, Secretary Root said: "The important military event of the year affecting the Regular Army has been the reorganization of the system of military control under the General Staff Act approved February 14, 1903 * * *. This act abolishes the separate office of Commanding General of the Army, provided for the President a military Chief of Staff who, acting under the direction of the President or the Secretary of War, representing him, should have supervision not only of all the troops of the line, but also of special staff and supply department, which have heretofore reported directly to the Secretary of War; and created for the assistance of the Chief of Staff a corps of 44 officers who were relieved from all other duties."

In the regulations issued by the Secretary of War (Mr. Root), by direction of the President, putting into effect the law establishing the General Staff, will be found the following:

"Under the Act of February 15, 1903, the command of the Army of the United States rests with the constitutional Commander-in-Chief, the President, . . . The President's command is exercised through the Secretary of War and the Chief of Staff. The Secretary of War is charged with carrying out the policies of the President in Military affairs. He directly represents the President and is bound always to act in conformity to the President's instructions. Under the law and decisions of the Supreme Court, his commands are the President's commands and his directions and orders are the President's directions and orders. The Chief of Staff reports to the Secretary of War, acts as his military advisor, receives from him the directions and orders given in behalf of the President and gives effect thereto in the manner hereinafter provided. . . .

The supervisory duty vested by statute in the Chief of Staff covers *primarily* duties pertaining to the command, discipline, training, and recruitment of the Army, military operations, distribution of troops, inspections, armament, fortification, military education and instruction and kindred matters, but includes also in an *advisory* capacity such duties connected with fiscal administration and supply as are committed to him by the Secretary of War. . . . In the performance of the duties hereinafter indicated and in representation of superior authority, the Chief of Staff calls for information, makes investigations, *issues instructions*, and exercises all other functions necessary to proper harmony and efficiency of action upon the part of those placed under his supervision."

Note that Mr. Root clearly understood what the primary duties of the General Staff should be and that such instructions as it issued to the staff and supply departments were to be those necessary to bring their work into harmony with the Army as a whole.

It is now prescribed by law that an officer shall not be detailed to our War Department General Staff unless he is competent to perform General Staff duties with troops. In our original organization of the General Staff, which did not include a General Staff with troops, we did not have available men with the basic experience or training which foreign armies considered necessary for General Staff duty with troops. Our original idea seemed to be to get men of marked ability in their various specialties and let them run things. We got together what was probably the ablest body of men in the service at that time, but it was not a General Staff. It was an aggregation of exceptionally able infantry, cavalry and artillery officers, engineers, quartermasters and other gifted specialists. Our General Staff system soon started doing on a grand scale for the military establishment just about what Major Lee recommends on a smaller scale for a division. The General Staff gradually worked itself into power and took command of things. Note again that it did this mostly along the lines that Major Lee advocates—that is to say, technical and supply service lines. It began to take actual command of the technical and supply services while slighting its own peculiar tactical and planning functions as understood in all important foreign armies. It is worthy of note that most of the criticism of the General Staff down to date has come from the various staff bureaus, and not from the line.*

*This does not prove that the General Staff did not in fact improperly assume line functions. The line was inarticulate as it had no chiefs or spokesmen for its various branches except for the Coast Artillery, whose chief was a member of the General Staff and had no occasion to publicly criticise his co-members. Forceful, strong minded infantry or cavalry officers in the General Staff became in effect, if not in name, the chiefs of their respective branches and influenced from within the actions of the General Staff in all matters pertaining to their respective arms.—Ed.

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The volume of the criticism and the caliber of many of the officers doing the criticising should make us pause and think before we dismiss the subject with a few pitying remarks about pigmy minds. There is an old proverb about fire where there is much smoke. Is it not possible that even in recent years, the General Staff has sometimes forgotten the basic reason for its existence?

In 1906, Major Morrison (now Major General) revolutionized the educational system of the Army by putting into effect at the Fort Leavenworth Schools a definite system to prepare officers for tactical command of troops and General Staff duty. Note again here that the training for the two is the same, as the primary function of the General Staff is to assist and relieve the commanding officers of burdensome details in their own peculiar function of tactical training and handling of troops.

The result of our experience in the World War has been to strengthen the belief in the correctness of the doctrine taught at Fort Leavenworth as to the mission of the General Staff, and the training necessary for a General Staff officer.

Since the war, thought on this question has become further crystalized to the extent that the training system now prescribed for qualification for appointment to the General Staff is designed to insure that a General Staff officer shall be a specialist along tactical lines. I am not to be understood as saying that, because a man is an excellent division Chief of Staff, he will necessarily develop into an excellent division commander, or that an excellent division commander must necessarily have the same detailed technical knowledge as an excellent Chief of Staff; other factors enter in. The general must know enough about strategy, logistics, and tactics to come to a sound decision on the project as a whole. Just as the commanding general will consult his Chief Engineer as to whether or not an engineering project involved in his plan is feasible and his Chief Engineer may suggest another one in case the one thought of by the commanding general is not feasible, so the Chief of Staff must be able to furnish his commanding general technical advice along generalship lines. For instance, he knows the details as to the position of each unit of the command, how much road space each one will take up, how long it should take to get the command into a given formation or position, the latest information known as to the enemy, the state of supplies and transportation, and other essential details. All this must influence any tactical decisions made by the commanding general. The mind directing the division, or army corps, or other unit is not a composite mind. It is the mind of one man—the commanding general. However, this mind should not clutter itself up with details either of information (tactical, engineering, etc.) or of execution (the orders it is necessary to give to each unit to carry out his decision). This is not to bolster up a figure-head but to leave a big-caliber man's head clear for the big aspects of the problem. The credit for success, or the responsibility for failure, is rightfully his.

The Chief of Staff and the Fourth Brigade

Taking up the point that the division commander divides his task and personnel into four parts and allots one part to each brigade and one part to the staff troops commanded by his Chief of Staff, it is not believed that the tactical mission assigned a division permits of such an allotment and even if it did, the Chief of Staff is not the man to command the fourth brigade (composed of the staff troops).

If a tactical mission is subdivided on lines of direct responsibility and command, all subdivisions are tactical. Normally, the staff and staff troops are auxiliary means at the disposal of the division commander to assist his tactical units in achieving their missions. If he divides the mission of his division amongst the brigades, he must see that the means are also distributed so that each brigadier shall have proper assistance. He may allot engineer and signal troops to each brigade and may even take batteries from the field artillery brigade and place them directly under the orders of the infantry.

In subdividing the tactical mission of the division, the staff troops do not act as one body and receive one integral section of the mission. They are functional troops (so to speak) and are the means to assist those units that do take over sections of the tactical mission.

Even if the staff troops were to be combined in one brigade (which is believed to be wrong in principle) the Chief of Staff should not command it. His education and the uses to which he is to be put in the division are mainly tactical.

The idea that a division commander should rely on his brigadiers for tactical information and advice appears highly questionable and is entirely aside from the fact that they are not always available. Each is naturally more interested in his own brigade than in the others and ordinarily has neither the time nor the opportunity to study the problems of the division as a whole, as have the division commander and his Chief of Staff. If time allows, the division commander would probably talk over with the various brigadiers the missions to be assigned them and possibly make some changes in boundary lines of the sectors and other details. However, it is believed that ordinarily the brigadiers would not be consulted until the division commander (with the assistance of his Chief of Staff) had blocked out the plan for the division as a whole.

Most of the successful military commanders of history have not relied on the town-meeting method of arriving at a decision. In the words of one of them: "If the commander, after consultation with his authorized advisor, feels the need of asking others what to do, the command is in weak hands."

The True Mission of the General Staff

The military history of our own and foreign countries appears to establish the fact that the true mission of the General Staff is *not* to command the supply and technical services; that on the contrary the General Staff is a technical service in itself and its true mission is to furnish detailed assistance in its own specialty of troop leadership.

Even the G-1 and G-4 branches of the General Staff, which deal with matters other than tactics, deal with them from the tactical and strategical points of view. They are in existence merely to keep personnel and supply matters closely in touch with the details of the strategical, tactical, and training plans. The training prescribed in order to qualify for detail in any section of the General Staff is based primarily on handling of line troops.

The Basis of Staff Organization

Having considered what a General Staff is, and what it is for, let us now take up the second point brought up by the author of that article, as to how it should be organized, whether along functional lines or on the basis of direct responsibility and command.

Major Young's excellent article on the "Fundamentals

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of Staff Control" in the same issue of THE MILITARY ENGINEER as that in which Major Lee's article appeared has covered so well the necessity of organization along functional lines for the General Staff that I merely wish to put his rule for staff control into slightly different words. His rule is "non-interference except when questions concern two or more bureaus or services." I would prefer to say "except when the decision on the question directly affects the tactical situation." This amounts to the same practical criterion as that given by Major Young, but it brings out a little more clearly the basic mission of the General Staff as expressed in the first part of this article.

For instance, Major Young cites an example where a decision is needed as to which one will have the use of certain transportation—the division engineer or the division quartermaster. As he says, this would be decided by G-1 who thinks "in terms of transportation questions." The additional words "with respect to the tactical situation" are of course understood.

This rule covers the extent of General Staff control fairly well if we are sure that we are all speaking the same language. However, since some General Staff officers apparently operated on this rule during the World War and still succeeded in missing the whole point, let us go a little further into detail as to exactly what we mean.

It is believed that many of the mistakes made by General Staff officers in the World War were due to lack of comprehension of one of the simplest and most fundamental principles of management that apply to both military and civil work. This is, when you give a man a mission, you must also give him the means to accomplish it. "Means" consist of many different things, but to illustrate the point let us consider the example used above by Major Young—transportation.

A division commander has a certain amount of transportation at his disposal. He has a number of officers under him whose work requires transportation. He can not give each of these officers all the transportation needed for any task that may be assigned them, yet if he assigns a task he must also assign the means necessary to perform the task. The proper distribution of transportation is then to give each officer requiring transportation such an amount as will enable him to accomplish his average amount of work or even his minimum amount of work if transportation is very limited. The rest of the transportation should be kept in such a flexible state of control that it may readily be diverted from one activity to another, according to the need for it, and a staff officer put in charge.

This staff officer in charge of transportation is not there in a negative role to "interfere," nor yet to refrain from interfering; he is there to help by positive action whenever help is needed. If things are moving along smoothly and his assistance is not required, the less he has to say the better it will be for all concerned. Since the time when help is most needed is in a crisis, let us consider the case of a division about to attack over ground cut up with trenches and shell holes. A number of officers have to prepare to meet a crisis demanding transportation and they all apply for help. The division quartermaster and the division ordnance officer want to be ready to rush supplies forward; the division surgeon anticipates more wounded than his transportation will handle; the division engineer says he can't build his road through without extra trucks, etc. All the transportation of the division, plus all it can get from the corps, would not be sufficient to hand over on demand to each of these officers all that he needs, yet each must receive the means necessary to carry out his task. It is not a question of relative importance of the tasks. They are all essential and all must be carried out. I believe a case like this illustrates fairly well what the General Staff officer in charge of transportation is there for. It is not a case of interfering or deciding between two men who both ask for the same transportation. It is a case of G-1 furnishing, if he possibly can, such help as will let both or all of them carry out their missions.

It is fortunate that even in an emergency like the case under consideration, the crises of the various activities occur at different times and can, to some extent, be foreseen and the curve plotted in advance. For instance, in this case the crisis of the division engineer unquestionably comes first in point of time. He should have immediately all available transportation to enable him to get his road through promptly. Incidentally, the division engineer should be given the exclusive control of the road for a certain number of hours. After the staff has arranged to help the division engineer with his mission, then they may arrange to help the others in the proper order, according to circumstances, as to the quartermaster and ordnance officers getting supplies forward and the division surgeon getting his wounded back. It would be poor staff work to allow the division quartermaster to keep supply trucks loaded ready to rush forward. The daily radius of action of a truck is such that he can get his supplies forward much more promptly by unloading the supply train and letting the division engineer use these trucks for road material. The trucks can come back and be reloaded and still reach the troops more promptly than if they had remained loaded readv to start.

Thus G-1 does not really "interfere" with anybody, but does help all by so using his limited transportation that each officer is furnished sufficient means to perform his allotted task.

Now let us consider a case where it is impossible to assign sufficient means to carry out an order: If the division engineer is given a task that requires more transportation than that normally allotted to him, he must also be given the necessary extra transportation by the authority assigning the task—that is, the division commander. In the example cited by Major Young, both the division quartermaster and the division engineer evidently need the use of certain transportation to carry out orders given them. It is not enough for G-1 to decide who shall have it by thinking in terms of transportation, and deciding who has the greater need of the limited amount available. Suppose both need this transportation at the same time, and it has been decided that the division quartermaster's work should be given priority over that assigned the division engineer, and G-1 assigns the transportation to the division quartermaster. The matter is not settled yet. G-1 must see that the mission assigned the division engineer is changed to correspond to the reduced means given him to accomplish it. The mission and the means are inseparably bound together.

For instance, the division engineer is ordered to build within a certain time two bridges, which are to be used simultaneously by two columns of troops, and he states that he needs a certain amount of transportation to do it, which is more than he has. If G-1 finds that he can only furnish enough to make up half the amount of transportation needed, he must see that the orders issued the division engineer are changed so as to allow him to double the time or else

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require only one bridge to be built within the time limit. Of course, if the division engineer habitually makes wrong estimates and insists on more transportation than he needs, that is a different matter. The remedy in that case is to get a new division engineer. If G-1 takes the stand that the division engineer can perform his mission with less transportation than the division engineer claims is the minimum needed, then the division engineer is no longer responsible for results. G-1 has assumed responsibility for the results of the mission given the division engineer. In fact, G-1 has done even more harm. He has taken the prerogative of making a tactical decision, affecting the division as a whole, away from the division commander and given it to the division engineer. If there is not time to go over G-1's head to the Chief of Staff or the division commander, the division engineer now has to decide what he had best do with the means available, whether to carry material to both bridge sites, and thus take double the time allowed, or to construct first the bridge that he (the division engineer) considers the more important and then start on the other. The decision must be made by someone. If the division commander doesn't do it, the division engineer must.

The General Staff officers are present for the main purpose of keeping things closely tied in with the tactical situation. G-1 must keep the Chief of Staff, and through him the Commanding General, informed as to the transportation situation, so that orders will not be issued requiring transportation not available. If it develops later that enough extra transportation can not be allotted to enable an assigned mission to be carried out, then the staff must see that the mission is changed to correspond to the means available. Otherwise, the power of making the decision passes from the officer giving the order to the one receiving it. If poor staff work allows a subordinate commander to receive conflicting orders or a mission without sufficient means to carry it out, then if time does not allow the matter to be taken up with the Commanding General, the decision must be made by the subordinate commander as to which order he will obey or what part of his mission he will not carry out, due to the lack of means. It is up to the division staff to preserve to the division commander his right to make decisions on matters affecting the division as a whole.

Major Lee, from the viewpoint of his different experiences, has come to an opposite conclusion from that of Major Young. In objecting to the functional organization of the General Staff, he says, "It is not known why Leavenworth should indoctrinate the American Army with such an impracticable framework when the simple principles of organization can be applied to the staff as well as the line." Is it true that one good system of organization will fit all cases? Because the system in force in the line works well there, does it necessarily follow that it ought also to work if applied to the staff?

Both Major Lee and Major Young appear to agree that the basic principles of General Staff organization apply to any unit having a General Staff. However, since their experience with the General Staff in different sized units has led them to different general conclusions, let us consider some of the basic principles that should apply to the General Staff regardless of the size of the unit.

Major Lee gives a list of seven "first principles of organization," and by applying them to the problem finally arrives at the conclusion that the organization of the General Staff should be along the same lines as that on which the line of the Army is organized. Let us prefix to his list of first principles one that appears to have priority over all that he mentions, viz, that the first determining factor to be considered in organizing is the object for which the organization is to be formed.

There is more than one way of subdividing almost anything, and the method of subdivision used depends on the use to which the subdivisions are to be put. For instance, water may be subdivided on at least two dissimilar bases. The city water company considers it as composed of units of the same kind as the whole, such as gallons, cubic feet, or other units of water, while the chemist considers it as composed of hydrogen and oxygen, which enter into the composition of each and all of the units. Organization of men consists of a subdivision into units so as to facilitate the handling of the whole by one man at the head; this subdivision also may be effected in more than one way, depending on the use to which the subdivisions are to be put. Before organizing we must first decide on what the subdivisions are to do. It is a little hard to generalize, but possibly it may be expressed in this way: Are the duties of the heads of the various subdivisions primarily *downward* or *upward*.

Organization for Control Downward or Assistance Upward

Downward. In this case we are organizing so that the commanding officer of any unit can be given an integral part of the mission of the next higher unit. He is given an integral part of the means available with which to accomplish his mission, and is held responsible for results. His duties are *downward*. That is, he so uses the means placed under him as to accomplish the results required. In organizing with this object of successively subdividing and distributing the missions and means of the whole *downward* we have found, by experience, that the type of organization used with line troops is the best.

Upward. If our object is to organize a force to furnish technical information, advice and assistance *upward,* that is to the chief in command, we necessarily organize by subdivisions according to nature of information and advice.

Both of the above types of organization are correct, but neither is correct for all cases. The one that is here described as "downward" is the one best adapted for the line of the Army, while the one here characterized as "upward" is found in organizations of most staffs, military and civil.

To which of these two subdivisions does the General Staff belong? As shown in the first part of this discussion, the mission of the General Staff is universally regarded as being that of furnishing technical information, advice, and assistance to the commanding general and preparing the orders necessary to give effect to his decisions—that is to say, its duties are primarily *upward.*

It may be objected, as Major Lee says, that the General Staff gives orders and exercises control *downward* and that, therefore, its organization should be like that of the line. However, why does it give orders? Is that its basic function? It is not. Take the War Department General Staff for example. It not only furnishes technical information and advice *upward,* but exercises control and command *downward.* However, the control and command exercised downward are but corrolaries to its principal reason for existence—its work upward. It amounts to just this: The Secretary of War has a great number of matters of diverse character presented for his decision. No one man, no matter how capable, can possibly give each of these matters the amount of study necessary for a proper decision. Consequently, he needs a body of assistants organized according to subject matter to prepare studies on which he may base his decision without having to dig out the facts himself. A

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matter is ordinarily referred to that section of the General Staff handling subjects of the same character. The Secretary of War ordinarily does not make a decision on any subject until an expert has clearly laid out the possible decisions that may be made and effect of each decision not only on the matter in hand, but on any matter it may affect.

Many minor matters that are of too little importance to take up the time of the Secretary of War must be decided on from the viewpoint of the Army as a whole. These are handled in the name of the Secretary of War by those to whom he specifically delegates the power to give orders in his name (Chief of Staff and the Assistant Chiefs of Staff). What this amounts to is that within certain specified limits the Secretary of War approves in advance the recommendation of his adviser, who is an expert in the particular question at issue, who knows his policies, and who also knows his intentions with regard to the Army as a whole. Thus the fact that the General Staff does also give orders downward does not call for any different organization than that necessary to it for information and advice upward. The functional organization of the General Staff, therefore, appears to be suited to its duties both up and down, since its duties downward are of a secondary incidental nature and based directly on the confidence the Secretary of War has in the sound judgment of its advice upward.

Mr. Elihu Root, with his customary clarity of thought and expression, said of the General Staff: "It is not an executive body; it is not an administrative body; it acts only through the authority of others. It makes intelligent command possible by procuring and arranging information and working out plans in detail, and it makes intelligent and effective execution of commands possible by keeping all the separate agents advised of the parts they are to play in the general scheme."

The commanding general of a division, having decided on a course of action and discussed the main points with his Chief of Staff, may authorize the latter to give orders for the minor details necessary to carry his decision into effect. Just how far the Chief of Staff can go in making arrangements without presenting the case to the commanding general depends on the individual commanding general and his opinion of the capabilities of his Chief of Staff. The General Staff officers are not charged with any specific integral part of the tactical mission of the division. They are assistants to the commanding general in discharging duties that are his. If he allows his Chief of Staff to issue orders and make decisions in his name, it signifies merely that many minor points come up that must be decided from the viewpoint of the division as a whole; that the commanding general has no time to consider personally each one of these minor points, so he decides in advance that he will take the advice of his advisor, who is an expert on all such matters and who also knows his intentions with regard to the division as a whole. Therefore, the Chief of Staff gives not his own decision, but the decision of the commanding general. The Commanding General may not be personally consulted, but the Chief of Staff knows in advance what his decision should and will be. If he doesn't know, he had better take the question up with the general, or else the general will soon be asking for a new Chief of Staff.

The point I wish to bring out is that the Chief of Staff is *not* in the chain of command; that while he gives decisions and orders without consulting the commanding general in every case, these decisions and orders are always such as he believes the general himself would issue were the matter before him. These orders are with the consent of the commanding general, and only go as far as he allows. This point is important: Orders given by a General Staff officer are given only with the consent of the general commanding, either express or implied.

Organization and Assignment

After we have determined the form of organization best suited to attain our object, we next consider how we can best use the personnel available to effect this organization.

Having first drawn up our organization chart, we *then* write names of persons selected to fill the various positions.

Gen. Fox Conner points out that our staff organization should have the same subdivision of duties throughout all organizations from G. H. Q. down to the smallest unit large enough to have a staff. However, we note as we get down to the smaller units that a function which in large units may require all the time of one man plus a number of assistants, may in the small unit not have sufficient work connected with it to occupy all the time of one man really big enough to handle the job. This problem is usually solved by assigning a man of sufficient ability to do the work and utilizing his surplus time by assigning to him other duties as well. In other words, his name is written in several places on the organization chart. The point that so many persons miss is that organization and assignment are not the same thing. In some of our small Army Posts one man frequently was Post Adjutant, Post Ordnance Officer, and Post Signal Officer. No one would contend such an assignment to mean that those three branches were grouped together in one organization.

The main purpose of a study of organization is too often considered as determining the limiting lines separating the work of one man from that of another. This conception is apt to lead to a system of water-tight compartments and poor team-work. I mention it here, as the point should be stressed that it isn't a place where their work *divides*, but where it *meets*. The New York Stock Exchange is not the dividing place between buyers and sellers. On the contrary, it is the place where buyers and sellers *meet*.

Technical Staff Advisors

The commanding general of a division who has the responsibility of deciding on some project or enterprise may need engineering advice. For instance, suppose that an important part of his scheme depends on being able to get a bridge built near a certain point in a certain length of time. He very properly calls into consultation the chief engineer of the division and asks him if it can be done. The general has to make the decision, and he wants his expert advice first hand. Assume that the chief engineer says it can be done and that the general decides that he will adopt the operations plan he was considering. He informs the Chief of Staff of his decision, and the latter promulgates the same in suitable orders. He includes therein the task assigned to the divisional engineers. He allots to the latter such necessary transportation, material, and other means as may not previously have been under the control of the regimental commander. The Chief of Staff should, however, bear in mind that the orders to the chief engineer should be merely those that indicate where the work of the engineers fits into the general plan of operations decided on by the general. The chief engineer, by virtue of his close touch with the commanding general, knows the latter's aims and desires; he knows what is needed; knows the resources at his command, what can be done, and when and how. The Chief of Staff should indicate the task of engineers in rather broad, general terms and should not give de-

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tailed instructions to the chief engineer on matters which are clearly within the sphere of the latter as an engineer.

Under this mode of procedure the officer commanding the engineer regiment functions in a dual capacity—that is to say, he has his name written in two places on the organization chart. In his capacity as division engineer he is the technical advisor of the commanding general on engineering matters; he also commands the engineer regiment, which is the unit that executes the engineer projects.

While with the 30th Division I had a good opportunity to observe Col. H. B. Ferguson, Corps of Engineers, who commanded the divisional engineer regiment. From him I learned a great deal on organization and how the engineers fitted into the scheme. In important matters involving engineering advice, the commanding general consulted him personally. The decision having been made by the commanding general, the regimental commander took orders from the Chief of Staff as to his part in carrying out the project.

It is admitted that the various G's have often meddled in details pertaining to the various units of a division to such an extent that they really commanded those units in fact, even though they did use the phrase "by command of." It is suggested that one remedy for this situation is to have only such a number of staff officers as are actually needed to perform their proper functions. They will then have no time to try and do someone else's job for him. A staff officer who is not actually needed for proper staff work is a positive detriment to the command. It is not only wasting a man who should be used elsewhere, but he is apt to create work for himself by meddling in someone else's work.

Functional Organization of Division Staff

Major Young's article makes it quite plain that the organization of the General Staff at G. H. Q., A. E. F., must necessarily have been along functional lines. Without going over the ground already covered so well by him, it may be stated that his contention that the General Staff should be organized on functional lines may be extended up to the War Department. The experience of the War Department since the General Staff was organized in 1903, to date, leaves no reasonable doubt that the organization of the War Department General Staff should be along functional lines rather than along the lines of organization advocated by Major Lee for the General Staff.

When it comes to extending Major Young's thesis down to include the division, I have to admit that my experience with a division has been quite limited compared to that of Major Lee. Aside from the difference in the size of the units, what is the real fundamental difference between the work of the various general staffs as we progress from the War Department down through G. H. Q. to the division? Is it not the time factor? The General Staff is primarily a planning body. Its duties of seeing that all the separate agents work together as a team and of seeing that every agent is provided with the necessary means for carrying out his mission are performed in its plans. However, we note that as we proceed downward from the War Department, each successive General Staff plans for an event less far in the future, until we sometimes find the General Staff with a division furnishing plans of action for an event only a few minutes in the future. I offer the following suggestions as a substitute for Major Young's explanation of why the theory of functional staff organization, as set forth by him, for General Headquarters did not agree with what Major Lee said about experience indicating organizational control being best for the General Staff with a division.

Major Young says in part: "I think the conclusion to be drawn is that strictly functional division of staff duty is proper at the upper end, with the supreme command of a very large force; and that as one proceeds downward through armies, corps, and divisions, its outlines become more and more blurred, until in the division an arrangement is found in effect very similar to that outlined by Major Lee, implying a combination of organizational and functional control, with the former predominating."

Much of the seeming blurring of the fundamental principles of functional organization disappears if it is recognized that the General Staff is to assist the general in his own peculiar functions of command and that there is a difference between organization and assignment. As we progress downward from the War Department to the division the successive commanders have less and less far-reaching plans and decisions to make, but their plans and decisions have to be made more quickly and the orders necessary to carry them into effect have to go into greater detail. Consequently, these successive general officers use their General Staff less and less for comprehensive studies and more and more for working out and issuing the detailed orders necessary to carry the plans and decisions of the commanding general into effect. This progressively increases the proportion of the order giving duties of the General Staff downward and decreases the volume of its advisory duties upward. However, we must not lose sight of the fact that the unit commander only allows these orders in his name because he has confidence in the staff officer as an expert in his particular specialty. Therefore, it seems that the General Staff should still be organized according to special subjects or functions. G-1 handles the details of his specialty for the whole division (but only in so far as they affect the division as a whole). His duties are more intimately connected with certain units of the division than others, but this is no reason for G-1 actually commanding those units. This would tend to incline him to meddle in details that do not concern the division as a whole, and it loses sight of why there is a G-1.

As Major Young says, "Where personal contact and personal understanding weaken, there must be an increase in system and theories of organization." In small organizations, personal contact and understanding can be used to such an extent that system and theories of organization are not needed to the same degree as in larger units. Also, organization and assignment become more or less confused, and a few capable men in the key positions will enable the commanding general to handle his unit. All this makes it difficult to formulate theories as to General Staff organization of general application, based on what worked in some one division. Possibly this is why the theory of General Staff organization based on experience with higher units will work in the division, but the theories deduced by Major Lee from what worked in a division would not be applicable to G. H. Q. or the War Department.

Basic Principles Apply to All Units

The same basic principles of General Staff organization should hold for units of all sizes. The functional organization of the General Staff has worked, does work, and will work for any unit from the War Department down to the smallest unit large enough to have a General Staff. The same can not be said of the theory of General Staff organization advanced by Major Lee.

Major Lee states that the system advocated by him has actually been tried with success. Not infrequently have capable men obtained good results in spite of, and not because of, the form of organization employed.

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Popularizing R. O. T. C. Instruction

By

Lucius D. Clay

Captain, Corps of Engineers
Assistant Professor, Military Science and Tactics
Alabama Polytechnic Institute

[*Note.* We cannot too often remind our readers that the R. O. T. C. is the source from which our government expects to draw the trained officers to lead its forces in the next war emergency. Next to the regular army, perhaps, the R. O. T. C. is the most important element in our present military policy. It is a workable and working scheme for providing a reserve of trained officers.

It is an important duty of the Society of American Military Engineers to support and encourage the R. O. T. C. in every possible way. And as a first step towards this it is necessary that we understand what the R. O. T. C. is, what it aims to achieve, and how it is going about its task. The best picture of the R. O. T. C. which we can present is shown in the accounts of the enthusiastic young officers, like Capt. Clay, who are giving the best that is in them to make a success of this important work.—ED.]

THE R. O. T. C. has been developed to a point where it is a vital link in the nation's chain of preparedness. To increase its value and its scope, the question for the future is how to popularize it with both students and faculty, how to emphasize its value as a part of the college curriculum. The answer to these questions lies in the methods of instruction given to the students. This instruction can no longer be the deadly routine of close order drill and physical training. It must be instruction of a broad and comprehensive nature presented always with enthusiasm and with an appeal to the interest of the students. It must carry to the student the fundamentals of all phases of military training, teaching him in the class room how to apply theoretical principles to actual conditions. It must be tangible, something that can be seen by the faculty and by the parents of the students, and at the same time, it must be instruction that is essential to prepare these youths for their place in the event of a national military crisis.

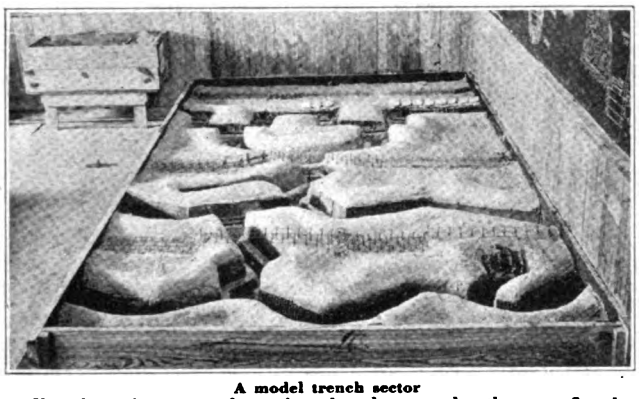
Bearing in mind this idea of training the members of the R. O. T. C. to the highest degree and, at the same time, so popularizing the work that both student and faculty will consider the military work an important and interesting part of the curriculum, the Department of Military Science and Tactics at the Alabama Polytechnic Institute has adapted several schemes of instruction. These schemes have achieved satisfactory results in that the R. O. T. C. has developed until it has an accepted place as one of the principal courses given at the institution and as one having the interest and support of both students and faculty.

The schedule requirements of the R. O. T. C. are based on a four-year course covering a total of 576 hours, and are designed to give a well-rounded knowledge of military fundamentals with special instruction in the duties of each branch of the service. To accomplish this result, work must necessarily be divided into two parts; theoretical and practical instruction. During the scholastic year, theoretical instruction predominates; it seeks to give to the student the basic knowledge which he will be able to apply to practical conditions during the summer encampment. The first requirement is to develop "esprit de corps" both for the individual unit and for the branch of service it represents. To develop this spirit, it is essential to have a period, or periods at which the entire unit can be consolidated for drill purposes. This period gives the advanced student the opportunity to prove his ability as a leader and also serves to furnish occasions for ceremonies and drills calculated to arouse the interest of the faculty and alumni of the college. It gives the opportunity for the student to apply in practice his theoretical training. Finally, it brings out the competitive spirit; everyone is working for the final goal, which is a competitive drill between all the branches of the service represented at this institution. This furnishes the incentive to work by arousing the desire to win, that spirit so essential to the salvation of any organization.

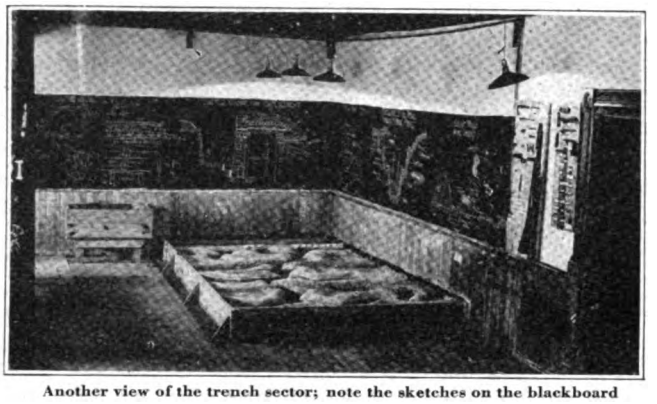
However, it is in the class room that the success and efficiency of a unit are determined. This work for the most part is theoretical and is conducted from text-books, by recitations, conferences, lectures and problems. Tactics, fortifications, mapping, map reading, bridges and range firing are examples that illustrate the variety of subjects treated. At this institution, the class room work is divided into two phases—the class room proper and the laboratory. The R. O. T. C. laboratory furnishes almost unlimited possibilities for the development of interest and enthusiasm on the part of the student. At a very low cost the instructors here have developed a laboratory useful in many courses and of such universal interest that faculty and alumni are continually bringing their friends in to examine it. The college furnished a well ventilated room, 20 by 40 feet in size. The lighting and equipment was left to the ingenuity of the instructors. The equipment now consists of chairs, blackboards, shelves, tables, desk, book cabinet, and water hydrant. As one enters the door he is confronted with a disassembled Springfield rifle, caliber .30, and a Colt automatic pistol, mounted on the wall with each part labeled. Lights are arranged to make each part plainly visible at all times to the interested students. Shelves and window sills are utilized to hold models of trestle and spar bridges, gin poles, pile drivers, revetting material, and wire entanglements. A military library containing the private library of the instructors is kept in a book cabinet in one corner, while in other corners are found machine guns, automatic rifle, Stokes mortar, and the 37-mm. gun, all so displayed as to catch the attention of the student as he enters the room, and so placed that they may be surrounded and inspected at any time. Walls are covered with blue-prints of a military nature and with pictures of R. O. T. C. activities. Blackboard spaces are reserved for lecture use or covered with sketches of various types of trenches and emplacements. Two 8-foot by 6-foot tables are equipped as terrain sand tables; another is covered by a large 12-inch war-game map; and a fourth contains the B. H. relief map. A large fortification model is built on the floor in a sand-box 14 feet by 7 feet. This box is built to represent a trench sector, and is equipped with many types of revetments, obstacles, latrines, and emplacements. These sand sets are used for such purposes as tactics, map

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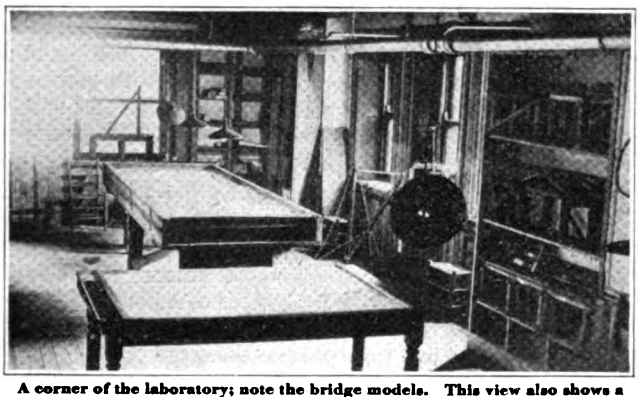
reading, engineer reconnaissance, sketching, fortifications, etc. They are equipped with realistic bridges, houses, rivers, and fields constructed by the non-commissioned personnel here. These tables represent a very small expenditure of money, but a large expenditure of time. However, their use has been well worth the time, as they are of continual interest to the students. In presenting subjects in the laboratory, competition is considered the first essential to success, and the instruction is given accordingly.



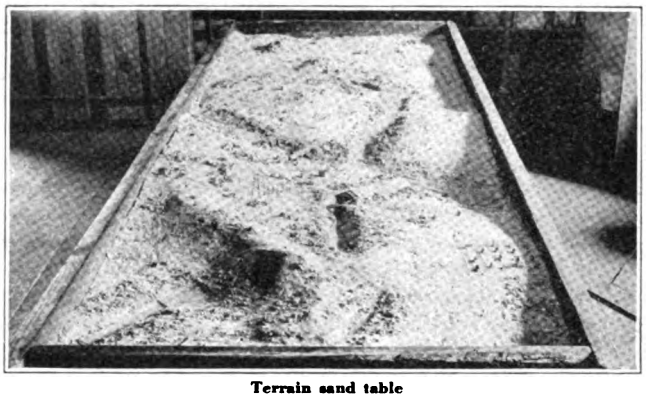
A model trench sector
Note the various types of revetting, obstacles, etc.; also, the camouflaged machine-gun emplacement



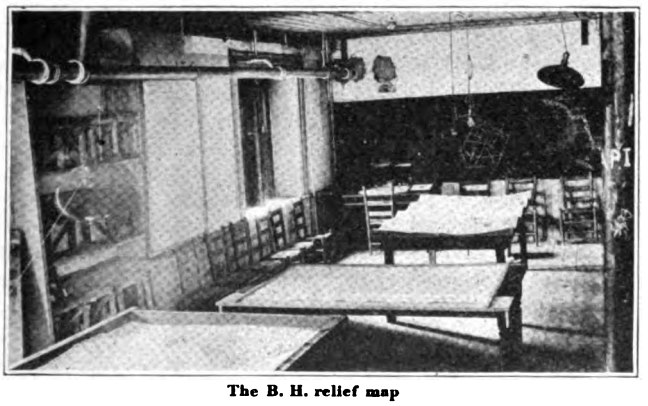
Another view of the trench sector; note the sketches on the blackboard



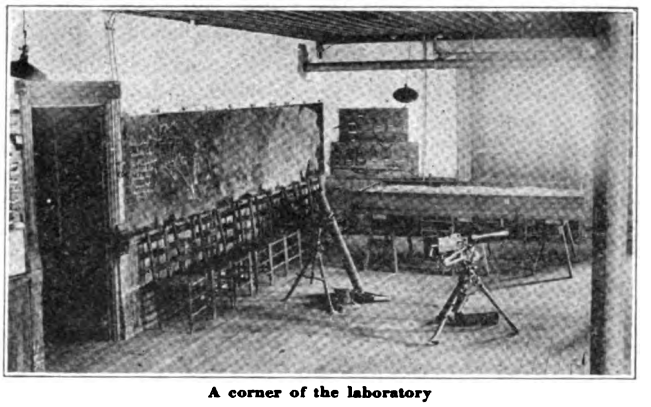
A corner of the laboratory; note the bridge models. This view also shows a terrain table and war-game map



Terrain sand table



The B. H. relief map



A corner of the laboratory

Tactics, for example, is a subject taught almost entirely on the war-game map and sand tables. For studying the conduct of patrols, the students are divided into two groups, representing patrols sent out by opposing bodies of troops. These patrols are sent out to work in the same area. Only one patrol is allowed in the room at a time. While this patrol is determining its movements on the sand table, the hostile patrol position is concealed until it is located by the patrol present. From the patrol problem, the tactical work is carried on to the actual engagement, where the winning side is finally developed. Throughout the entire course, competition is forcing the students to keep up their interest, to make every attempt to be on the winning side at the end. The two groups soon begin to argue the questions involved, then they become aroused and determined to win. The tactics course is now real to them. The other models are used for lectures and demonstrations. The laboratory is also used for map reproduction and photography. This same spirit of competition is carried into all branches of the work.

Inter-company athletic competitions are arranged to arouse enthusiasm for the individual organization and to keep the name R. O. T. C. continually before the students. Gallery teams are developed, and matches are fired with other colleges having R. O. T. C. units. In short, whenever

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possible, the spirit of competition, that invincible asset of American youth, is fostered and encouraged and adapted to promoting the efficiency of the R. O. T. C. Now, the most difficult proposition of all is to make the classroom instruction proper prove interesting to the students. To do this several schemes have been tried with satisfactory results. The first method is the problem method. In this method, the assignment for the day is developed in the form of a problem which is given the class to solve collectively. Let this problem be one for the engineer unit—say a problem in road building. The instructor designates a student to take charge as the senior officer, the chief engineer. The class then conducts the problem. The chief assigns various phases of the work, such as map reconnaissance, traffic data, etc., to various members of the class. These men turn the report in to the chief, who consolidates it and gives it to the instructor as the class solution. The instructor is always on hand giving advice and assistance when called on. Or, for another example, suppose the problem to be in organization of the ground. The instructor gives the problem to the class and allows a few minutes for study. He then calls on a certain student A to state his analysis of the situation. The rest of the class is free to criticize and correct A's solution. At any point, the instructor stops A and calls on B to proceed with A's solution. This, of course, demands hard and long preparation for the class on the part of the instructor. At the same time, however, it is justified, as it demands concentration and real thought from the members of the class.

Another method of instruction is the collective blackboard method. In this method the instructor prepares a number of questions on the day's assignment. In the classroom he sends his class to the board. He gives out a question and allows a certain fixed time for answering it. He then gives a certain time for the student to correct this question, which he then follows with another question. The advantages of this system are that it serves as a means of emphasizing the important parts of a lesson, it teaches the student how to pick out these points; it corrects mistaken ideas about these points and, finally, it teaches him the necessity for quick thinking. It is an excellent method for one instructor to use when handling a large class.

Moreover, the class room instruction is never allowed to become a monotony. The instructor cannot sit at his desk and successfully put across a piece of instruction. He has to carry it to the students. He has to break through the natural wall of inattention that surrounds the brain after a few hours of work in the average grind of college instruction. To do this, he must keep in motion, focusing the attention of the students. He must illustrate his instruction with sketches so that brain cells fatigued by sound waves may be rested while an impression is received through the eyes. And he must relieve restlessness when any member of his class shows signs of such a condition by sending that member to the board to illustrate a point or by some other similar device. In other words, the student is in the class room and at disposal of the instructor. He is willing to learn, he wants to be interested. His brain is absorbed in concentration on various college courses. It is up to each instructor to penetrate that veil of lethargy and preoccupation and carry the instruction to him with an enthusiasm and an energy that will arouse his interest and make his work and the instructor's work a real pleasure.

However, all repetition breeds monotony. Therefore repetition must be avoided. The military departments are fortunate in this respect, for class-room work can be broken by devoting a day now and then to dismantling and assembling the infantry accessory weapons—a job which is more play than work to the average college student. Lectures on interesting subjects, accompanied by slides or motion pictures, may be given. In other words, every opportunity must be grasped to provide something new, something different, for the students and they will soon respond with enthusiasm to the instructor's overtures.

Furthermore, the instructor must be willing and must show his willingness to answer all questions of the student. When he is unable to answer a question, he must say so with the resolution that he will look up the answer. In other words, he must not attempt to "run a bluff" for the average student soon detects the bluffer and diagnoses him accordingly.

This article has attempted to show how R. O. T. C. instruction may be popularized. It has not gone into the method of popularizing the R. O. T. C. by clubs, dances, sponsors, and other social activities. It is the belief of the instructors at this institution that the truly successful way to popularize the R. O. T. C. is to make the class-room work attractive; to convince the student that he is being given something of permanent value.

The Professor of Civil Engineering does not give dances to attract students to his classes; he does not organize clubs to attract students to his subject. Neither does the Professor of History do these things. Their work speaks for itself. And to make the military course hold its place, it too must be made to speak for itself. The social side should not be neglected, for it always carries a tremendous appeal to the average college student, but the real appeal for permanent success and a proper place in the college curriculum should be made on the basis that a course in the R. O. T. C. is more than a pleasure—it is a distinct profit. Finally, it should be impressed upon the student that the fulfillment of his patriotic duty, which is to increase his value to his government, carries with it an increase in his own efficiency, a greater ability to act and think with decision and promptitude. When this viewpoint is finally given the student, the faculty, the college administrative authorities, and the parents of the boys, then and then only the R. O. T. C. will be established on a permanent basis as a course of true value in the college concerned.

Map Making in Italy

The Geographical Institute at Florence is charged by the Italian government with making all official maps of the country. The institute is a part of the Ministry of War, and its director is usually a general officer of the staff. At present, the director is General Vachelli. The personnel of the institute is either civil or military. Most of the work, of a very technical nature, such as color printing, transforming maps, etc., is done by civilians of long experience. The Geographical Institute not only make maps for the war department, but also works for the government railroads, department of the interior, and, in fact, does all the official map making in the country. Italy is very proud of this institute, which, it is claimed, is one of the best in the world.

Other maps are made by Agostini, a civilian firm, and by the Touring Club of Italy. Agostini simply reproduces the Geographical Institute maps for sale to the public. The automobile club has some men in the field who report new roads, etc., to the club, in order to keep the club maps up-to-date.

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Functional Organization of Engineers

By

F. B. Wilby

Major, Corps of Engineers

[*Note.* The following talk was delivered by Maj. Wilby before the New York Post of the Society of American Military Engineers, at their meeting on March 1, 1921.—Ed.]

THE subject of the meeting to-night is "Functional Organization of Engineers." I am not sure that I understand exactly what is meant by that subject. If it is intended to convey the idea that engineers are organized into water-tight compartments, in accordance with their different specialties and functions, each different kind of an engineer being supreme in his own sphere, I am afraid I will have difficulty in discussing the subject. But if, as I believe, it was intended to call for an outline of the probable future organization of the engineer service, showing how the many different kinds of engineers can be fitted into an organization for efficiently and smoothly carrying out their manifold duties in war, I believe I can give you an outline of the general principles of the organization project now being perfected in the office of the Chief of Engineers in accordance with policies recently adopted by the War Department.

In the first place, the theory of operation for the engineer service as a whole must be based on that primary principle of sound military organization—that the commander of any military unit or area in the theater of operations is in full control of that unit or area, and is alone responsible for military results therein. This fundamental principle of military organization is the outgrowth of years of experience in war, and however much it may interfere with our theories of the most efficient organization for performing any particular duty, it must be accepted as the basis of our organization.

The commander, while responsible for results, is not expected to give his personal attention to all of the details of administration of the unit or area under his control. He is given for this purpose a certain staff, each one of which is more or less of a specialist in his line, and serves as adviser and sometimes as executive for the commanding officer in his specialty. One member of this staff is the engineer. As the assistant to the commander for the execution of engineering work, the unit engineer must have the confidence of his commander, and in accordance with the measure of that confidence he will act as the agent of the commander in carrying out the engineering work required by the unit, or in the area concerned.

In the recent war we were called upon to organize rapidly a huge army, larger than any we had ever conceived of, and it was natural that in deciding on the preliminary organization of this army we should have called upon our allies for the results of their experience. Consequently, the first organization project for the A. E. F. was modeled in large part on the British and French organizaion, and as a result contained innumerable services, arms, and special troops peculiar to the long period of stabilized warfare which had been in existence on the western front for several years.

This initial organization for the engineers included many special troops and services; among others, we find a mining service, a water-supply service, a general construction service, an engineer supply service, a survey and printing service, a road service, a light railway service, a quarry service, electrical and mechanical troops, gas troops, sound and flash-ranging troops, searchlight troops, camouflage troops, not to mention inland waterway troops, stevedore troops, and innumerable different kinds of standard-gauge railway troops whose duties differed from those performed by troops of the light railway service only in the number of inches between the rails of the railroad they were supposed to construct, maintain, or operate.

As a result of these many different kinds of special troops and services, each under the impression that it could only be called on to do one thing, but firmly convinced that it knew more about that one thing than anyone else, there resulted a constant conflict of authority between these special services and the various military commanders and their unit engineers as to whether the special service was independent of the local authority or whether the local commander and his unit engineer were in full control. All of you who served in France have vivid recollections of some of these troubles. It is our hope that in the new organization of the Army we can settle beforehand the number of necessary special services and kinds of special troops in those services and define as nearly as possible the purpose of each and its relation to the various military commanders so as to avoid in the future some of the troubles we had during the past war.

As for the number of separate services or arms, for the present this has been decided by Congress in the re-organization of the Army under the National Defense Act as amended by the Act of June 4, 1920. This Act, unless changed, fixes the number of combatant arms as seven (7): Infantry, Cavalry, Field Artillery, Coast Artillery, Air Service, Corps of Engineers, and Signal Corps. In addition to these seven (7) combatant arms there are various other staff corps and departments, including the Quartermaster Corps, Medical Department, Ordnance Department, Chemical Warfare Service, and others of a purely administrative nature. By thus fixing the basic organization, certain separate services which grew up during the war have been definitely eliminated. Among them may be mentioned the Construction Service, the Transportation Service, and the Motor Transport Corps; all three of these are now, under the law, functions of the Quartermaster Corps.

It is interesting to note that under the law as now written the Corps of Engineers will have very few duties in war other than building fortifications, mapping, and possibly some mining and demolition work. The law does not lay down the duties of the Corps of Engineers, but it does prescribe the duties of the Quartermaster Corps, and in so doing, it assigns to them most of the duties per-

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formed by the engineers in France. This section reads as follows:

"The Quartermaster General . . . shall be charged with . . . the direction of all work pertaining to construction, maintenance, and repair of buildings, structures, and utilities other than fortifications connected with the Army; . . . with the operation of utilities; . . . with the transportation of the Army by land and water, including the transportation of troops and supplies by mechanical or animal means; with the furnishing of means of transportation of all classes and kinds required by the Army; etc. . . ."

Under this authority the Quartermaster Corps would do all construction in war, as well as in peace; and in the theatre of operations, as well as in the zone of the interior. This, of course, was not the intention of the law, and the law will probably be changed in the near future.

The War Department has therefore been proceeding on the principle that the engineers will have certain well-defined duties in the theatre of operations, similar to those performed by them in France at the end of the recent war. The only exceptions are sound and flash-ranging, and the operation of searchlights, which have been transferred to the artillery. The duties thus assigned to the Corps of Engineers in the theatre of operations may be briefly stated as:

Construction,
Mining and Demolitions,
Operation of Utilities,
Mapping,
Engineer supply.

As laid down in more detail in a draft of Army Regulations recently approved by the War Department, but which has not yet been published, the Corps of Engineers is charged with the following duties within the theater of military operations:

"All work of construction, and the repair and maintenance of all structures, of every character, except telephone and telegraph systems and other signal communications for the use of troops.

"Military mining, demolitions and protective measures against enemy mines.

"The operation of railways, portable and fixed electric light and power systems, water supply systems, and all other utilities of general service, except such as are specifically assigned to other services.

"The execution of surveying and mapping, including the production and distribution of maps.

"The procurement, storage, and issue of all materials for construction work, for the organization of defense systems, and for all other operations assigned to the engineer service, including all plant, tools and appliances for such work."

In order to carry out these duties, the latest approved project for the re-organization of the Army, calls for certain kinds and numbers of engineer troops. These are specified in detail in Engineer Memorandum No. 1, dated December 10, 1920, of which I have a few copies here, as well as in an article on "The Organization of the Engineer Service for Military Operations" in a recent number of THE MILITARY ENGINEER, the number for January-February, 1921.* I will not go into the details of that organization here, other than to say that the troops proposed for the engineer service in time of war are divided ino two classes, general engineer troops, and special engineer troops; the first class being ready to perform all kinds of engineering work, and the latter being recruited and trained primarily for special work.

General engineer troops constitute about 85 per cent, and special engineer troops about 15 per cent, of all engineer troops assigned to the theatre of operations. Of the 15 per cent special troops, about 9 per cent are railway operating troops, and 4 per cent are bridge and water tank trains, leaving about 2 per cent for all other special troops.

The general engineer troops include: combat engineer regiments and mounted battalions, for assignment to infantry and cavalry divisions; engineer regiments (general service), and auxiliary engineer battalions.

The special engineer troops include: topographical, camouflage, railway, lumbering, and shop troops, and bridge and water tank trains.

Some of you may be of the opinion that important special troops have been omitted, while others may think that too many special troops have been included. Possibly some might agree with my friend, Colonel Graves, who is of the opinion that there should be only one kind of engineer organization, capable of performing all kinds of engineer work. Such a consummation would certainly be ideal, but I, for one, am not quite so optimistic as to the capabilities of such a standard organization.

Now as to the *use* of the special engineer troops which have been authorized, as well as the various individual specialists which will be required for various purposes; if we will keep in mind the fundamental principle of military organization—namely, that the commander of each unit or area is responsible for all operations of that unit, or in that area, and that he is given an engineer as his assistant for the execution of all engineering work required by that unit or in that area, then it necessarily follows that this engineer should be given the troops and assistants needed to carry out that work. The troops, thus assigned, owe primary allegiance to the military command to which they are attached. No man can serve two masters. If every kind of special engineer organization belongs to a separate special service, reporting directly to G. H. Q. and not under the control of the local military commander, can we hold that commander responsible for military success, when that success may depend upon the work of some unit, operating in his territory, but over which he has no control? By this, I do not mean that there may not be advice and direct correspondence on technical matters of no vital interest to the commander concerned, but all *control* vests in the local commander where the responsibility necessarily lies.

There is one service which is an exception to this rule, that is the operation of railways. This service is of such a nature that it is impossible to permit local commanders to control the operatives within their respective territories without endangering the collapse of the entire service. The organization for the operation of railways will, therefore, be modeled as closely as possible after the method of operation in civil life. The Chief Engineer at G. H. Q. will act as Director of Railways for the theatre of operations. He will control and direct the operation and maintenance of all railways by means of a General Manager of Railways on his staff; a General Superintendent on the staff of each Army Engineer for handling the extension and initial operation of railways in the army area until turned over to the communications zone, and a Gen-

*Recent changes in this project have substituted an *engineer regiment (general service)* for each *corps and army regiment, construction regiment*, or *road regiment*; and *shop* troops in place of *depot* troops.

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eral Superintendent on the staff of the Engineer Communications Zone, in charge of the operation of all other railways in the theatre of operations.

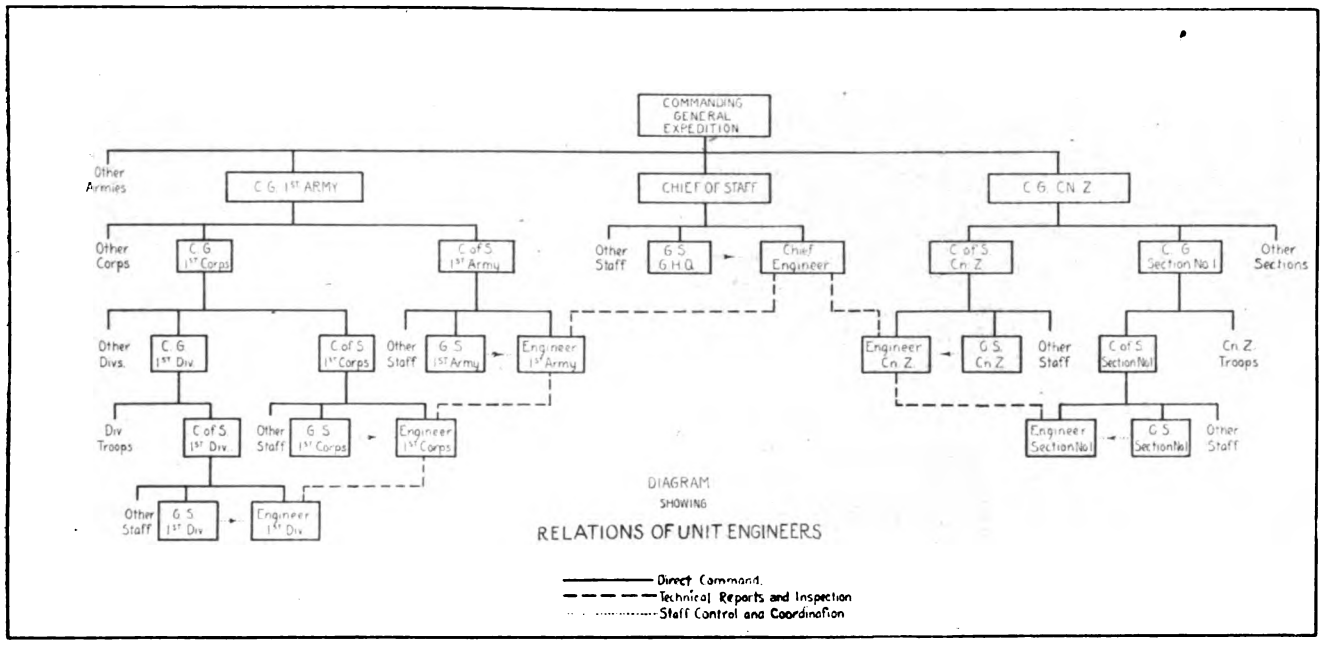
The Service of Military Railways cannot be entirely separated from the engineer service as it was in France, without causing an undesirable duplication of effort. If the military railway service were modeled exactly along civilian lines, all railway construction would be carried out by that service. However, the principal construction agencies of the army are organized for general construction work under the Corps of Engineers, and if a separate railway service were organized paralleling civilian practice, with its own construction organization, it would result in two construction forces in the theatre of operations, constantly competing with each other for men, material and supplies. The solution which is favored generally in the office of the Chief of Engineers, and I believe in the War Department, is to have the railway service in the theatre of operations under the Corps of Engineers, operating along civilian lines as a separate branch as far as possible, but with all large railway construction projects planned or proposed by the railway service, approved by the unit engineer, and carried out by the other construction agencies at the disposal of the engineers.

Having determined the number of separate services in the military establishment, the probable duties of the engineer service in war, and the number of different kinds of engineer troops to be organized for carrying out those duties, let us see how we can conveniently group our duties for most efficient supervision and control. The essential principle of unity of control vested in the local commander does not mean that his engineer will not have to organize the engineering work into certain more or less definite groups based on the character of the work to be performed.

The duties of engineers in war may be grouped as previously stated into five general classes:

Construction,
Mining and Demolitions,
Operation of Utilities,
Mapping,
Engineer supply.

Of these, "mining and demolitions" is almost entirely a function of combat engineers with infantry and cavalry divisions, and may be neglected so far as other units are concerned. The "operation of utilities" with the exception of the operation of railways, is usually so intimately connected with the installation, construction or repair of such utilities, that it can well be handled by the organization having charge of their construction. Our principal duties may then be regrouped for the purpose of supervision and control under four main heads:



1. A *Construction* Section in charge of all general construction, including the operation of utilities except railways.

2. A *Railway* Section in charge of the operation of railways.

3. A *Mapping* Section in charge of production, reproduction, and distribution of maps.

4. A *Supply* Section in charge of engineer supply.

These four main divisions of engineer operations will appear throughout the engineer service from top to bottom, and form a basis for the organization of each engineer headquarters. In addition to the four sections just given, there will usually be required two additional sections for handling purely administrative work; a Personnel Section; and a Plans, Training, and Intelligence Section. With these six sections, it is believed the engineer service will be organized into as many separate groups as can be properly controlled and supervised by one man, the unit engineer. The Railway Section will only appear in those headquarters having control of railway operations, that is, in the headquarters of the Engineer Communications Zone, and in the headquarters of each army engineer. The Construction Section at most headquarters will be by far the largest section, and will include all general construction including railways, roads, quarries, bridges, buildings, water supply, electrical and mechanical installation, etc., as well as the operation of all utilities, except railways, and in addition certain minor related functions such as camouflage and geology. The Supply Section will include procurement by purchase, manufacture or requisition of all engineer material and supplies, including the production of lumber, as well as

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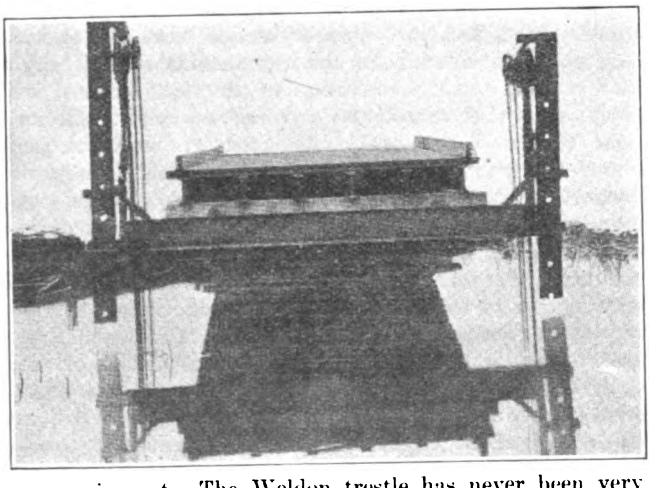
the operation of cement, camouflage, or other factories. You will note that there is no separate Department of Light Railways and Roads, no separate Camouflage Service, or separate Forestry Service; each being only a branch of the larger division or function of Construction or Supply, as the case may be.

In conclusion I want to touch briefly on the relations of unit engineers to each other, and to other arms of the service. Nearly all of our problems originate with the combat division. It is the fighting unit—the unit upon which all depends. If the division fails to carry out its mission—the army fails. If the division succeeds—the army succeeds. Consequently, all engineers of higher units need only remember that 90 per cent of their job is done if they succeed in helping the unit engineer of the next lower unit to solve his problems. Everything that is done at home, in the communications zone, the army, or the corps, is done with the object of assuring the accomplishment of a tactical mission by some division, or group of divisions. The vital needs of the army develop at the front, and as a result, certain impulses which create engineer operations are transmitted all the way back. The impulse comes from the *front,* and in general the activities of the engineers of higher units are controlled by this impulse, and not the activities of lower units by the impulse from the rear.

Our relations with other arms can be covered by the one word—SERVICE. In other words, our only reason for existence is to help the infantry win the battle, or, by helping the other arms auxiliary to the infantry, to accomplish the same purpose. To do this we must have the confidence of the General Staff and of our respective commanding officers. This confidence can only be gained by producing results, and those results must be, not merely a monument to our skill as engineers, but the results desired by the General Staff, and by our commanding officers.

New trestle for British ponton equipage

As the British ponton equipment is now being re-designed to carry light, medium, and heavy loads, it is necessary to consider the question of a service trestle for use with this



new equipment. The Weldon trestle has never been very popular and does not lend itself very well for use with medium and heavy loads. A new trestle has therefore been designed and tested and is shown in the illustration.

The legs consist of 8-inch by 4-inch rolled steel joists (I-beams) and the transom is a 12-inch by 5-inch joist. The general dimensions of the trestle are the same as the Weldon trestle, but it will carry medium loads. The construction of the trestle is very simple. The transom has brackets permanently secured at each end; these brackets carry rollers through which the legs can slide. In this way the legs cannot splay or move out of line, but each leg can slide up or down independently so as to suit an uneven bottom (footing) if necessary. The legs are drilled every six inches, and after the transom has been adjusted for height, it is supported on pins passing through these holes. Two types of shoe are provided. The normal shoe is of timber and measures 10 inches by 18 inches; this shoe is suitable for rocky bottom or ground which will support a pressure of four tons per square foot. A second shoe is provided which measures 2 feet by 3 feet; this shoe can be bolted onto the normal shoe and provides a pressure of just under 1 ton per square foot. The trestle weighs 1,180 pounds, or 40 per cent more than the Weldon trestle, but will carry an 8-ton axle load. Two trestles built up side by side as a tower will carry heavy loads. The trestle can be put together and launched more rapidly than the Weldon trestle, and the legs can not jamb against the transom under any conditions. The transom is raised or lowered by means of two 2-ton Morris blocks. These blocks are a considerable improvement on the differential blocks for trestle work. The trestle has been tested with a 12-ton axle load. Further trials are to be carried out with this trestle.—*Royal Engrs. Journal.*

Petroleum production of the world, 1919-20

(*American Petroleum Inst.*)

The production of petroleum in 1920 has been estimated at 688,474,000 barrels against 514,504,000 barrels in 1919. The 1920 production represents a gain of approximately 173,970,000 barrels, or 33.7 per cent. The United States supplied 443,402,000 barrels, or 64.4 per cent of the total production in 1920, and Mexico supplied 159,800,000 barrels, or 23.2 per cent. The United States and Mexico made the greatest gains in production in 1920, the former having increased its production from 377,719,000 barrels in 1919 to 443,402,000 barrels in 1920, a gain of 65,683,000 barrels, or 17.4 per cent. The latter increased its production from 87,073,000 barrels to 159,800,000 barrels, a gain of 72,727,000 barrels, or 83.5 per cent.

The tabulation shows the estimated gain by countries:

	1919	1920	1920 in per cent of 1919
Mexico	87,073,000	159,800,000	184
Venezuela	321,000	500,000	156
United States	337,719,000	443,402,000	131
Roumania	6,518,000	7,406,300	114
Peru	2,561,000	2,790,000	109
Persia	6,290,000	6,604,700	105
Japan and Formosa	2,121,000	2,213,000	104
Dutch East Indies	15,780,000	16,000,000	101
India	8,453,000	8,500,000	101
Canada	220,000	220,000	100
Italy	38,000	38,000	100
Galacia	6,255,000	6,000,000	96
Argentina	1,504,000	1,366,900	91
Russia	34,284,000	30,000,000	88
Egypt	1,662,000	1,089,200	66
Trinidad	2,780,000	1,628,600	59
Germany	925,000	215,300	23
France	----------	700,000	----------
Total	514,504,000	688,474,000	134

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Bituminous Pavement Design

By

F. S. Besson

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THE question of Rigid Concrete Bases *versus* Flexible Ones for bituminous pavements has of late received wide attention. Two hypotheses advanced are as follows:

(*a*) A rigid smooth base is conducive to pushing and cracking of bituminous surfaces; inherently, because of the rigidity and smoothness of that base. Further, cracks develop in surfaces corresponding to whatever cracks may occur in the base.

(*b*) The measure of probable life of a pavement is load impact rather than dead load and a flexible base is accordingly a better one for a bituminous surface than a rigid base.

Having half a century of experience with bituminous pavements to its credit, the District of Columbia has adopted as its standard an asphalt surface on a 6-inch concrete base, the latter of 1:3:7 proportion using Potomac River ravel as the coarse aggregate. In view of the fact that this policy is contrary to any that might be derived from the hypotheses set forth in the preceding paragraph, it would appear that the time is ripe for a critical analysis of the paving situation in Washington in order that the relative correctness of its adopted policy may be definitely settled.



Fig. 1. This picture illustrates cracking into small lozenge-shaped patches. This type of crack appears only when a flexible base is used. It appears in bituminous surfaces even though the design of the mixture is perfect.

Trinidad, Cuban, Bermudez, Maracaibo, Montezuma, California, Aztec, and Standard asphalts have been used in paving the streets of Washington. Original surfaces on concrete bases exist in all ages up to 43 years. Traffic on the different streets varies from a negligible quantity to 1,160 tons per yard of width per day. Though a great number of "perfect" streets may be looked upon with justifiable pride, the District has its share of waved and cracked surfaces. Paralleling the history of streets with concrete bases and of even earlier origin in Washington is that of pavements with so-called flexible bases. Old granite block and cobble pavements, and macadam and gravel roads have been utilized; also bituminous bases constructed by the penetration method; and in other cases, stone premixed with bituminous cement. These latter have been laid with as great a thickness as 10 inches, underlain by 6 inches of gravel as a sub-base.

All these different asphalt paving conditions existent in the city and available for study present a most favorable situation for successful investigation: First, is the adoption of a rigid concrete base shown to be a sound policy? Then, if the use of concrete is warranted, and cracks, waves and short life are not due to the rigidity of the base, what does cause defective pavements? Further, what system of design can be followed in order to insure full value in future construction?

This last problem has a broad aspect. Not only should design preclude defects but it should also supply true economic value. Examples of all types of bituminous surfaces are available in Washington, varying in thickness from 1 to more than 3 inches. Aggregate combinations exhibiting every sieve analysis advocated in asphalt paving practice may be found. The surface adopted by the city as standard consists of a binder course 2 inches thick before compression and a topping 2½ inches prior to rolling. This is a high-priced surface. Binder stone is expensive, sand used in the topping costs 2½ times as much as concrete sand, and limestone dust mixed with the sand adds to the cost. Is this design truly economic?

It is difficult to determine the relative merits of flexible and rigid bases except through practical experience. Unsupported theory is of little use, and tests to be of value must duplicate actual conditions. Maintenance data taken in connection with service rendered affords a good basis for study, and several generations of the Highway Division of the District have thereby passed judgment in favor of concrete. Where a deep telford foundation exists or a thick richly cemented bituminous base underlain by sand and gravel, pavements compare favorably with those having concrete bases. This is because their rigidity approaches that of the latter. Such bases are not used in Washington to-day, however, because rigidity is obtained thereby only at a cost much above that for concrete.

A great many of the pavements in the city laid with a flexible base were so constructed because of price limitations written into appropriation acts by Congress. For instance, when the price per square yard was thus restricted to $2, the lowest bid received for sheet asphalt on concrete base was $2.25 per square yard. This led to the use of a bituminous base 4 inches thick, which with the 3-inch surface, gave a 7-inch pavement costing $2.00 per square yard

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as compared to the standard 9-inch pavement which would have cost but 25 cents more. As to the degree of quality worked into the bituminous base pavement, its cost of $2 per square yard is a fairly good measure.

Typical of these pavements, and of all other flexible base ones in the city, is the eventual cracking of the asphalt surface into small lozenge-shaped pieces. This is illustrated in Fig. 1. The cracks are not due to sub-base failure, which is evidenced by the fact that their growth is not necessarily accompanied by the development of other defects. Instead, it is habitually found that the contour of the street surface remains true to grade. In the illustration it may be noticed that the cracks occur not only in the original pavement but also extend through repair patches of various ages and compositions. This deterioration is thus shown to be independent of the composition and type of asphalt surface. Further, it is not found where a rigid base exists.

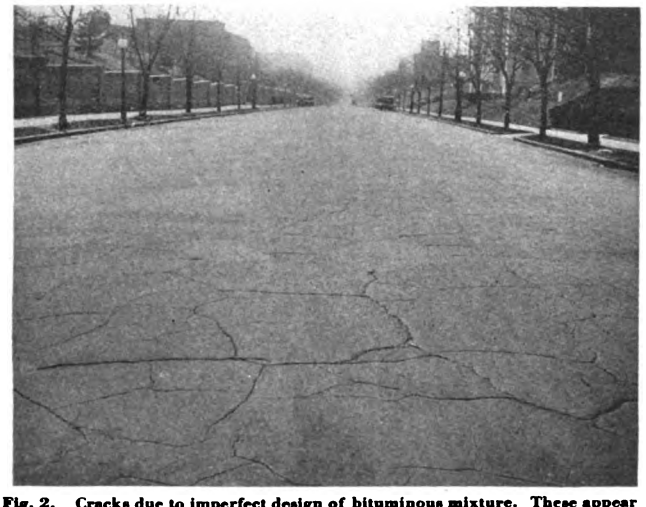


Fig. 2. Cracks due to imperfect design of bituminous mixture. These appear irrespective of the type of underlying base

Significantly different from the cracking which has just been described is that illustrated in Fig. 2. This occurs, no matter what type of base is used and is entirely due to imperfections in the asphalt surface itself. When a new surface is laid, on the old base, the asphalt mixture being correctly designed, the cracks do not appear. That cracks in bituminous pavements are not caused by cracks in the concrete base may be verified by following the work of district patching gangs. In the working season, these men approximate 500 patches daily. By watching their work of stripping the asphalt from the base, it may readily be observed that cracks in the surface have absolutely no relation to cracks in the concrete base.

Inspection during the repair of pavements also shows conclusively that pushing or rolling or waving of the surface is independent of the base, whether it be concrete or other construction, corrugated or smooth. It has been claimed that the binder course is placed between the topping and base in order to prevent waves in the surface. A certain patent calls for 2 or 3 inch stone imbedded in the base and projecting half way into the surface asphalt in order to key it to the concrete and thus prevent waves. On some bridge work it is understood that 2 by 3 inch timbers have been alternated with 2 by 4 inch, in order to form a corrugated base upon which to lay an asphalt surface. At one time the District of Columbia used ribbed rollers and special tampers in order to form ridges in the concrete. This practice was abandoned years ago and to-day asphalt is placed even on the smooth hard surface of old concrete streets; also, on level plank bridge floors newly laid.

The illustration, Fig. 3, illustrating a section of sheet asphalt actually taken from a street, shows a wave clearly independent of the base and even of the binder course. Movement has taken place completely within the topping. The conclusion is drawn that, given a rigid concrete base, causes of defects in a bituminuous surface must be searched for within the latter itself. These surfaces are in reality either concretes or mortars made with bituminous cement. While somewhat analogous to hydraulic concrete, they are, however, vastly different. A sample may be cut from a street, the bitumen extracted and the mineral aggregate obtained in a free clear state.

In seeking reasons for the wide variations that occur, a large number of specimens have recently been taken from pavements, from good ones and poor ones, the latter either cracked or waved. With the aid of personnel of the Engineer Department of the District, especially Messrs. J. C. Elbert and Vernon Cleaver, these samples have been investigated. Naturally, most attention at first was given to the extracted bitumen since this item in construction specifications is usually so minutely described and restricted. While the quantity of bitumen soluble in carbon bisulphide and the specific gravity of this amount have been obtained with a high degree of accuracy, it has been impracticable to get dependable results on other investigations relative to this bitumen. A slight trace of solvent, while having a negligible affect upon weight and specific gravity determinations, has a destructive influence on the value of results obtained in other tests, as, for instance, the penetration determination. Just how erratic these results may be is shown in many cases where original records are available made at the time of laying the surface.

Original penetration records have been studied but they show no relation to the degree of excellence of the pavements examined. While it must be realized that different penetrations are required for each of various constructions, it appears that specifying the penetration within two or three points is unnecessary refinement, placing undue hardship on the manufacturers of bituminous materials. Grade divisions with ten point ranges should certainly suffice. Pat tests have also been made from specimens brought from the streets but without useful results. It is not desired to underrate the value of penetration and pat tests as now made use of while construction of a pavement is in progress. However, investigation made along those lines subsequent to the appearance of defects leads to no discovery of the causes thereof. Bituminous cements as

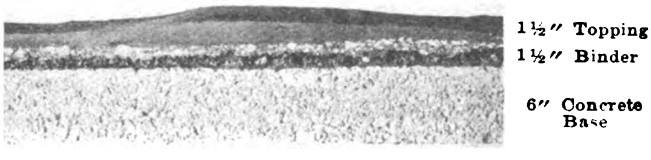


Fig. 3. Wave in the 1½-inch topping course of a sheet-asphalt pavement. This wave is clearly independent, not only of the concrete base, but also of the binder course.

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marketed to-day are well stabilized products and by following recognized practice all difficulty as to quality may be precluded. Investigations of defective pavements for the purpose of aiding future work may therefore proceed along other lines.

One theory advanced for waved pavements is that they are due to the use of sand or mineral aggregates, the grains of which are round and smooth instead of angular and rough. No general relation can be discovered between the shape of the grains of aggregate and the nature of the service rendered by pavements. In fact, all sizes of aggregate retained in the 200 mesh up to and including 1 inch binder stone as taken from Washington streets, appear to be angular and rough. Examination shows that even beach sand used for polishing platinum evaporating dishes, though having no sharp cutting edges, may be very angular in shape, and it is difficult to know to what extent the term "round and smooth" would apply. While the grains of Standard Ottawa sand may be said to be round and smooth, find, dependent upon the bituminous cement and mineral aggregate, just what the voidage should be in order to guarantee perfect results. How much bitumen should be combined with any particular aggregate, it would seem, depends upon the association of various grains of sand and stone making up that aggregate as a whole. The combinations may vary in numerous ways; each used with its required amount of bitumen and resulting in a definite percentage of voids when compressed into a pavement. The problem can be solved if the association of sand and stone making up each particular aggregate can be measured.

A cubic foot block of stone may require a definite volume of bitumen to paint it. If the stone is broken into 1 inch cubes, the film thickness and other conditions remaining constant, 12 times this volume will be required in order to coat all surfaces now presented by the stone. This fact is the basis of "surface area of aggregate" theories which have always received a great deal of credence. Rela-

Per cent passing each sieve and retained on the next smaller.

Sieve Number	1	¾	½	⅜	3	4	6	8	10	14	20	28	35	48	65	100	150	200	Total
Per cent	4	4	3	4	3	3	2	2	5	5	6	13	12	12	8	5	3	6	100

Fineness Modulus	Weighting by Arithmetical Progression
100	4× 1= 4
96	4× 2= 8
92	3× 3= 9
89	4× 4= 16
85	3× 5= 15
82	3× 6= 18
79	2× 7= 14
77	2× 8= 16
75	5× 9= 45
70	5×10= 50
65	6×11= 66
59	13×12=156
46	12×13=156
34	12×14=168
22	8×15=120
14	5×16= 80
9	3×17= 51
6	6×18=108
1,100	1,100

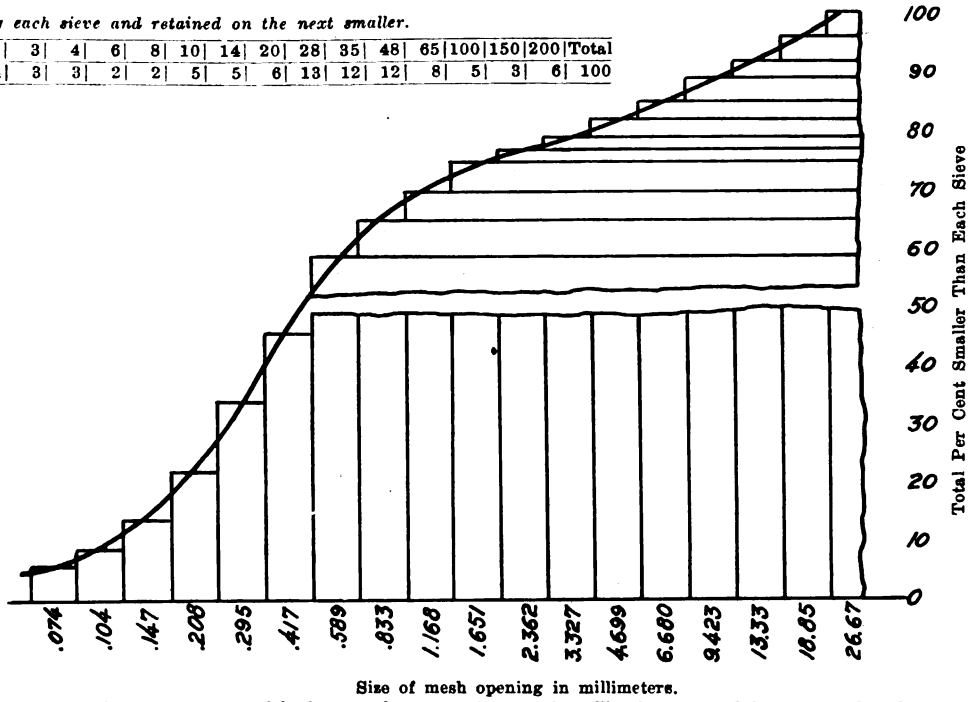


Fig. 4. The area beneath the curve may be obtained either by summation of the horizontal or vertical rectangles. The fineness modulus or sum of total percentages finer than each mesh is equivalent to weighting the percentage passing each mesh in accordance with arithmetical progression.

a like description can be applied to but few other sands and it seems that the shape of grains can hardly be the determining cause of a defect of such a wide general occurrence as waves in bituminous surfaces.

Much value has at times been attached to density measurements of samples taken from streets on the assumption that bitumen with mineral aggregate acts like water with sand. Too much gives mushy results or quicksand, just enough gives a smooth hard surface like a motor racing beach, and too little, a dry sand without sufficient substance to hold the grains together. To obtain a good mixture for paving it has been claimed that all voids in the compressed aggregate must be filled with bituminous cement. Tests do not establish this claim and it is found that voids exist in specimens taken from excellent streets. Even mixtures that contain too much bitumen and have waved under service conditions show a quite noticeable percentage of voids. Personally, notwithstanding this, it is felt that the question of voids does have an important bearing upon the problem. It is probably an impossible task to tive amounts of bitumen necessary to cover surface areas may be determined but having done so as with the 1 inch cubes, information is still lacking as to the quantity of bitumen necessary to add to the combination of pieces in order that they may be cemented together and compressed into a monolithic slab. If two-thirds of the cubic-foot block of stone were broken into 2-inch cubes and the remaining one-third into ½-inch cubes, it would have to be acknowledged that a different amount of bitumen would be required to cement them than the 1-inch cubes, though the surface areas would be equal.

The surface area theory is arbitrary when applied as a measure of the required bitumen content of paving mixtures. In computing surface areas, the grains of mineral aggregate are assumed to be either cubes, spheres or other shapes, in formulæ relative to which a mean diameter and certain constants enter. When a granulometric analysis has been made, the various mesh sizes are assumed to be the mean diameters. The number of grains in a net volume of matter passing through any one sieve depends

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upon the volume of each grain, that is, the number varies inversely as the cube of the mesh diameter. The area of each grain varies as the square, and therefore, the total area of the volume through each sieve varies inversely as the diameter.

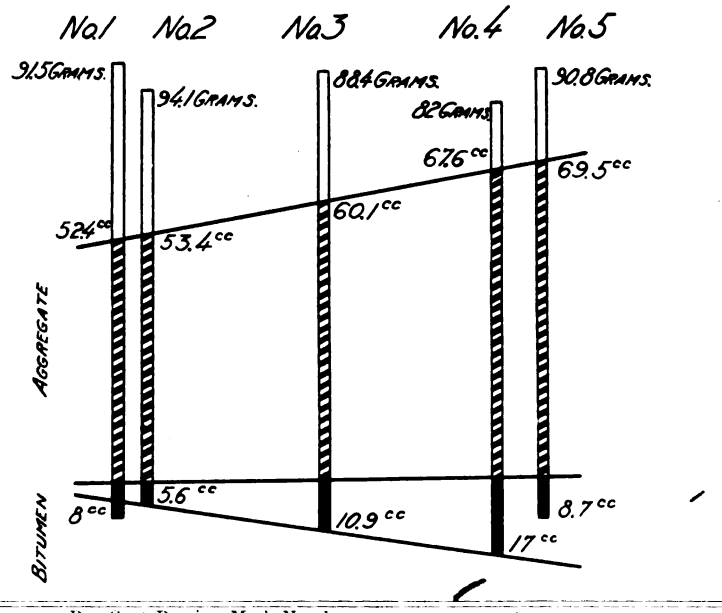
There are records of sands that give identical sieve analyses and, therefore, equal surface areas. Notwithstanding this, their dry loose void percentages vary from forty to fifty-five. Such a wide range of voidage shows clearly that mesh openings alone cannot be used as an indication of the particular combination of grains of mineral matter making up any specified aggregate for bituminous constructions. The inaccuracy of the surface area theory is further shown when an attempt is made to apply it to that portion of the aggregate passing the 200-sieve. This matter is habitually an impalpable powder and distinctly different than that retained on the 200, the granular component being clearly evident. In order to assign sizes to the particles passing the 200-sieve (some of which are often of a colloidal nature) the method of elutriation is used. Though the importance of dust in bituminous mixtures is acknowledged, the huge values as to bitumen requirements assigned by arbitrarily weighting the sizes inversely as their diameters, are manifestly out of all proportion.

Another representation said to compare combinations of mineral grains, sand, stone or gravel, is based on what is known variously as the mechanical analysis, cumulative plat, or fineness modulus method. In Fig. 4. using a logarithmic horizontal scale, the curve represents an aggregate with the per cent finer than each sieve platted against mesh diameters in millimeters. Using eighteen sieves, 5-5/9 per cent, passing the smallest, 11-1/9 the next and so on by equal increments to 100 per cent for the largest, gives a straight line or uniform gradation. The full value of the cumulative plat is to show the relative uniformity of aggregate siftings diagrammatically. It can not be used for the determination of bitumen requirements of aggregates.

In the fineness modulus method the cumulative plat is made use of by taking the sum of the ordinates of the curves. Its inapplicability is illustrated by the fact that there are numerous dissimilar aggregates well known as to their widely different bitumen requirements and yet having equal fineness moduli. Fig. 4 illustrates that the sum of the ordinates, or fineness modulus, can be considered as measured by the area beneath the curve. This area may also be obtained by a summation of the horizontal rectangles, thus showing that the fineness modulus method is an arbitrary one since the weight or value placed on the percentage of aggregate passing each sieve of a complete nest is made to progress arithmetically, from the largest mesh to the smallest.

Experience has shown that the amount of bitumen required is proportionate in many instances to the aggregate percentages through the 80, 100, and 200 sieves. It is this fact that has given the semblance of applicability to those systems just described which arbitrarily magnify the percentages through the smaller meshes.

In seeking a new theory it was noticed at a mixing plant that a certain weight of asphalt is used for each cubic foot of aggregate dumped into the mixer. In other words, the proportion of bitumen to aggregate, expressed in percentages by weight depends upon the weight of a cubic foot of dry loose aggregate, or what is the same thing, the volume of a unit weight. In carrying out investigations upon this basis volume measurements have been made by means of a graduated cylinder with a diameter of 62 millimeters and of sufficient capacity to hold 1,000 grams of dry loose aggregate. In order to reduce aggregate separation, specimens have been poured into the cylinder by quarters. With coarse materials, personal equation enters greatly but the method is open to refine-



Quality of Mixture	Sample Number	Per Cent Passing Mesh Number												Per Cent Aggregate	Per Cent Bitumen	Sp. Gravity Aggregate	Per Cent Voids
		1	¾	½	¼	10	20	30	40	50	80	100	200				
Waved	1	4.1	2.0	7.6	9.6	6.6	10.0	9.8	13.4	11.5	5.3	5.4	6.2	91.5	8.5	2.73	36.1
Good	2	9.2	14.5	27.1	11.2	2.5	3.9	5.1	7.6	4.7	3.2	1.9	3.2	94.1	5.9	2.82	46.7
Good	3	----	----	----	0.10	4.8	9.8	10.2	17.1	18.5	9.6	12.8	5.8	88.4	11.6	2.62	37.5
Good	4	----	----	----	----	----	1.6	1.6	0.8	4.3	4.3	4.4	65.0	82.0	18.0	2.98	59.3
Cracked	5	----	----	----	0.4	5.3	14.6	16.5	20.0	17.8	7.5	5.0	3.7	90.8	9.2	2.30	43.2

Fig. 5. Relation of aggregate weights to aggregate volumes and of bitumen volumes to aggregate volumes

Note.—Aggregate Volumes Measured Loose in a Cylinder of 6.2 c. Diameter.

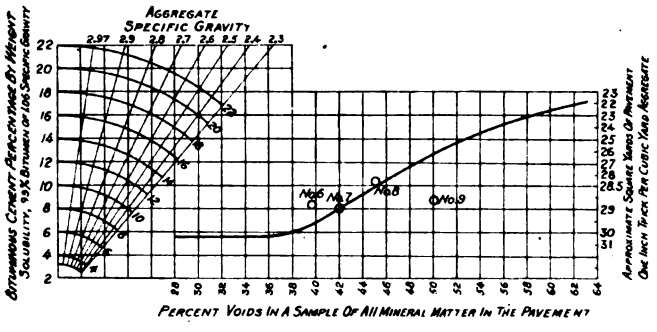
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ment so that such influence can be reduced to a minimum.

It has been found that, as with other theories, in many cases a relation exists as to the 80, 100 and 200 aggregate percentages. On the basis of 1,000 grams of pavement and an average of 10 per cent by weight of aggregate passing these three sieves, it is not unusual for the volume of the total aggregate to lie between 500 and 550 c. c. Similarly, if these sizes comprise 25 per cent, the total usually lies between 550 and 600 c. c., and if 35 per cent, between 600 and 650. In annual reports for the past forty years and in technical literature it is stated that dust is added to aggregates in order to lessen the voids. On the contrary the voidage is thereby often increased. Surface area, fineness modulus, per cent smaller than No. 80, all three lead to uncertainties. There are some paving mixtures whose volumes of unit weights of aggregate have no definite relation to the sand and dust smaller than the No. 80 sieve. It is in these cases that surface area and fineness modulus fail to be of service and the volume separate control and are not in reality related to the primary design of bituminous surfaces. There are but two essential elements, bitumen soluble in carbon bisulphide, and mineral aggregate. There may be traces of organic or other matter but such should be negligible. Having chosen an aggregate suitable as to quality, size, and gradation, for any particular purpose, the problem of design is to proportion the mineral matter and bitumen so as to best insure economic service.

From the results of a number of analyses, it has been possible to prepare as an aid to proper design, the diagram, Fig. 6, which has been drawn for asphalt cement, 99 per cent bitumen of 1.06 specific gravity. This permits its direct application with sufficient accuracy to a wide range of asphalts in common use. The diagram can readily be modified to answer for any asphalt.

Specimen No. 8 is an aliquot part of 150 daily samples from a contractor's plant during a working season and is, therefore, representative of present construction in Washington. No. 6 is an asphaltic concrete taken from a pavement laid in 1913, the service rendered by which has been most unfavorable as compared to sheet asphalt streets of the same age subjected to identical traffic. Such examples tend to the disparagement of certain types of pavement, whereas in this particular instance the diagram goes far in explaining the disparity. No. 9, though having not an unusual aggregate graduation, has a relatively low specific gravity and high percentage of voids. Insufficient bitumen has been used and the pavement is badly cracked. Pavement cracks are often attributed to lack of traffic, which, perhaps, may be true to a limited extent. However, in one such case where there has been no traffic for the past ten years, a specimen analysis shows up beneath the curve in Fig. 6, and the cracks are undoubtedly fully accounted for thereby.



Sample Number	Per Cent Passing Mesh Number												Sp. Gravity Aggregate
	1	¾	½	¼	10	20	30	40	50	80	100	200	
6	3.7	7.8	14.3	23.4	13.0	8	4.5	4.9	4.8	2.7	4	8.9	2.90
7	---	---	---	0.1	6.0	20.9	23.4	20.8	7.3	4.0	2.9	14.6	2.64
8	---	---	---	0.1	4.9	9.6	10.9	18.2	25.4	13.4	13.2	4.3	2.79
9	---	---	---	0.3	9.0	6.8	55	11.3	23.4	16.0	14.8	12.9	2.65

Fig. 6. Bitumen requirements for pavements as controlled by voidage and specific gravity of mineral aggregate

method as controlled by void percentage and specific gravity of aggregate continues to be truly indicative of the bitumen required.

In Fig. 5, Nos. 2 and 3 represent specimens taken from excellent street surfaces in the city. No. 4 is platted from a mixture made up in accordance with a specification taken from a trade journal. The cross-hatched areas represent dry loose aggregate volumes which are dependent upon void percentage and specific gravity of aggregate. The solid black portions represent bitumen. Notwithstanding that the loose volume for No. 1 is less than for No. 2 the bitumen is markedly greater. Too much bitumen means a soft pavement and No. 1 actually exists as one of the waved streets of the city. Insufficient bitumen is manifestly the trouble with specimen No. 5 and the pavement which it represents is very much cracked.

Study of the aggregate siftings recorded in Fig. 5 does not afford any help in ascertaining reasons for the defects in No. 1 and No. 5. Both the Surface Area and Fineness Modulus methods place No. 1 midway of Nos. 2 and 3, and No. 5 between Numbers 1 and 3 in positions that would tend to show that their bitumen contents were exactly right. In like manner the sum of the 80, 100 and 200 siftings place the two inferior specimens between No. 2 and No. 3, permitting no inference as to the causes of their defects.

Caution is necessary when interpreting investigations of specimens cut from pavements. It has been found that in many streets constructed years ago the mixtures lack uniformity. Bitumen percentages vary; also the aggregate, as to quality, voidage, and screen analysis. In new construction these points can be properly taken care of and constancy insured by careful supervision and workmanship. Sometimes foreign influences, as for instance, illuminating gas, are very destructive. Such factors call for

In fact, well-constructed bituminous pavements are remarkably stable and free from abnormal deterioration, due either to traffic or the lack of it, and we are fortunate that this is so. Where there is no traffic to-day, there may be heavy traffic to-morrow. Almost a fourth of the total existing yardage of bituminous pavements in Washington was laid more than twenty-five years ago. Certainly at that time there was no conception of the traffic to which these pavements would be eventually subjected. It should be reiterated that "well constructed" is conceived to include a rigid base. One street carrying the heaviest traffic in the city has long been classed among our roughest and most waved surfaces. Notwithstanding the tremendous daily impact which the 6-inch base is thereby forced to sustain, the concrete in it is as good to-day as when newly laid twenty-seven years ago.

Specimen No. 7, Fig. 6, represents a remarkable pavement laid forty-two years ago. Maintenance expenditures

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for it have always been noticeably low. For the past ten years they total $241.76 for its area of 1,282 square yards, or 1,88 cents per square yard per year. Present traffic amounts to 250 tons per day per yard of street width. Another exceptional point about the pavement is that it was laid without a binder-course between its concrete base and 2-inch surface. This specimen is placed between two great classes of bituminous surfaces; the one class including coarse-grain mixtures—topeka, concretes, etc., having bitumen requirements of less than 8 per cent by weight; the other class having bitumen requirements of more than 10 per cent by weight. The inclusion of this 9 per cent specimen completes the range and shows that the general worth of an aggregate is independent of its bitumen requirement. Whether or not any particular aggregate will meet specially imposed conditions can be determined only through experience. At one extreme are the coarse stone bituminous concretes, at the other, dust mixtures that can be pared with a sharp knife as if they were hard rubber; and each has its special application. Having decided upon the aggregate, its bitumen requirement can be closely approximated by means of the diagram. While the use of this diagram is fundamentally correct, it must of necessity be accompanied by practical tests of aggregates. In addition to void percentage and specific gravity there are petrographic and physical qualities of aggregates affecting results to a more or less extent. Moreover, since the data leading up to the preparation of the diagram have been brought together with little time available, by a highway construction rather than a research organization, they are undoubedly open to refinement in some respects.

Two thoughts are suggested by a consideration of the preceding facts. Can the extra cost of binder be safely eliminated? Can a natural aggregate be used instead of the expensive artificial ones of usual practice? A search through literature on the subject fails to reveal any good reason for the adoption of the binder course. That it may be successfully eliminated is substantiated by examples in Washington of various ages. The most recent instances, and directly comparable with sheet asphalt and binder practice of to-day, are several streets laid in 1911. For these, topping mixture alone was used, and to-day no surface conditions can be noted to differentiate them from streets constructed at the same time with the identical topping laid over a binder course.

In order to lessen the cost of topping mixtures, the obvious course to follow is to substitute natural sand for the usual artificial mixture. This natural sand in Washington has long been used for hydraulic concrete with good results. To be workable with bituminous cement, experience must show whether or not its dry, loose volume per unit weight is of sufficient constancy. This sand costs but 80 cents per cubic yard, as compared to $2.65 per cubic yard for the mixture of special sand and limestone dust now in use. Because of this and a reduction in the bitumen requirement a saving of from 10 to 15 cents per square yard would result. While a few experimental patches have been laid in accordance with this idea, the problem is one that can be settled only after further research. It should be of particular interest in those localities where, to-day, bituminous sheet surfaces are almost prohibited because of the high cost of those artificial aggregates habitually prescribed in current practice.

The question of the binder occupies a wholly different status, and it appears to me sufficient facts exist to warrant the elimination of this course. A three dollar and twenty cent pavement is made up of $1.62 for the 6-inch concrete base, $0.67 for the binder and $0.91 for the topping. With elimination of the binder it is believed that the opportunity should be grasped to increase the thickness of the concrete base, thereby increasing the stability of the construction; for, setting flexibility and rigidity arguments to one side, the word best describing the worth of a base is "Stability." Eight inches of concrete base at $2.16, with $0.91 for topping, gives a 9½-inch pavement, costing $3.07, as compared to $3.20, for the present 9-inch standard. The 1½-inch surface may not last as long as the 3-inch, but its replacement will cost a great deal less. It is the part of wisdom to put every possible cent into insuring for the base permanency throughout the uncertainties of the years to come.

Due to the stability of Washington's concrete-base pavements, it has thus far been unnecessary for the District authorities to put into effect any restrictions as to weights of motor vehicles and their loads. The heaviest trucks made use of in the District are 7½ tons, which, with their loads, give a gross weight of 30,000 pounds. They are equipped with 14-inch tires in rear, giving a load of 2 or 3 pounds more than 800 per inch width. Two generations, even one generation ago, in laying concrete bases no conception was had as to the loads to which they would be subjected to-day. The traffic of the future is to the present generation just as impossible of discernment; however, every practicable effort must be made to provide for it.

Highway construction must keep pace with national growth and progress. Washington has examples of all types of roads and streets. Cheap construction is warranted in some cases, but on main-travelled arteries it gives way to a more permanent type. It was a wise and economical policy which years ago adopted the concrete base as a standard. To date, this class of base has given every indication of being the one permanent part of a bituminous pavement, the outstanding feature of which is the economy with which repairs may be made and, further, the ease with which a worn-out surface may be stripped from the base and replaced with new.

Progress of the United States During the Past Century

Area of the United States—Square Miles.

1820	1,792,223	1920	3,026,789

Growth of Population

1820	9,638,453	1920	105,633,108

Growth of Population per Square Mile.

1820	5.38	1920	34.91

Import Trade—Dollars.

1821	62,585,724	1920	5,279,398,211

Export Trade—Dollars.

1821	43,671,894	1920	8,080,818,455

Commercial Vessels Entering American Ports.

	American		*Foreign*	
	Per cent	Tons	Per cent	Tons
1821	97	765,098	3	81,526
1920	42	32,125,649	58	31,999,082

Clearing American Ports

	American		*Foreign*	
	Per cent	Tons	*Per cent*	Tons
1821	79	804,947	21	83,073
1920	44	34,030,978	56	33,790,594

—*Department of Commerce.*

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Prize Map Problem

Solutions and Discussion

IN the January-February number of this journal we published a problem on the Duties of Divisional Engineers in an Advance. As prizes for the best solutions submitted we offered several subscriptions to THE MILITARY ENGINEER, paid up for a period of three years each. Much to our disappointment only six solutions were received. These were forwarded to a Board composed of three members of the faculty of The Engineer School, viz. Majs. R. C. Crawford, W. H. Holcombe and D. O. Elliott, all of the Corps of Engineers, U. S. Army. Needless to say, the names of competitors were not made known to the Board. The latter, after careful consideration, pronounced the best paper to be that submitted by Capt. Charles H. Roe, Engineer Reserve Corps (No. 68 Lake Avenue, Tarrytown, N. Y.), and the second best was that submitted by Capt. John E. Wood, Corps of Engineers (Municipal Building, Washington, D. C.).

Again, without divulging the names of the contestants, all solutions were submitted for discussion to Lieut. Col. George B. Pillsbury, Corps of Engineers (Army Staff College, Washington, D. C.).

We can not here repeat the statement* of the problem, which will be found on Page 13, Volume XIII, No. 67, of THE MILITARY ENGINEER, but we print below the winning solutions and Colonel Pillsbury's comments. As suggested in these comments, it is to be hoped that others will submit remarks on the problem and the solutions, which will assist our readers in arriving at a thorough understanding of the duties of engineer troops attached to a force of all arms making an advance in the face of the enemy. [ED.]

First Prize Winning Solution

By

Charles H. Roe
Captain, Engineer Reserve Corps

(a) *Organization and Standing Instructions.*

Colonel A has not introduced any new or novel feature in his organization. Regimental headquarters is constituted and functions exactly as is contemplated by the compilers of the organization tables. On account of his duties as Divisional Engineer requiring considerable of his time, Colonel A has left the actual work of administration of the regiment very largely to Lieutenant Colonel B. Captain M, topographical and intelligence officer, has charge of the work of correcting maps. The other staff officers are working as usual. Colonel A retains the one motor car given the regiment for his own use, and the four motorcycles are in charge of the Supply Officer, who sends them out upon order from the Adjutant. Major Y, of the 1st Battalion, has been instructed to report progress twice daily by telegraph on his work of reinforcing bridges. The company, with the advance guard, reports twice daily by runner or other convenient, expeditious method upon the following points: Condition of the road being traversed, the railroad, bridges, and any possibilities of water supply for the troops.

(b) *Results of Conferences.*

Before 6 P. M. Colonel G gives G-3 the following proposed disposition of engineer troops:

"Company F will relieve Company E with the advance guard before the march begins to-morrow. The same six detachments of engineer troops in automobiles and the ten mounted men with the cavalry, all under command of Captain M, topographical officer, who have been engaged in correcting maps, will continue on this work to-morrow. The 1st Battalion is en route to join the regiment, having been relieved by the corps troops, and the regiment will, accordingly, be intact to-morrow with the exception of the company with the advance guard. The engineer train will be with the regiment, immediately following."

Colonel A also hands G-3 a copy of the wire from the Corps Engineer relative to the relief of the 1st Battalion and the ponton equipage, and requests that he issue the necessary orders for the engineer train to move up directly in the rear of the regiment. Colonel A sees G-2 and informs him that the work of correcting maps will be continued as he requested. Before 7 P. M. Colonel A sees G-1 and hands him the following proposed plans for water supply the following day:

"Water-tank train will leave OCEANSIDE with full tanks. There may be water obtainable in ENCINITAS, and possibly from the SAN MARCOS or the ESCONDIDO creeks. If no water supply has been uncovered by the advance by noon, the water-tank train will deliver its supply to the various units during the noon halt and return at once to OCEANSIDE for a fresh supply. Upon reaching DELMAR water is obtainable there unless the enemy has cut the pipe line supplying the city, in which case water is sure to be found in the SAN DIEGUITO River which the water-tank train can carry to the division. The company of engineers with the advance guard has been instructed to report at once any wells or other possible source of water supply that they find."

G-1 approves this plan. Colonel A hands G-1 a copy of the wire from the Corps Engineer relative to the relief of the 1st Battalion and the ponton equipage. Colonel A then requests G-1 for a requisition for the entire stock of bridge timbers and railroad ties in the railroad yards at OCEANSIDE and that the necessary steps be taken to have this material loaded on flat cars and sent south by rail with the division, so as to be available for use by the engineers wherever necessary. G-1 asks the colonel to appraise this material and report to him.

(c) *Orders and Messages.*

To C. O.'s Company E and Company F; by motorcycle to Company E and by orderly to Company F."

"The division advances at 5:30 A. M. to-morrow. Com-

*In his letter of transmittal, one of the competitors remarks on the statement of the problem as follows: "The problem appears to me to be practicable and very well stated, but, on the quiet, I wish you would tell me where Colonel A. got those six autos. Also, who ever heard of an engineer regiment going into action with a well-stocked lumber dump in the back yard? It is too good to be true."

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pany F will report to the officer in command of the advance guard in the morning in time to relieve Company E and to take up the march at that hour. Company E, after being relieved, will be ready to take its proper place with the regiment as it passes. In addition to other information to be reported upon by the company with the advance guard, as prescribed in Regimental Order No. __, August 25, 1920, Company F will report immediately to these headquarters any source of water supply found, its nature, and estimated quantity. By order of Colonel A, Captain N, Adjutant."

To Majors X and Y, C. O.'s Companies A, B, C, D, E, F., Engineer Train, Water-Tank Train; by orderly to Majors X and Y, Companies A, B, C, D, and F; by motorcyclist to the others:

"This division and the 10th are in contact with enemy outposts and small, retreating detachments of enemy troops. It is estimated that not over two Red divisions have landed in SAN DIEGO. We advance at 5:30 A. M. to-morrow. DELMAR is the day's objective. The regiment will be ready at all times to take up a defensive position and assist as infantry if superior enemy forces are encountered. The regiment will form as usual, the 1st Battalion leading. The 2nd Battalion will reserve road space for Company E, who will join the regiment on the march. Company F will be with the advance guard. The Engineer Train will follow directly behind the regiment. Messages will be sent to Lieutenant Colonel B at the head of the column of the leading company. By order of Colonel A, Captain N, Adjutant."

To C. O. Water-Tank Train, by orderly:

"You will leave OCEANSIDE to-morrow with all tanks filled. You will be prepared at any time to-morrow, upon receipt of orders from these headquarters, to return to OCEANSIDE and refill tanks. By order of Colonel A, Captain N, Adjutant."

Verbal instructions to Captain L, Regimental Supply Officer:

'Go at once to the railroad yard at OCEANSIDE and list and appraise all the railroad ties and bridge timbers piled there beside the tracks. Keep a copy of this appraisal yourself and give me the original for G-1 and a copy for myself. Please have this ready for me by 9 o'clock."

(d) *Proposed Action for Following Day*

Colonel A intends to find out, by any means possible, the nature of the pipe line supplying DELMAR, and if he thinks it is practicable to effect repairs in case it has been cut, to order material for that purpose immediately by wire from LOS ANGELES. He makes a mental note that he will impress upon First Lieutenant K, commanding the Engineer Train, as soon as he reports to the colonel, the imperative necessity of keeping his technical trucks and wagons instantly available for issue of material. The colonel notes that the bridge across HEDIONDA creek is intact as reported by Captain Z, and determines that Major Y and the 1st Battalion will resume the work of strengthening bridges or repairing same just as soon as any are encountered that require it, but that he will keep the regiment intact to-morrow as long as possible.

Second Prize Winning Solution

By

John E. Wood
Captain, Corps of Engineers

(a) *Organization and Standing Instructions.*

I. Organization of Regimental Headquarters.

1. Colonel assisted by Adjutant; orders, and liaison with division headquarters; and commanding troops.

2. Lieutenant Colonel: directing field functions—
Trains,
Water supply,
Roads and bridges,
Materials,
Mapping.

3. Topographical Officer: in charge of division water supply.

4. Supply Officer: commanding officer of animal trains (under Lieutenant Colonel).

5. Commander of Engineer Train: with trains.

6. One lieutenant with Headquarters Detachment.

7. Mounted Section, Headquarters Detachment, with Advance Guard.

8. (*a*) One Lieutenant, Company D, at OCEANSIDE, in touch with Corps Engineer.
(*b*) One Lieutenant, Company E, liaison with Division Headquarters.
(*c*) One Lieutenant, Company F, liaison with Artillery Brigade Headquarters.

9. Motors:
Cycle riders—
3 to Regimental Headquarters,
1 to Trains.
Car—
Regimental Headquarters.

10. Water detail of one Master Engineer, 15 men from Company F.

II. Transmission of orders.

1. All companies to receive orders through Battalion Headquarters, except when acting separately. (Two motorcycles detailed.)

2. Separate companies and trains will receive orders direct from Regimental Headquarters; charged to Lieutenant Colonel. (One motorcycle detailed.)

3. March orders to be issued before daybreak and distributed by messenger.

4. Immediately upon reaching objective, Company Commanders to report to Regimental Headquarters.

(b) *Results of Conferences.*

I. With G-1.

1. Troops will carry water:
(*a*) Canteens filled,
(*b*) Water carts filled. Necessity for conservation of water.

2. Water will be available at DELMAR in afternoon.

3. Information will be disseminated through G-1 as soon as water points shall have been established. Organization commanders to instruct troops as to water points:
Troops only,
Animals.

4. Organizations to provide headquarters signs.

5. Two motor trucks for water supply.

II. With G-3.

Position of engineers in column approved as follows:

1. Company E and 4 tool wagons (with Headquarters Mounted Section attached) with advanced guard.

2. The regiment, less Company E, and mounted section of headquarters detachment with main body, immediately following artillery.

3. Trains of engineer troops will lead their respective columns—
(*a*) Animals,
(*b*) Motor.

Reporting to Division Train Commander; but subject to orders from regiment (rights of way over all other transportation).

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4. One Lieutenant, Company E, Division Headquarters liaison.

III. With Artillery Brigade Commander: one lieutenant of Company F, with Artillery Brigade headquarters.

IV. With Corps Engineer: message as to—

1. General conditions.
2. Condition of troops.
3. Availability of materials.
4. Establishment of material dumps.
5. Water supply—
   Pumps,
   Damming materials,
   Designation signs.

V. With Division Sanitary Officer: re chlorination of water.

(c) *Orders and Messages.*

I. Field Orders, Headquarters, 8th Engineers.
No. 8, Fire House, OCEANSIDE,
Map CALIFORNIA, 5-D. Sept. 29, 1921.

1. A Red force, approximately 50,000, landed at SAN DIEGO, September 25. They will probably advance inland and to the North. Red patrols have been encountered by our advance cavalry near AQUA HEDIONDA.

The advance southward will be along the OCEANSIDE-ENCINITAS-DELMAR road. The 10th Division is advancing southward along the MOOSA-ENCINITAS-MERTON road; and bivouaced last night at MOOSA.

The country to the south is generally treeless and uncultivated; water is scarce.

2. This division will proceed at 5:30 A. M. to-morrow, the 30th. DELMAR is the day's objective. Our cavalry will precede the advance guard, and establish contact with the advance units of the 10th Division inland. The division will be ready to take up a defensive position if required. Division Headquarters will be established at ENCINITAS.

All troops will carry canteens filled. Water carts will be filled before striking camp.

3. Company E, with 4 tool wagons and Mounted Section, Headquarters Detachment, will report to Lieutenant Colonel A. P. commanding Advance Guard, at 5:30 A. M., the Court House at CARLSBAD; the remaining transportation of Company E will join regimental trains in rear of main body, at CARLSBAD.

The regiment, less Company E, and headquarters mounted section will form at OCEANSIDE preparatory to moving out at 5:30 A. M. to-morrow. Our position in the column will be immediately following the 25th Field Artillery. Transportation will join trains.

4. Trains will report to Supply Officer, and will be ready to join the column at 5:30 A. M. to-morrow. The animal train will consist of

(*a*) Regimental transportation,
(*b*) Company E transportation, less tool wagons,
(*c*) Companies D and F transportation,
(*d*) Engineer Train.

Motor train will consist of

(*a*) Engineer Train,
(*b*) Water-Supply Train.

Transportation of the 1st Battalion is proceeding southward along the OCEANSIDE-ENCINITAS road; and should reach OCEANSIDE on October 1.

The animal and motor trains will lead their respective columns. The Supply Officer will report his commands to the Commander of Trains, but subject to subsequent orders from his regiment.

An Engineer Dump will be established at OCEANSIDE, Lieutenant A. Y., Company D, in charge. Trees in limited amount may be expected along the line of march; lumber or bridge materials will be available at OCEANSIDE.

5. Regimental Headquarters will be established at ENCINITAS at noon to-morrow. Company Commanders will report as soon as reaching objective.

By order of Colonel A.

W. Y. X., Captain of Engineers, Adjutant.

Copies to:
File,
Lieutenant Colonel B,
Battalion Headquarters (four each),
Supply Officer,
Topographical Officer,
Corps Engineer,
Division Headquarters,
Commander of Engineer Train,
Commander of Headquarters Detachment.

II. In view of the inexperience of junior officers, the following subjects will be discussed at officers' meeting, 8 P. M., September 29:

1. Situation.
2. Orders.
3. Security.
4. Punctuality.
5. Road discipline.
   (*a*) Troops.
   (*b*) Transportation.
6. Bivouacs.
   (*a*) Occupation.
   (*b*) Policing.
7. Initiative.
8. Food and water.
9. Contingencies.
10. Dependability.
11. The "Message to Garcia."

(d) *Proposed Action for Following Day.*

In the absence of any material change in the situation, plans will be based on an uninterrupted advance of three days longer, at any time of which, or after which, it will be necessary to organize the terrain over the division front.

Mapping will be expedited.

Adequate water supply will be provided by two trucks carrying—

Pumps, hand,
Pumps, power hose,
Dam materials,
Designation signs.

Engineer Dump will be established at ENCINITAS.

Troops will bivouac in shelter tents.

Material dumps will be established and relinquished to Corps Engineer when corps troops arrive. The officer in charge of rear material dumps will be in contact with Corps Engineer at all times.

Discussion

George B. Pillsbury

Lieutenant Colonel, Corps of Engineers

The selected solutions, as well as others not printed, are excellent. It is to be regretted that more competitors did not enter the lists, for the study of such problems will go far toward perfecting the engineer service for its field duties.

(Continued on Page 293)

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The Military Engineer

Dedicated to the National Defense

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Wilmington Post—Secretary, Society of American Military Engineers, U. S. Engineer Office, Wilmington, Del.

Interest and Value of Personal Experiences

A GREAT soldier once remarked that he would rather talk for 15 minutes to a man who had actually taken part in a battle, than to read all the theory on the Art of War that was ever written. Not remembering just who it was that said this, we might follow the common practice of attributing the remark to Napoleon, or perhaps to Grant, were it not that this literary liberty has been already so much abused as to border on license. So we allow the remark to stand anonymously on its own merits.

Certainly none will deny that personal experiences have a practical value and a human interest that mere theory can never possess. The few personal experiences of the Great War that we have been able to present to the readers of this magazine have aroused more interest than anything else we have published.

The interesting personal experiences of the war are not limited to the battlefront. The S. O. S. can contribute its share of them.

Our society includes several thousand former officers who served in the World War. Probably there is not a single one of these who has not enjoyed, or does not now enjoy in retrospection, many personal experiences of the great conflict. Probably also the great majority of these personal experiences would be both interesting and instructive to our readers, would help to popularize our magazine and to increase the solidarity of our society.

Yet the editor can count on his fingers the number of contributions of this kind that have been received during the life of the magazine.

We wish our members would come to a full realization of the fact that The Military Engineer is *their* magazine, that it is their contributions alone which keep it going.

Let your fellow members enjoy the narrative of some of your interesting personal experiences, in the war or out of it. Tell them through the columns of your magazine. Do not let the fact that you are not in the habit of writing deter you. Confidentially, we like to receive the contributions of those who don't know how to write, or think they don't. They possess a freshness and charming originality too often lacking in the products of the habitual writer.

Will you not contribute something along these lines—some little anecdote pointing a moral, or containing a useful hint for your fellow members? Make it brief, the shorter the better, humorous if you will, for all our members have a sense of humor, and in your own words.

Obey that impulse! Do it now!

Human Maintenance and Repair

AS soon as a piece of machinery is placed in commission, as soon as a strip of roadway begins to bear traffic, as soon as a building is exposed to the weather from without and to wear and tear from within, the engineer must take up the work of maintenance and

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repair. This involves, first, inspection; second, application of well-established practice in forming a logical plan for maintenance and repair; and finally, faithful work in carrying out the plan. In this way, and only in this way, can the original construction continue to serve the needs for which it was designed and built. Mechanically, most engines and other structures having moving parts can not reach their highest efficiency until they have "found themselves"; until they have become broken in; until they have to their credit a certain amount of service. If good lubrication is maintained, if careful inspection and timely repairs are regularly made, the period of maximum efficiency is greatly prolonged. This is true economy and true efficiency, which constantly postpones the day when the machine must be replaced in its entirety.

Now what of the human machine, especially as we have it in the service? By a careful process of elimination we select our raw material. It must be sound. This we begin to develop, and, by years of training, years of experience and years of elimination, we finally obtain a product which usually reaches a maximum efficiency in the average officer between the ages of thirty and forty-five, considering not only his technical experience, but also his physical equipment and his mental balance, which depend largely upon his physical condition. As the officer grows older his experience ripens. Unfortunately, however, his physical vigor, and with it his mental strength and his will power, usually declines. What is the answer?

For some years there has been in existence an organization of prominent scientists and other well-known men whose mission it is to apply scientific knowledge to the maintenance of health. These gentlemen assert that the life of the average business or professional man can be prolonged fifteen years by the application of well-recognized principles of physiology and hygiene. It is claimed that the man who undergoes a thorough examination and follows the advice of qualified specialists, can, on the average, add fifteen years of successful effort to his professional career.

As engineers, we can appreciate the advantages of this. We can indorse the idea because we know that it is scientifically sound. Who of us wants to be retired for disability at the age of fifty when he could go on to sixty-four by the application of a few common-sense principles which medical men all grant are sound and well recognized? Perhaps the average officer, who must be in better physical condition than the average civilian, can not prolong his life on the average the full fifteen years. If only ten, if only five, who would not gladly accept this as worth while? The recent emergency was less than five years. We had many able officers ripe with experience, just the men we wanted for positions of responsibility, and positions wherein they could not only be of great service to the country but win great distinction and fame. Yet because of physical weakness, weakness which developed under the stress of the emergency, they became casuals, were left behind and had to be replaced by men of fewer years and less experience.

It is the present policy of Congress to rely on the veterans of the World War for the defense of the nation, even though they have now returned to civil vocations. If the health of the experienced officers who served during the recent emergency can be maintained unimpaired for ten, fifteen, or more years, if for that additional period they can be counted on as a potential military force, it would be economic folly not to take advantage of this great asset. "But the army has such a system," some may say. We of the service know, however, that the only examinations—which, by the way, have been called off for this year—are more or less superficial. At best the mission of the Examining Board is primarily, perhaps solely, one of elimination, of detecting the unfit, of making recommendations as to retirement. In our experience we have never known of a case where a medical examiner gave counsel and advice to the officer examined as to what repair and maintenance work his system required. The idea of "life extension" as applied to the individual officer seems never to have taken root in the army. We have made splendid strides combating scourges and diseases for the army personnel as a whole, but never have we taken up the systematic policy of individual examination as thoroughly and completely as science to-day will permit, of sound diagnosis by experienced doctors and of advice to the officer as to how he can safe-guard or improve his physical condition.

The charge made by the organization to which we have referred, for this service of life extension for its members is $20 per annum. Can not the Government afford $20 a year in order that its highly developed, specially trained commissioned personnel may be given this extra lease on life and increased period of usefulness? As an investment it would be well worth the consideration of the Government. As a matter of fact, however, such charge should not be necessary except for the occasional officer on detached service far removed from army centers. The officers of the Medical Corps of the army are competent to do this work and, while they are undoubtedly well occupied in the discharge of their ordinary duties, and are earning the pay allowed them by the Government, it is not improbable that by a proper distribution of this additional duty they could make the necessary examinations of the officers enrolled in the regular establishment. It might be possible to carry the idea even further and to extend the privilege of examination by officers of the Medical Corps of the army to the higher grades of officers enrolled in the Reserve Corps. By a comparatively small increase in the number of officers in the Medical Corps, or possibly by some arrangement with Medical Reserve officers, this privilege of examination could be extended to the officers of every grade in the entire Reserve Corps. These officers are enrolled and trained at no small cost to the Government, and economy would dictate such additional measures as may be necessary to conserve their experience and training.

Some policy of human maintenance and repair is needed in the army and should have the support of all engineers. The success of the experiment on a large scale in the army might ultimately lead to the application of "life extension" methods to our citizenry as a whole, or to such as wished to avail themselves of its benefits.

The Metric System

CONTACT with the French during the war seems to have revived to some extent the agitation in favor of adopting the metric system in the United States. We have no fear that this will ever be done, for while a number of scientists are in favor of the metric system, it finds little support amongst business men, manufacturers and practicing engineers, and certainly there is no suggestion of a popular demand for a change.

The advantages of the metric system are two—first, the decimal relation between its units, and second, the rational connection between the different units of length, weight, temperature, etc.

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Our complex industries are based upon the English system, and to change to the metric system, which is incommensurable therewith, would throw our industries out of gear and require that they be made over. The perfect language, Esperanto, is admittedly better than English so far as simplicity is concerned, but its adoption is out of the question, and the same is true of the metric system.

The manufacturers of the nations using the British system greatly exceed those of the metric-system nations, and it would be much easier for them to adopt our system than for us to adopt theirs. It is not in accordance with democratic principles that the desires of a minority be forced upon an unwilling majority.

The fundamental unit of the British system is the *inch*—our industries are based upon this unit—which, while arbitrary perhaps, is no more so than the meter. Any change which involves the abandonment of the inch would be so difficult as to be out of question.

If it be desired to adopt a *decimal* system, the only practicable scheme would be one based on the *inch* as the fundamental unit. Some of our measures certainly seem irrational, notably the degree Fahrenheit, the pound, the mile, the gallon, the bushel. The foot and yard are not decimal multiples of the inch, but they have the advantage of being divisible by 2 and 3, though probably 2 and 5 would be better. All of these units could be brought into decimal relation with the inch without throwing our industries out of gear. For example, 1 foot equal 10 inches, 1 mile equal 10,000 feet, 1 pound equal the weight of 50 (or 100) cubic inches of water, 1 gallon equal 250 cubic inches (instead of 237). This would simplify calculations. But the difficulties of calculation are probably not as great as the exponents of the metric system would have us believe. It would, of course, be an advantage if the pound, gallon and bushel were decimally related to the inch, but it is comparatively seldom that the conversion from inches to gallons must be made.

In conclusion, then, the adoption of the metric system, whose unit is incommensurable with our well-established inch, would so disturb our industries that it is manifestly impracticable. The difficulties of calculation under our present system are not, after all, so very great, but if we desire to avail ourselves of the advantages of a true decimal system, quite as satisfactory as the metric system, the only practicable and possible solution for the English-speaking people is a system based on the inch as a unit.

Accordingly, we suggest giving up the futile effort to force the French metric system upon us. If its advocates are still determined that we shall, whether willing or not, enjoy all its advantages, let them see what they can do with the inch as a unit. For we can never abandon the inch.

The Survey of Personal and Material Resources—A Task for Military Engineers

MODERN war involves putting to efficient use all of a nation's resources in men and materials. The outbreak of the World War found practically all of the participants badly informed as to their resources in men having the various kinds of technical skill for which the war created an immediate large demand, in capacity for manufacturing the many kinds of things needed for equipping, supplying and maintaining modern armies, and in facilities for transporting such armies. Indeed, exact knowledge seemed to be lacking as to nearly everything required to be known before dependable plans could be formulated. In spite of the well-known difficulties of the European participants in the war, when we came in we had done little to forestall experiences similar to theirs.

Much of our trouble and confusion in 1917 and 1918 was due to a lack of basic facts stated in figures, or, in other words, statistics. While it is not the function of military engineers to originate broad military policies, they are highly trained men whose daily employment brings them in contact with matters that are of vital importance when the nation is suddenly called upon to make use of its latent military energies. For example, some 8,000 or 9,000 officers and 200,000 men were in service as military engineers engaged in tasks requiring peculiar skill and experience. Yet we had no record to enable us to select the men best fitted for the task in hand, and many men were diverted from the work they were best qualified to do. We must compile correct statistics as to the qualifications of our members and, in addition, we ought to agree upon a program for collecting and keeping currently correct other information or statistics appropriate to our war-time activities, such, for example, as the location and capacity of quarries, gravel beds and other sources of road-building material, the location of stocks of such materials as cement and lumber. It will be said that all these things are well known, but such knowledge is general, not specific, and it has never been studied from the standpoint of our possible military needs.

The above ideas are merely suggestive and might be amplified, but it is obvious that, on the outbreak of war, we shall need facts—that is, correct statistical information, suitably arranged, in regard to our resources.

To make the necessary general surveys and detailed examinations and to compile the needed statistics concerning all our resources in personnel and material, is a proper function of government, and should be included as a part of our military policy—a very important part indeed.

To foster and encourage, and to assist in the compilation of important statistics, and of working plans based upon these statistics, is part of the mission of the Society of American Military Engineers, as included in is larger mission of promoting the National Defense. Indeed, one of the specific objects of the Society is to promote the efficiency of the military engineer service of the United States.

At this stage of national preparedness what can be more important, what can more greatly contribute to engineer efficiency than an accurate detailed knowledge of our resources in men and material? It would appear that a responsibility in this matter rests directly upon us, inasmuch as the investigation of all things pertaining to supply and manufacture is a proper function of the engineer. Insofar as resources of personnel are concerned, our interest may, of course, properly be limited to the personnel engaged in manufacture or other form of production, and that available for engineering service in the event of war. But a little reflection will show that this includes a large proportion of our able-bodied male population.

Elsewhere in this issue we publish an article indicating the plans of the War Department for the formation of the Organized Reserves, for their training in time of peace, and for their mobilization in time of war. This involves the organization of various engineer units as well as the tentative establishment of groups of specialist officers for service at Corps, Army and Expeditionary Headquarters. Corps area commanders have been charged with the organization of these bodies of the Organized Reserves, and in due course will make public the information necessary to the work.

To avoid the misplacements—the misfit assignments of

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valuable personnel—which caused so many disappointments during the war, provision is necessary. The information has been carded and catalogued. Every member of the Reserve Corps is card-indexed according to information furnished by himself, supplemented in certain cases by observations made by his superiors during the period of his war service, but there are many who served during the war who are not enrolled in the Reserves. There are many others graduated from our technical schools during and since the war who were too young for military service. For these there is no specific information in the files of the War Department. Furthermore, an "index" is never a complete specification and assignments by card catalogue do not approach in efficiency assignments based on a direct personal knowledge of the officer assigned. It is precisely in this work of organization and assignment that the local sections of the Society of American Military Engineers can render valuable assistance.

Attention is invited to the fact that the constitution and by-laws of the Society provide for a standing committee "on service relations and military policy." This committee is charged "with the consideration of all matters which may be properly brought before the Society or may originate within the committee itself, involving the relations between the military engineers and other arms of the military service, and between the military engineers and the engineering profession in civil life, including all questions relating to the tentative military organization of the matter, and other measures of military preparedness affecting such engineers."

The organization of the Society and its objects have been approved by the former Secretary of War, by the Chief of Staff, and by the Commander-in-Chief of the American Expeditionary Forces. There is, accordingly, ample warrant for each local branch to organize a committee with the above-indicated functions and to volunteer its assistance to local military authorities in connection with the organization of engineer units of the Organized Reserves.

The fate of the civilian engineers in time of war lies almost entirely in their own hands. At the present time there appears to be no greater field of usefulness, and no activity fraught with greater consequence, than this matter of the organization and utilization of the engineering resources of the Nation in men and material. The question is one deserving of the careful consideration of the members of the Society, and their interest should not be limited to passive contemplation and idle conversation. Let them formulate plans and specifications, let them get on the job, start the machinery and keep everlastingly at it. "Lets go" and keep going.

Military Instruction

IN this number of THE MILITARY ENGINEER we initiate a new department under the simple heading "Military Instruction." This department will be conducted by members of the Instruction Staff of The Engineer School, Camp A. A. Humphreys, Virginia, under the general direction of the Assistant Commandant, Lieut. Col. James A. Woodruff, Corps of Engineers.

The material will be presented under three general subheadings—namely, Military Art (Minor Tactics), Military Engineering, and General Subjects. The latter will include administration, law, and various other miscellaneous subjects not clearly within the scope of the sections on Tactics and Engineering.

It is the intention to cover in this department of the Journal all important military instruction essential to the training of the Reserve Officer of Engineers. The matter presented will also prove of assistance to the officer of the regular establishment, and will serve to keep him in touch with developments in the various fields. The scheme of instruction will be that known as the "applicatory system," now universally recognized in the armies of all the leading military nations as the best practicable method of teaching the art of war in time of peace.

In brief, this system includes—

First, a study of theoretical principles and practical methods applicable to the various situations that may arise in campaigns, and

Second, a series of practical problems usually laid on a map in which the application of the principles is exemplified.

The theoretical instruction will be given in a series of notes and lists of references to standard texts, and in each issue of the Journal there will be one or more practical problems whose solutions will be given in the next succeeding issue. Plans are under consideration whereby it may become practicable to review and criticise solutions submitted by officers who desire to take this advantage of the course. Needless to say, an officer who solves the various probems in accordance with instructions issued will reap far greater benefits from the course than he who merely reads the problem and the solution. The former must do constructive thinking on his own account, while the latter merely follows in a passive sort of way the thought of the instructors.

The matter will be published in solid form, without advertisements, at the back of the magazine, so that it can be detached and bound or filed by those who wish to do so. Postal regulations prevent its issue as a loose pamphlet, and also prevent the perforation of the pages for detachment. Indexes of all matter issued will be published from time to time.

It is hoped to make arrangements to issue with the magazine the maps necessary for the solution of problems. In the meantime THE MILITARY ENGINEER will furnish without charge the necessary maps to any who may desire to undertake the solution of problems.

A word as to the illustration which adorns the heading of this new department of instruction may be of interest to our readers. It is the reproduction of a bronze group entitled "Military Instruction," which flanks the statue of Maj. Gen. Baron von Steuben, erected in 1910 in Lafayette Park, Washington, D. C. The pedestal of the statue bears the following inscription, viz:

"Erected by the Congress of the United States to Frederick William Augustus Henry Ferdinand Baron von Steuben in grateful recognition of his services to the American people in their struggle for liberty.

"Born in Prussia, November 15, 1730; died in New York, November 28, 1794.

"After serving as aide-de-camp to Frederick the Great of Prussia, he offered his sword to the American Colonies and was appointed Major General and Inspector-General in the Continental Army. He gave military training and discipline to the citizen soldiers who achieved the independence of the United States."

In view of the part which von Steuben played in the establishment of our national independence, it is peculiarly fitting that we should typify the aims of this new Department of Military Instruction by this group representing sage Experience imparting counsel for the future to untutored Youth.

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Petition for Amendment to By-Laws

In accordance with Paragraph No. 2 of Article XII of the By-Laws, the undersigned active members of the Society respectfully petition for an amendment to Paragraph 1, Article VIII of the By-Laws, which now reads:

"The annual meeting for the election of officers and for the transaction of other business of the Society shall be held in the City of Washington, D. C., on the Friday preceding the third Wednesday in January."

Amend by striking out the word "preceding" and substituting the word "following"—so that Paragraph No. 1 will read:

"The annual meeting for the election of officers and for the transaction of other business of the Society shall be held in the City of Washington, D. C., on the Friday following the third Wednesday in January."

The object of this proposed amendment is to bring the annual meetings of the Society of American Military Engineers and the American Society of Civil Engineers within the same week, and with only one day interval between the meetings, thus enabling those who are members of both Societies to conveniently attend both annual meetings—the annual meeting of the American Society of Civil Engineers being held on the third Wednesday in January in New York.

(Signed) F. A. MOLITOR, New York City.
J. P. HALLIHAN, New York City.
C. DAVIS, New York City.
F. G. JONAH, St. Louis, Mo.
D. C. JONES, St. Louis, Mo.
J. W. SKELLEY, St. Louis, Mo.
J. L. BUCHANAN, St. Louis, Mo.
R. P. GARRETT, St. Louis, Mo.
A. K. B. LYMAN, St. Louis, Mo.
T. B. PERRY, St. Louis, Mo.
G. C. GRAETER, St. Louis, Mo.
A. T. PERKINS, St. Louis, Mo.
J. A. LAIRD, St. Louis, Mo.

Personals

Leave of absence for three months granted to Col. THOMAS H. REES, Corps of Engineers, has been extended for three months.

Col. CHARLES L. POTTER, Corps of Engineers, has been granted leave of absence for two months.

Col. GEORGE P. HOWELL, Corps of Engineers; Maj. GORDON R. YOUNG, Corps of Engineers, and Capt. HARTWELL W. WILLIAMS, Quartermaster Corps, have been appointed to investigate the alleged damage to Silver Lake caused by débris from the Remount Station at Camp Gordon, Georgia.

Col. HARLEY B. FERGUSON, Corps of Engineers, has been relieved from his duties at the General Staff College, Washington Barracks, D. C., and ordered to report to the Assistant Secretary of War for assignment to duty in his office.

Lieut. Col. CLARENCE O. SHERRILL, Corps of Engineers, has been detailed in charge of the public buildings and grounds in the District of Columbia and as Military Aide to the President, relieving Maj. CLARENCE S. RIDLEY, Corps of Engineers. In addition to his other duties, Col. SHERRILL has been detailed by the President to act as Superintendent of State, War and Navy Department Building.

Lieut Col. W. GOFF CAPLES and Majors LAURENCE V. FRAZIER, FRANCIS B. WILBY, CLARENCE S. RIDLEY, FREDERICK B. DOWNING, CHARLES L. HALL, JOHN R. D. MATHESON, CHARLES J. TAYLOR and DAVID MCCOACH, JR., all of the Corps of Engineers, have been ordered for duty as student officers at the School of the Line for the year 1921-22.

Maj. ARTHUR R. EHRNBECK, upon the expiration of leave of absence on account of sickness, has been transferred from his station in the Hawaiian Islands to San Francisco, Calif., for assignment to duty as Assistant to the Engineer, Ninth Corps Area.

Maj. WILLIAM A. JOHNSON, Corps of Engineers, has been detailed, in addition to his other duties, to superintend the construction or repair of any aid to navigation authorized by Congress in the Nineteenth Lighthouse District, relieving Col. CLEMENT A. F. FLAGLER, Corps of Engineers.

Maj. HENRY A. FINCH, Corps of Engineers, has been granted leave of absence for three months.

Maj. JAMES G. STEESE, U. S. A., retired, in addition to his other duties, has been detailed to superintend the construction or repair of any aid to navigation authorized by Congress in the Sixteenth Lighthouse District, relieving Col. JAMES B. CAVANAUGH, Corps of Engineers,

Maj. JOHN C. H. LEE, General Staff, has been transferred from Fort Sheridan, Illinois, to Manila for duty as Assistant Chief of Staff for Military Intelligence, Philippine Department.

Maj. ROBERT C. WILLIAMS, Infantry, has been transferred to the Corps of Engineers.

Capt. HIRAM B. ELY, Corps of Engineers, has been transferred, at his own request, to the Ordnance Department, Regular Army.

Capt. EDMUND H. LEVY, Corps of Engineers, has been granted leave of absence for one month and five days.

Capt. AUBREY H. BOND, Corps of Engineers, has been ordered, at the expiration of his present leave of absence, from Camp Jackson, South Carolina, to Camp Lewis, Washington, for assignment to duty with the Fourth Engineers.

Capt. GEORGE J. NOLD, Corps of Engineers, has been granted leave of absence for one month.

Capt. RALPH E. CRUSE, Corps of Engineers, has been granted leave of absence for one month effective upon his arrival in the United States.

Capt. HENRY M. UNDERWOOD, Corps of Engineers, has been transferred from the Hawaiian Islands to Troy, N. Y., for assignment to duty as a student at the Rensselaer Polytechnic Institute.

Capt. THOMAS HAY NIXON, Corps of Engineers, has been transferred, at his own request, to the Ordnance Department, Regular Army, and assigned to the Watertown Arsenal for Duty.

Capt. MILTON HEILFRON, Engineers, has been transferred to the Coast Artillery Corps and assigned to the Thirty-first Artillery Brigade, Coast Artillery Corps, Camp Lewis, Washington.

Capt. CLIFFORD E. BLACK, Infantry, has been transferred to the Corps of Engineers.

Capt. WILLAM H. WAUGH, Quartermaster Corps, has been transferred to the Corps of Engineers.

First Lieut. JOHN C. ARROWSMITH, Corps of Engineers, has been granted leave of absence for one month.

First Lieut. WILLIAM A. CALLAWAY, Corps of Engineers, has been transferred to the Infantry.

First Lieut. CONRAD P. HARDY, Corps of Engineers, has been granted leave of absence for two months effective upon his arrival in the United States.

First Lieut. (since promoted to the grade of Captain) HAROLD J. ADAMS, Corps of Engineers, has been transferred to the Signal Corps.

List of Applicants for Membership

This list contains only those applicants from whom formal applications have been received between March 1 and April 19, 1921:

Anderson, Col. P. M., 5508 Broad Branch Road, N. W., Washington, D. C.
Andrews, Lieut. Martin Arthur, Camp Travis, Texas.
Barrows, Capt. R. G., 89 Rawson Road, Brookline, Mass.
Berliner, Richard W., 460 W. 147th Street, New York City.
Bermel, Capt. P. E., General Delivery, Tucson, Ariz.
Blackstone, Henry, 76 W. 85th Street, New York City.
Bonfils, Capt. F. W., West Point, N. Y.
Boughton, Maj. Wilfred E., 1665 Grand Concourse, New York City.
Brokaw, Lieut. Van S., 1057 Balmoral Avenue, Chicago, Ill.
Brown, Marshall W., 50 Voorhis Avenue, Nyack, N. Y.
Brunel, Louis J., Angels Camp, Calif.
Bunker, George H., Wilmington, N. C.
Burns, Lieut. Donald S., 5th Engineers, Camp Meade, Md.
Bush, Warrant Officer Peter A., 27 Hillcrest Avenue, Cranford, N. J.
Carlson, Arnold G., 427 32d Street, Paterson, N. J.
Carter, C. B., 1062 McCormick Building, Chicago, Ill.
Chadwick, Lieut. B. F., Camp Humphreys, Va.

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Activities of Our Local Posts

San Francisco Post

The Activities Committee met on March 7, with the following members present:

Col. Herbert Deakyne, C. E.; Lieut. Col. John H. Skeggs, E. R. C.; Maj. U. S. Grant III, C. E.; Capt. D. W. Dodge, E. R. C.

The functions of this committee as defined in the plan of organization adopted by the Post, are:

(*a*) To arrange inspection and observation trips.
(*b*) To establish and maintain close relations between the regular establishment and the reserve.
(*c*) To initiate and support movements of interest and advantage to reserve officers.
(*d*) To serve in conjunction with courses of training and study.

The committee decided to arrange for a trip over the coast defenses about San Francisco Bay, the trip to be preceded by a description of the works and the plan of defense.

Other trips planned include the Presidio of San Francisco, parts of the State Highway, with particular reference to their military value, the Hetch Hetchy water-supply project for San Francisco, and the U. S. Disciplinary Prison on Alcatraz Island. The committee believes that not only will these trips be interesting and instructive, but also that they will serve to bring the members of the Post into close personal touch with one another, which is highly desirable.

In lieu of the April meeting a trip has been arranged to the Mare Island Navy Yard through the courtesy of Capt. Edwin L. Beach, U. S. N., Commandant. The chairman of the committee, Colonel Deakyne, has proffered the use of the U. S. Engineer boat for this trip.

Los Angeles Post

At a meeting on April 5, Mr. C. M. Cram, 725 Central Building, Los Angeles, Calif., was appointed as secretary to succeed Mr. Burt Harmon, whose resignation was accepted.

Chicago Post

The March meeting was held on the 17th at the Electric Club, where the members of the Post were the guests of Castle Post of the American Legion for dinner. The subject of the evening was Military Railways. Mr. S. M. Felton, director general of military railways during the war, introduced the speaker of the evining, Col. F. G. Jonah, chief engineer of the St. L. & S. F. Ry., who served as chief engineer of the Division of Light Railways, A. E. F. Col. Jonah gave a very interesting talk based upon his wide and successful experience in the operation of light railways in France, with many lantern-slide illustrations.

The Chicago Post is rapidly developing an extensive program of subjects to be presented at the monthly meetings and hopes to make a definite contribution to the development of military engineering.

Portland, Oregon, Post

The Portland, Oreg., Post, Society American Military Engineers, was organized June 15, 1920, and was granted a charter under date of October 4, 1920.

The following officers were elected:

President, Maj. Lyman Griswold;
Vice-President, Capt. W. H. Emrick;
Secretary, Capt. P. Hetherton;
Treasurer, Capt. J. W. Morris;
Assistant Treasurer, Capt. R. E. Kremers.

Meetings have been held on the second Tuesday of each month since July 15, 1920, the first meetings having been devoted to discussions of policies and two problems worked up by special committees in connection with land-defense matters at the mouth of the Columbia River. The meeting of August 12 was in the nature of a farewell meeting for Lieut. Col. J. R. Slattery, under whose auspices the Post was organized.

Commencing with the November meeting the program has been preceded each month by a very enjoyable dinner served in a private dining room of the Portland Chamber of Commerce, except for the February meeting, when the dinner and meeting were held at the City of Portland Municipal docks, where the members of the Post were guests of the Dock Commission. Since the inauguration of the dinner feature the meetings have been attended by as many as sixty members and as few as twenty, with an average attendance of about thirty.

Two local inspections of engineering works were made prior to attending dinner, one in February, when the extensive docks, grain elevator, flouring mill, and ore-handling plant at Municipal Terminal No. 4 were visited, and the other in April, when the electric light, power, and steam-heating plant of the Northwestern Electric Company was inspected.

It is planned to hold the next meeting at the Portland Automobile Club, and to invite the ladies, serve a buffet supper, and dance to the jazzy strains of a local orchestra.

The dinner feature contributes not a little to the interest taken by the local engineers and the very gratifying progress of the Post. You know that it is ever so much easier to get communicative and appear interested after a square meal, and a cigar will almost always last as long as a meeting ought to last, not to become boresome.

Well, after dinner is over, about 8 o'clock, the president opens up, and the items of business are rapidly disposed of. Then comes a report from the Current Events Committee, giving a summary of military events that have happened during the month that should be of permanent interest to members. After that, the Library Committee usually reports a new publication placed on the library shelf. The Program Committee suggests where to meet and what to do next month. The committee in charge of the Rifle Association work usually reports progress. Then come the fireworks. We always try to have some fireworks. In a large body of intelligent men or women there are usually found legitimate differences in viewpoints on important questions. Lately we have been discussing the proposed Department

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of Public Works and the effect on the Corps of Engineers of losing the river and harbor work.

At the last meeting the opinion seemed to predominate that while a Department of Public Works ought undoubtedly to be organized to co-ordinate the engineering work of the Government, the term engineering work includes such a mass of undertakings that, unless some discriminations are made, it may rightly claim authority over things technically of an engineering nature but practically not properly to be included under a Department of Public Works. The river and harbor work is distinctly an engineering function, but it should be excepted just as certain other phases of Government work of a technical nature are bound to be excepted, for one reason or another, not just because all phases cannot be united under one head, but because there is at least one overwhelming reason for keeping river and harbor work under the Corps of Engineers, and no cogent reason for taking it away, such as prospective increase in economy and efficiency of the particular work affected.

Now, the one compelling reason why it should remain under the Corps is that through its agency, and at no extra cost, the officers of the Corps of Engineers get the engineering experience and the contact with the engineers of the country which is absolutely essential for the Corps if it is to handle successfully the engineering problems of the next war. Mr. O. Laurgaard, city engineer of Portland, presented cogent reasons for establishing a Department of Public Works, but agreed that the river and harbor work was not of such vital importance to the correct functioning of the Department of Public Works to make it a matter of great concern, whether it were included in the new department or not, but on the basis that this work was purely of a civil characer, it was only reasonable that the civil bureau should handle it. He felt that there was plenty of opportunity on fortifications and purely military work for training the military engineer. The latter assertion was rebutted by Major Park and Capt. Ben Morrow. Lieut. Col. Lewis H. Rand was a welcome guest, and he presented some well-considered reasons why the Corps of Engineers should retain the work. Mr. J. N. Teal, who has just been relieved by Senator Chamberlain on the U. S. Shipping Board, spoke strongly on behalf of continuation of the river and harbor work under the Corps of Engineers. Mr. C. L. McKesson, of the Bureau of Roads, gave some interesting side lights on the general subject.

New Local Posts being formed

Steps have been taken to establish several new local Posts of the Society. The list is given below, with the names and addresses of the temporary secretaries. All members in the vicinity of these new Posts are urged to get in touch with the secretaries, with a view to affiliation with a local Post.

The local Posts are the backbone of our Society. They provide the opportunity for personal contact and for the discussion of all matters pertaining to the maintenance of an adequate Engineer Reserve. Without such discussion, it will be difficult or impossible for the editors of the journal to keep in touch with the actual needs of the Society.

Following is a list of new Posts:

Baltimore Post—Capt. John S. Doyle, E. O. R. C., 309 Custom House, Baltimore, Md.

Boston Post—Lieut. Louis A. Armistead, Room 701, 108 Massachusetts Avenue, Boston, Mass.

Buffalo Post—Mr. Albert F. Krause, Builders Exchange, Court and Pearl Streets, Buffalo, N. Y.

Cincinnati Post—Capt. Hugh J. Krampe, E. O. R. C., 1608 First National Bank Building, Cincinnati, Ohio.

Detroit Post—Maj. Richard B. Hewitt, E. O. R. C., 712 Bord Building, Detroit, Mich.

Indianapolis Post—Capt. C. L. Harrod, E. O. R. C., Public Service Commission of Indiana, Indianapolis, Ind.

Twin Cities Post—Capt. John F. Druar, E. O. R. C., 512 Globe Building, St. Paul, Minn.

Akron Post—Lieut. Sears S. Day, E. O. R. C., Lock Box 254, East Akron, Ohio.

Suggestions for Articles

"Comments by company and platoon commanders on the engineer wagons used in France, their suitability, and changes suggested for future use."

"Military railways; their construction, maintenance and operation."

"Carrying parties; how to lessen the man-power requirements of this work in position warfare."

"The Military Capacity of a Wagon Road."

"The Service of Supply in the Next War."

"The airplane as an aid to transportation."

"A World War bibliography for the E-Officer."

"Water Supply in mobile Engineer Operations."

"Construction and maintenance of ponton bridges under battle conditions in France."

"Universal Service."

"Effect of sea water on reinforced concrete."

"Problem requiring establishment of an advanced engineer depot, showing organization of office method of purchasing from local sources, methods of storage, and issue of material."

"*Esprit de corps* among reserve officers."

"The development of explosives during the War."

"Methods of administration, cost analysis, and progress reports on engineer construction work."

"Roads and road making in battle areas."

"Maintaining interest in local posts of the S. A. M. E."

"Propositions of men skilled in advanced trades required for a well-balanced divisional engineer regiment."

"The design of permanent defense structure in relatic to enemy aircraft operations."

"The diary of an engineer platoon commander in France."

"Training for engineer reserve officers; how can the two weeks' annual training period be utilized to the best advantage?"

"Types of barracks used in France; description and suggestions for improvements."

"Traffic control in combat areas."

"Linking the S. A. M. E. with the R. O. T. C."

"Engineer dumps; their establishment and operation."

"Map reproduction in the field; experiences and suggestions for changes in equipment."

Questions for Discussion

The opinion of the Society membership is desired in connection with the following Society matters:

I. *Marksmanship trophy for R. O. T. C. units.*—There are in existence nineteen (19) engineer units of the Reserve Officers' Training Corps located at various technical schools throughout the country. During the past year a number of indoor, or gallery, rifle matches have been conducted between various units of the R. O. T. C.—infantry, cavalry, etc.—in which the engineer units have come off with considerable credit. Contests, however, have generally been

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The Army Uniform

By

Aymar Embury II

Major, Engineer Reserve Corps

[*Note.* The question of a proper uniform for our Army has been under discussion since the Colonial days, and is apparently still unsettled. To be sure, the uniform appropriate for a particular epoch is not usually suitable for the next. Different uniforms are required for social and instructive purposes and for garrison and field duty, for the arctic and tropical regions, etc. Moreover, comfort and utilitarianism are not the only matters to be considered. The pride of the soldier must be stimulated, even the taste of the ladies has its influence—a very great influence, in fact.

These considerations give room for great differences of opinion, as is evident from the discussion on Major Embury's "ideal" costume for the soldier. His views, however, appear to meet the approval of the majority of the commentators.—ED.]

THE question of uniform is usually considered, especially by the civilian, as being of such minor importance that contemplated changes in uniform are regarded with the same sort of tolerant humor with which one regards the changing styles in women's hats. Unfortunately in the past the Army authorities have afforded a certain justification for this criticism, since changes in uniform have been usually proposed with a view to appearance rather than as questions of efficiency, the sole noteworthy change being that which put our Army in olive drab instead of blue. That the efficiency of an army in the field is dependent upon uniform to a considerable extent is evident when one realizes that the men usually sleep in their clothes and are frequently compelled to make long marches carrying heavy burdens. If their clothes are so uncomfortable that sleep is broken and disturbed, and if the clothes increase the difficulty of marching, reserve energy is very rapidly consumed. The extreme of comfort is therefore of the highest value in field uniform.

The original reason for putting soldiers into uniform was that they might be recognized by their comrades and their officers under all circumstances, and since the first uniformed troops were the so-called "Household Troops" attached to courts, the uniforms were designed with a view to their ceremonial use to suitably display the power and magnificence of royalty. These original uniforms were therefore made without regard to the comfort or convenience of the men inside them, and were of gaudy colors and striking design. The point of view from which a uniform to-day is regarded is considerably changed. We now regard the uniform as a suitable set of working clothes for a soldier. Unfortunately, however, the present uniform, except in color, does not fulfill the requirements of this new standard. Our campaign uniform to-day is essentially a simplified dress uniform in olive drab.

In talking over the question of uniform with older officers, suggested changes have invariably been met with the objection that they would detract from the military appearance of the men, as if to be military were to be uncomfortable, and while unquestionably it is desirable that soldiers should feel that their costumes are becoming, since the effect of clothing upon morale in either the civilian or the soldier is a definite and recognizable asset or the reverse, the very general dissatisfaction felt by the enlisted men of our Army with their uniforms from the point of view of appearance as well as of comfort, indicates that the uniform as at present designed has not fulfilled even the least of its purposes.

The defects in the present uniform are threefold: it is not easy to identify the unit to which a man belongs; the uniform is uncomfortable to a point where it is fatiguing; and it lacks the smartness necessary to good soldierly appearance.

Considering first the question of recognition, especially in the A. E. F., it will be remembered that at first the uniform was exactly alike for all branches of the service except for the small metal collar ornaments bearing the insignia of the arm and the regimental and company numbers. Since these can be read only at a distance of three or four feet it was impossible to tell at a glance to what unit any enlisted man belonged. Further, since these metal buttons were not as a rule carried in stock by the organization supply officer and as elaborate machinery is necessary for their manufacture, replacement troops ordinarily were without insignia or with incorrect insignia. A number of men in my own regiment never had correct collar ornaments during the entire time of their service, nor was it possible for me to obtain them. Further, these metal ornaments were often caught upon the shoulder straps of the packs and were detached and lost. The metal ornaments on officers' uniforms were so impractical that many officers purchased embroidered cloth badges. Some system of cloth ornaments of distinctive colors for indicating the branches of the service should be devised, just as in the A. E. F. the various divisions finally adopted shoulder badges and in some cases, as for example the 89th, the colors of these badges indicated the various branches of the service. Similarly in the First Army the capital "A" usually was combined with the badge of a branch of the service, as for example the Engineer castle or the crossed cannon of the Heavy Artillery.

In the Civil War under similar circumstances, the various army corps (which were much smaller than our divisions) adopted devices colored differently to distinguish the brigades. The men in the French and Italian Armies wore a colored badge on the collar to distinguish the branch of the service, with regimental numbers embroidered on it. The German Army used shoulder straps similarly embroidered. The English used colored divisional marks on the point of the shoulder or on the center of the back; the various units being distinguished by their metal cap badges and buttons. Our Army was the only one in which it was almost impossible to tell to what unit a man belonged, which resulted in very great confusion when troops went into action with a large number of replacements.

From head to foot there was not a feature of our uniform which was not severely and justly criticised as being uncomfortable or unsuited for field service, except the shoes. The campaign hat was withdrawn and the so-called "overseas" cap substituted for it. This cap had the sole

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merit of fitting comfortably into our infinitesimal pockets. Most of them were so manufactured that the flaps would not turn down to protect the ears against cold or rain, but the crease between the flaps and the center of the cap held water like a roof gutter. The cap was not the slightest protection against either sun or rain and could not comfortably be worn under a trench helmet.

The coat which approximated an army fit, bound the shoulders so tightly that it was very difficult to hold a rifle in its proper position and grenade throwing or bayonet work without taking off the coat was like running in hobbles. The close standing collar was pulled back so tightly against the neck by the shoulder straps of the packs that if it were not unfastened it would entirely cut off the supply of air from the lungs. The pockets were too small to be useful and as ornaments were a complete failure.

The breeches were so tight at the knees that they impeded marching and the time required to put them on and take them off was far too great. Further, as it was necessary to put on the breeches before the shoes, when the men slept on the ground they generally got their feet wet before they were dressed, which caused sore feet.

The issue puttees were not spiral and in order to make them stay up they had to be pulled so tight as to impede circulation. Also when it rained they kept slipping down, causing delays in the march.

The field shoes were splendidly constructed, extremely comfortable, very durable, impervious to water, and after one became accustomed to their weight, not especially heavy in marching.

The regulation overcoat was too long and had to be reduced and as the rain coats were not big enough to go over the overcoat, a man had the choice in wet weather of wearing his raincoat, keeping his body dry and letting his overcoat get wet, adding eight or ten pounds to the weight he was carrying, or of wearing his overcoat and throwing his raincoat away. As the raincoats leaked, neither way was satisfactory, and as the overcoats were not really warm, especially in the wind, they were perhaps the least useful article of the equipment as well as the most difficult to carry.

Now if the result of all this uncomfortable equipment had been to make the men look like magnificent soldiers and give them pride in their equipment, they might perhaps have been willing to endure the discomfort without grumbling, but as a matter of fact our Army was more slovenly in appearance than most of the others. It is true that certain military policemen or orderlies of the headquarters companies, who bought their own puttees, had their uniforms fitted by the company tailors and did not have to sleep in their clothes, presented a very smart and soldierly appearance. These cases, however, were the rare exception; the average soldier was equipped with clothing which fitted him only approximately and which he had no opportunity to have recut. In the effort which has been made by the Army to provide clothing to fit every shape and size of soldier, the table of sizes shows some forty numbers of coats and more than thirty of breeches, but as the supply officers were not permitted to carry in stock more than five per cent. in excess of the number of garments required for their units, the chances were twenty to one even under favorable circumstances that a soldier would not find the sizes he needed, and in the wholesale distribution that was attempted after each action, few men managed to procure all the different items of uniform in the correct sizes. Therefore from a point of appearance alone our uniform in field service was a complete failure, and our men were constantly seen with puttees that hung around their legs like a diagonal fringe, with coat collars so big that their heads would slip through them when they were fastened and with breeches which looked like those of the New Amsterdam Light Infantry of 1650. There is no question that our men felt ashamed of the appearance which they were compelled to present (no matter how hard they tried to look well) whenever they were on pass or on duty which presupposed a smart appearance.

The remedy for these difficulties is, I think, reasonably simple. The American soldier never looks so well as when he wears a loose flannel shirt without a coat. His excellent physique and easy, careless grace in loose comfortable garments are far more soldierly than his wooden motions in the regulation tight-fitting uniform. Further, loose garments can be carried in very few sizes and are smart when properly worn, as for example the blouse worn by the United States Navy, which is, I believe, manufactured in only five sizes, but in which our sailors are the smartest uniformed men in the United States. The Russians alone among the foreign troops appeared to appreciate this fact, possibly because their military uniform was the typical peasant garment of uniform color and cut. A loose blouse, either buttoned like a coat or similar to the Russian blouse with a V-shaped neck, held in at the waist with a belt and with loose sleeves with buttoned cuffs to keep them from falling down over the hands, would be extremely comfortable. The collar should be so arranged that it could be turned up and buttoned or strapped close around the throat in cold or wet weather, to keep out the rain or to protect the throat. Ample pockets should of course be provided.

Trousers should be substituted for breeches and should be made sufficiently wide so that they could be put on after the shoes. If puttees are entirely discarded and loose half-boots used instead of shoes, the bottom of the trousers could be worn either inside or outside the upper part of the boot, according to the weather. Boots extending to the calf would be sufficient protection from the mud under all normal conditions; in the trenches or swamps nothing is satisfactory. This way of wearing trousers and half-boots has been found the most comfortable sort of foot wear by construction engineers, lumbermen and others, who are confronted with the same problems as soldiers.

Instead of the overcoat and raincoat the so-called "trench coat" authorized for overseas use by all officers should be issued. The coat and lining can be worn in combination in cold weather and since the coat is wind-proof as well as waterproof it is an extremely warm garment. Further, the lining could be issued only when required, would be much less expensive than the overcoat, and when not worn could be packed in a small space. This combination has one additional advantage in that the lining can be used as an extra blanket and with the coat itself will completely cover a man; no overcoat will do this. A better and more practical garment it would seem impossible to devise.

Like the trench coat there is a hat in common use which is perfectly adapted for military purposes. Our campaign hat is in many respects the best military headgear which has yet been discovered but it cannot be worn under a helmet nor conveniently carried except on the head, and the hard, straight brim makes it impossible to conform the hat to the variety of heads which soldiers (in common with other human beings) seem to have. Our campaign hat was apparently made for a race of bullet-headed men and when anybody with an oval head wears it, it hurts his head

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until the brim turns up or down in a way which spoils the looks of the hat and the looks of a line of men wearing them. The common light felt fedora, so popular during the last few years in this country, is almost perfectly adapted to military use. The roll rim takes up any irregularity in the shape of the hat and when turned down is a perfect protection against the rain. A hat of good material can be folded up and put in the pocket if required, or the hat can be worn underneath the trench helmet more easily than the overseas cap..

It will be objected that a uniform of this kind is not sufficiently "military," but what is or is not military is largely a matter of custom. I cannot believe that the red-coated British soldier of the Revolutionary period would have thought that the British campaign uniform of 1918 had any military quality. Nor can I imagine any American soldier dressed up in a short skirt, bare knees and rolled-down stockings (like a Coney Island bathing suit) feeling as if he were in a proper uniform; yet that is exactly the uniform that the Highland troops wore, and no one thought of them as either looking or being unmilitary.

For dress occasions there seems to be no legitimate objection to a uniform of the traditional close-fitting type. The English Army has already returned to the scarlet tunic of pre-war days, believing that the men (not to mention their feminine admirers) like clothes in which they can dress up, and that this improves the discipline and the morale of the service. It seems to me that this point of view is perfectly logical. No human being likes to wear exactly the same garments on all occasions, including bed (if that is an occasion), and the old blue dress uniform of the United States Army, preferably varied to indicate the branch of the service and the organization, would unquestionably stimuate pride in its wearer. The Marine dress uniform is an excellent example of what a dress uniform will do for an organization, and the way the Engineer officer clings to his distinctive buttons is another indication of the same effect. It should not be forgotten that the purposes of dress and field uniforms are entirely different.

Discussion

George O. Squier
Major General, Chief Signal Officer

Just as one returns in an idle moment to the study of a problem that tradition implies was once solved, the solution lost, and which now apparently is unsolvable, so one takes up and reads this article on our military uniform. It is to be hoped that some one sometime will arrive at an approved solution. Until they do, the problem will remain with us.

I personally favor a smarter uniform for wear during hours off duty than our working clothes, and I would also like to see the open roll collar adopted for the field blouse.

The adoption of a blouse with a yoke, and with pockets which will hold bulky articles would, I believe, be open to criticism. A box pleat in the seams at the back of the coat just under the shoulders, and a reasonable fullness in the breast would give ample room to move the arms. Pockets similar to those generally used in civilian clothing should give room for the carrying of all articles needed when men are not equipped with the haversack or officers with the field carrying case. In other details I approve adoption of the field uniform as described in this article and illustration.

Wm. Mitchell
Brigadier General, Air Service

This article on the proper uniform for the Army has



Major Embury's Field Service Uniform

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been read with great interest. I believe that the suggested changes, as shown in the illustration, would greatly conduce to the usefulness and comfort of the men. The long trousers capable of being put on after the shoes, are a distinct advantage. The looseness of the coat over the shoulders and chest would also add to the comfort of those wearing this uniform.

It is suggested that the collar letter be placed also on the reverse of the collar. This would enable men to be identified when their collars are turned up in cold weather, yet not cold enough to require overcoats. There should be some means of fastening the collar in the turned-up position.

George D. Snyder

Formerly Major, Engineers, U. S. A.;
Late Colonel 22d Engineers, N. Y. National Guard

The Army is to be congratulated on receiving such practical suggestions from one whose profession is to combine utility with appearance, for we have given little effort to the harmonizing of these elements in the past.

Formerly we blindly followed the military fashions of the dominant nations in Europe, without regard to their suitability to our climate or the physical characteristics of the men inflicted with them. The Civil War was fought with French models. After the Franco-Prussian War these were abandoned and Prussian uniforms, including a spiked helmet, were substituted. The Spanish-American War found us without clothing or equipment suitable to a tropical climate; these had to be hastily improvised and were generally not received until the war was over.

At the beginning of the World War we gave up some of the most comfortable portions of our uniform to conform to the practice of our allies. Our campaign hat for instance; although the Australians and New Zealanders did very good work in theirs.

It is believed that we should have a uniform and equipment suited to the climate in which our troops are trained and ordinarily used, making such modifications as may be necessary should they be called to any unusual climate.

The following comments are confined to engineer troops not mounted, as the suggestions of Major Embury would have to be modified materially for mounted troops.

The increasing use of motor transport is reducing the number of mounted men with an engineer regiment, but some mounted engineers, not only with cavalry divisions but with infantry divisions as well, will always be required.

The engineer is a "hog for work" and needs clothing that will give him the necessary freedom of body and limb without making him look like one. It is believed that this will be accomplished by Major Embury's suggestions providing the blouse is not ordinarily taken in the field but is left in barracks, substituting a sweater for use in the field.

The half-length laced boots are an improvement on the present shoe and wrapped puttees, which impede the circulation and freedom of movement. An ankle height shoe may be found advisable for use in barracks, office duty or on furlough when the trousers are worn over the shoe.

It will be found that the trousers will not look well over shoes after being worn inside boots, without being pressed. In garrison the soldier will probably have two pairs; old ones to tuck in the boots and a newer pair for dress and for wear outside the shoe. Officers will find these trousers a great comfort for wear outside the shoe, when on desk duty, when in quarters, at social functions and the like.

The blouse will be found to be a great comfort for men on office duty and on pass. With the rolling V-collar a white shirt and prescribed linen collar and tie should be permitted when on pass, or at social and dress occasions. Give the soldier the same comfort in dress and the same ability to vary it to meet social conditions that prevail in civil life. The officers also would appreciate the right to wear similar garments now enjoyed by their brothers in the Navy.

It is believed that the chevron should continue to point upward as at present in accordance with heraldry.

Charles E. Stodter

Colonel, Cavalry

I have read this article with a great deal of interest and I thoroughly agree with the views expressed therein. There is no question that our so-called "service uniform" is not suitable for service. The attempt to combine a dress uniform and a service uniform has resulted in failure, as the purposes of the two uniforms are so radically different that a combination cannot answer for either purpose.

The *service uniform* should fulfill the following requirements:

(a) It should be comfortable.
(b) It should be suitable for all conditions of service.
(c) It should not be injurious to health.
(d) It should be as neat and pleasing in appearance as consistent with the above requirements.

Our present service uniform does not fulfill these conditions. In the first place, it is not comfortable. Comfort has been sacrificed because those responsible for its design have been handicapped by the idea that the uniform must be "military." This word seems to convey the view to a great many officers that in order to be military the uniform must be tight and uncomfortable. This misconception of the word "military" has handicapped progress in the Army more than any other word in our language.

The unsuitability of the service uniform has been recognized by many officers, and we have gone so far at times as to practically abandon the coat and to wear the flannel shirt or a sweater as an outer garment. There can be no question as to the need of a coat. We must have it for comfort, for the carrying capacity of its pockets, and for the sake of appearance.

The service uniform described in this article fulfills all the requirements of a real service uniform. A soldier can march, dig trenches, throw grenades, or sleep in this uniform with comfort. He can not do any of these with comfort in the present service uniform.

In regard to the details of the uniform depicted in the sketch, the hat is very similar to the old campaign hat which we had in the service twenty years ago. The brim is a little narrower, perhaps, and the crown a little higher, but it is not essentially different. That old hat was the best headgear we have ever had. It was abandoned in favor of the stiff-brimmed hat because somebody thought the old hat was not "military."

In regard to the coat, I have been advocating this type of coat with open V-shaped collar for more than ten years. The pockets as shown in the illustration are rather too small. I would make them considerably larger. A noncommissioned officer should wear his chevrons on both arms. We did this before the war and until someone figured that a few cents could be saved by omitting one chevron. The company letter and regimental number should be placed on a piece of cloth of the color of the arm of the service, that is yellow for cavalry, red for artillery,

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and so on. This shows at a glance the arm to which the man belongs, his company, his regiment, and with the division or corps devices absolutely identifies the soldier.

The tight cuff on the sleeve has some advantages, but it also has the disadvantage that when the soldier wears gloves, which he must do in winter, it is difficult for the glove to be tucked under the tight cuff and I believe that it is preferable for the glove to be worn under the sleeve rather than outside.

I am rather inclined to favor placing the lower pockets on the inside of the coat with only a buttoned flap showing on the outside. This presents a neater appearance and I believe is equally as useful and comfortable. The bellows can be made on the inside and the pocket can be so hung that when articles are carried in it they will not unduly bulge out the skirts of the coat. As shown in the illustration, the coat should be loose about the chest and arms, and the skirts should be rather full, and I would prefer to have them a little longer than shown in the illustration. A good tailor can make a loose garment so that it fits properly and hangs well from the shoulders. A poor tailor tries to fit a coat by drawing it tightly around the body of the wearer. The best fitting uniform I every had was one in which I could gather up at least six inches of surplus material in the chest and yet it hung properly and did not give any appearance of being too loose.

The long trousers and the high-topped shoes are excellent. They are practical. They have stood the test of years by men who spend their lives in the open. For cavalry, it might be desirable to provide breeches and the shoes should be several inches higher. For many years we wore long trousers in the cavalry service, both with boots and with leggings.

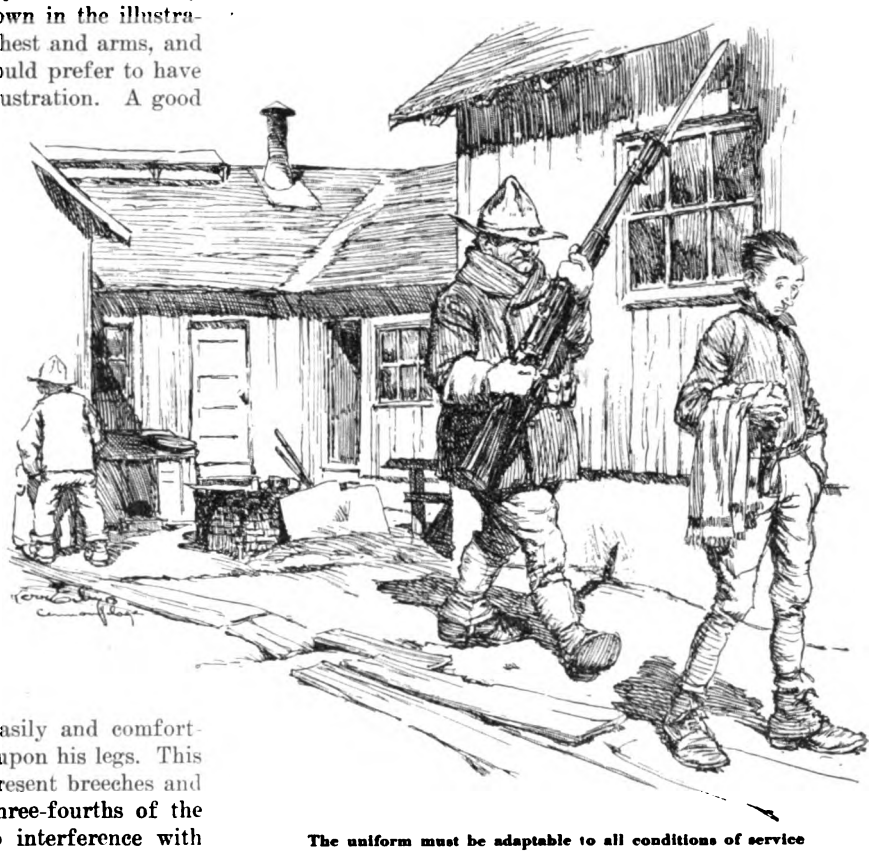
In order that a soldier may march easily and comfortably, there should be no undue pressure upon his legs. This condition cannot be obtained with our present breeches and spiral puttees. I have no doubt that three-fourths of the foot trouble among our men is due to interference with the circulation of the blood in the lower leg.

We need a dress uniform quite as much as a service uniform. The service uniform constitutes our working clothes, and no man likes to appear at social functions or on occasions of ceremony dressed in his working clothes. It would be just as appropriate for the farmer to go to church in his overalls or the business man to attend a formal social affair in his office clothes as it is for a soldier to appear on social or ceremonial occasions dressed in his service uniform. Every man likes to feel that he is properly dressed for the occasion, and the soldier cannot feel that he is properly dressed when he appears in society in his service uniform.

It has been recognized that morale is a very important factor in building up an organization and in obtaining success in war. A neat, attractive dress uniform adds greatly to the morale of our troops, and I am convinced that we would get twenty-five per cent more enlistments if our Army recruiting parties would appear as neatly and well-dressed as our Marine recruiting parties do.

I am thoroughly in favor of the trench coat as a substitute for the present overcoat and raincoat. The outer material should be of a strong, light-weight, wool material, like gabardine, and the inner lining of sufficient weight to give the necessary warmth. The coat should cost no more than the present raincoat and overcoat, would be much more convenient to carry, and, if well made, should certainly look neater than our present raincoat, and as neat as our present overcoat.

There are a considerable number of officers in the service who believe in the views expressed in this article. On the other hand, many officers have given the subject no especial thought or have been content to accept what we were given and to make the best of it. Many have the idea that we must be "military" at all costs, even to the extent of making ourselves uncomfortable. It is only by constant agitation and by keeping this matter before the Army that we can accomplish the desired changes.



The uniform must be adaptable to all conditions of service

Chas. D. Roberts
Colonel, Infantry

This article indicates a considerable grasp of the subject in general; and as a whole the suggestions for changes are well thought out, pertinent and practical.

The question of uniform is more important than it is usually thought to be. In time of war, serviceability necessarily becomes a paramount consideration. The stimulus of war is sufficient to make the service attractive, and "working clothes" only are required. The large number of men called to the colors "for the period of the emergency only," renders it highly desirable to make the uniform as simple as possible. The theatre of war is usually pretty well fixed and it is possible to adopt one kind of uniform as the standard that seems likely to be used throughout the war. Changes in the uniform during a war are not simple matters and mistakes once made can be

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corrected only at great expense and after much loss of time. Similarly, when the war ends, vast stocks of uniforms are on hand which must, as a matter of economy, be used by the peace-time army as long as the articles are reasonably suitable and available.

In our army the uniform is very complicated. Our troops serve in every kind of climate and must be prepared to take the field under every conceivable condition as to terrain and weather. It is impossible to so standardize the uniform as to make one kind fit service in Alaska, in Arizona, and in Panama. After much experience we have virtually come to two kinds of uniforms, one of cotton for warm weather and the other of wool for cold, with various additional or substitutional articles added for service under certain special conditions, as in Alaska.

In peace time the war stimulus is absent and various means are sought to attract men to the service and make it possible to carry on military training and to keep alive the military spirit until the next period of mobilization. One of the chief means now being employed is that of offering to recruits the opportunity of learning trades. But we should not neglect the attractive effect of a smart uniform for dress occasions. Most soldiers are young men who have an instinctive and natural desire to appear to advantage among their fellows (male and *female*). The army can not offer pay to compete with civilian occupations, and we must take advantage of every other opportunity to make the service attractive.

In my opinion the basic mistake in our present uniform is that it attempts to combine *smartness* with working efficiency and comfort. The result is unsatisfactory from either point of view. The present drab uniform is ugly, as well as uncomfortable and unsuited to field service anywhere.

In making changes we must not be influenced too much by our experiences in France. That was abnormal service for American troops and, perhaps, may never be repeated. Our long experience in service everywhere must be given full weight. We must remember that in tropical and subtropical regions the sun replaces the rain as the chief enemy to the soldier's comfort. Imagine a man in an overseas cap or a trench helmet marching under a tropical sun.

Taking up the proposals in the article more in detail:

Ornaments and insignia on woolen coats should be of cloth or embroidery sewed on. On cotton uniform they must be detachable for washing unless made of wash material, which is almost impossible. The divisional shoulder patches have been retained, and if made in various colors, as was done in the 81st Division—the first of all American divisions to use shoulder insignia—provide sufficient means for indentification. The hat cord could be replaced by a narrow hat band of appropriate color, which would probably be more satisfactory.

It is hoped that the overseas cap is a thing of the past. The campaign hat is the best headgear we have ever had for all purposes, and should be retained as part of the field uniform.

Almost everybody in the army wants a service coat with turndown collar and bellows pockets, loose enough for comfort. The tight cuff would be good for cold weather, but entirely unsuited to warm weather when a circulation of air around the wrist is essential to comfort. A buttoned cuff should be provided in the woolen coat.

I agree emphatically with the writer that breeches are entirely unsuited for foot troops. Loose trousers should be provided. However, the high shoes are not practicable for a large army, due to expense, and especially to the amount of leather needed. The present shoes, with a low, canvas legging of gaiter style, should be worn in the field. The type of legging used by our troops during the Spanish-American War was the best ever provided and, with an improvement of the strap passing under the instep, would be suitable. On no account should the legging fit closely around the ankle or calf, since the ankle must be flexed at each step, and the calf muscles must move freely.

The trench coat could well replace the overcoat and raincoat; but a lighter grade, well ventilated and without lining, should be provided for hot climates.

To sum up: (1) Give us a really serviceable, comfortable field uniform, "working clothes" made for utility, and of woolen or cotton to suit the climate. This would be the only uniform worn in war and the only one of which large stocks should be kept on hand.

(2) Give us back our plain, but smart, blue dress uniform. Allow organizations to adopt distinctive insignia, etc., for wear with this uniform.

Let this dress uniform be replaced in the tropics, both for officers and men, by a white uniform similar to that now worn.

C. W. Exton

Colonel, Chemical Warfare Service

General Fries has requested me to answer this letter for him. We have discussed the matter together, however, and I am really expressing his views as well as my own.

So long as we have but one uniform of olive drab for both field and dress occasions, we must approach this subject with that fact in mind.

It is admitted, I think by everyone, that the two essential qualities of a uniform are smartness and serviceability. As to smartness, it is believed that our uniform, with the skirt of the coat a bit longer and with the addition of the Sam Brown belt, is the smartest field uniform worn by any army to-day. As to serviceability, in cold weather the high collar of our uniform makes it much warmer and more comfortable than an open collar, which, as worn by the British, always requires some sort of neck scarf. In warm weather, the open collar would require a clean, well-laundered shirt. This might be obtained by the officers, but for enlisted men it seems questionable.

We seem to be committed to the olive-drab shirt for field service in the tropics and during warm weather in the United States. I doubt if this can be improved upon. For garrison wear, the khaki coat with the high collar is very smart looking and reasonably comfortable, and does not require a well-laundered shirt. There are some advantages in this. As to the long trousers, they would be quite impracticable for the mounted services, and I doubt very much if they would be found more advantageous for the infantry, especially as they would require a heavy, high-topped shoe at all times. The hat, while it might be extremely comfortable, would soon assume the characteristics of the wearer, the result being little uniformity.

I believe that our present uniform if properly fitted, not tightly, as generally worn, but easy and comfortable as it should be worn, will be found to be the most satisfactory uniform yet devised.

R. H. C. Kelton

Colonel, Coast Artillery Corps

Major Embury's views on the subject of army uniform are not only well written, but the arguments as set forth are quite correct and well presented. The logical reasons for

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putting soldiers into uniform are the same to-day as when this scheme was first adopted many hundreds of years ago.

The author makes as his primary point that in any uniform for campaign purposes, "The extreme of comfort is of the highest value," but, following this statement, remarks that in the history of this Government, and probably in that of all other governments (in reference to this same feature), all types of uniforms have been governed by desire for appearance rather than utility and efficiency, and that the only recent noteworthy exception to this policy as far as the United States is concerned, has been the change of color from blue to olive drab.

The author shows that the original conception of uniforms had no regard whatever for the comfort or convenience of the men inside of them, and involved only the ideas of gaudy color and striking design. At the present time, we are prone to regard the campaign uniform as "a suitable set of *working clothes* for a soldier," but, unfortunately, except in the matter of color (referred to above), the uniform does not fulfill the requirements of this standard. While we have adopted a neutral color, we have retained the constricting feature of tight-fitting clothes, and thus have produced only a simplified dress uniform in olive drab. We have sacrificed most of the characteristics which might be said to produce a soldierly or striking appearance in the public eye, but have adopted very little to add to the soldier's comfort in campaign.

In other words, we have tried to produce in a single outfit a compromise which does not accomplish either one of these two essential ideas: *First*, a good-looking, peace-time uniform, which adds to the prestige of the military man in the public mind, and to the self-esteem of the individual soldier. *Second*, a comfortable, satisfactory set of working clothes for a soldier in campaign.

If, in this effort to effect a compromise, we fail signally to achieve either of these *desired results*, it seems only logical that we should abandon the compromise and adopt a dual system of uniform which will produce the *proper effect* in time of peace and provide the necessary equipment and desired efficiency in time of war.

Personally, I am in favor of returning to the blue dress uniform for peace-time purposes, discarding, however, the military full dress and making any social or evening uniforms, authorized for the commissioned personnel, entirely optional. For purposes of campaign, the uniform shown in the author's illustration is of simple design, and evidently produces what the author of the articles calls a "comfortable set of working clothes."

If a campaign uniform is designed as such, and not diverted by any efforts to make its appearance dressy, and then a garrison uniform is designed for good appearance, we may succeed in producing something satisfactory under the head of military uniform.

The author's criticism on the various articles of the present olive-drab uniform are sound and well expressed, and his scheme for simplifying the question of sizes and fit is unquestionably a practical solution of the troublesome problem of manifold sizes.

The scheme of having one set of clothes in which to work and a wholly different set of clothes in which to take recreation or amusement, is almost universal among civilized peoples. All classes of tradesmen, artisans, skilled labor, and even a very large proportion of the unskilled labor in this country, to-day provide themselves with characteristic clothing in which they do their manual work, and yet possess some outfit of better-conditioned clothing, of distinctly different quality and design, which they put on in the evening and on Sundays and holidays.

A set of "working clothes" for the military man is recognized in the Coast Artillery, by the issue of the blue denim for general fatigue and for work around the guns; the same idea has long been recognized in the United States naval service, and there seems no reason why this idea should not be extended to include the soldier in campaign. A uniform designed to meet these three cardinal principles—(a) the maximum comfort of the soldier from a standpoint of muscular activity and protection from climatic conditions, (b) identification as to his own troop units, (c) concealment from the enemy—should solve the problem for campaign,



Field service in the winter time cannot be performed to good advantage in a social evening costume

leaving to the garrison or peace-time uniform the characteristics of color and dressy fit.

J. R. R. Hannay

Colonel, Quartermaster Corps

The question of the adoption of a uniform is necessarily influenced by three major factors, viz:

(a) Utility,
(b) Cost,
(c) Psychology.

It is believed that these are given in their order of relative importance. Unfortunately, in the adoption of a uniform for the United States Army, a futile effort has been made, by compromise, to include in a single costume these three dominating factors.

Prior to the World War, when our army had not reached its present proportions, and the total necessary outlay was comparatively small, it was deemed advisable, in an attempt to cover the requisites of utility and psychology, to provide a service uniform of olive drab for field work and a dress uniform of blue, designed to inculcate neatness and soldierly appearance by engendering pride therein. The uniforms were not entirely satisfactory, however, in obtaining the desires upon which they were predicated, inasmuch as the dress uniform was not sufficiently smart and the field

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uniform not sufficiently utilitarian. Mere man is prone to point the finger of scorn at the furbelows of women's dress, but if we study human nature we find that not only in the lower animal kingdom, but throughout the evolution of man the male is still, by instinct, really the "cock of the walk." and although there is no gainsaying that "fine feathers do not make fine birds," a well-dressed, neat-appearing man does, naturally, take more pride in his demeanor than one who is carelessly or slovenly groomed. This is so particularly evidenced in the case of the soldier that it has become a truism that "A neat and orderly soldier is also the best soldier."

The need for an army of adequate size in the United States to protect our huge and growing interests has necessitated the increased army created by the Act of June 4, 1920. To properly uniform the army so created without exorbitant cost, it is necessary to limit the soldier to one uniform, and in order that the one uniform prescribed shall fulfill the two other requisites of utility and psychology insofar as possible, in view of the fact that the psychological part can not be eliminated without detriment to the efficiency of the army, a compromise is still necessary.

A decision must, therefore, be reached as to how the maximum neatness and soldierly appearance can be obtained without any grave loss to comfort and usefulness.

It is believed that the uniform as suggested by Major Embury does, in general, fulfill these principles, such a uniform to comprise a loosely fitting sack coat with large bellows pockets, open at the neck, and worn with a flannel shirt and black tie, the sleeves of the coat capable of being buttoned close to the wrist; long trousers sufficiently large to be drawn on over the shoes, worn with lace half-boots, high enough to hold the bottom of the trousers firmly within the tops thereof. It is believed that the tight-fitting breeches now prescribed for the army are, from an anatomical standpoint, a grave mistake, and do materially restrict the marching ability of foot-troops as well as produce discomfort to the wearer and require an undesirable length of time for dressing. The expense and difficulty entailed in providing a sufficient number of sizes to properly fit all men in breeches should be given the weight of consideration it deserves.

Too much attention has been given to the detail of securing low visibility and the use of the single color, olive drab, as it is believed that the evolution of camouflage has thoroughly demonstrated that through the breaking of solid colors low visibility is best secured. If this hypothesis be correct, it is not understood why it should be thought necessary to have such minor details of the uniform as buttons and ornaments of self tone. Buttons of the uniform should be of brass, and the soldier induced to emulate our army of twenty or thirty years ago in the constant use of the button stick and buffer. Shoulder straps in the distinctive colors of the various arms would add materially to the appearance of the uniform, and it is believed that the lapels could be likewise faced in color, showing on one side the division number and on the other the regiment number and company letter. The bronze ornaments at present worn are a nuisance to the wearer, too small to be read except at arms length and impossible of extemporization, such as is often necessary in the quick creation of a large army. It is therefore distinctly advisable from every standpoint that these insignia should be of colored cloth, and not less than three-quarters of an inch in height. That the principle of self tone in chevrons and insignia has been abandoned is apparent from the recent adoption of a blue back to the chevron, which is now worn only on the left arm. If coloring is added to the uniform, it should not serve, however, to plainly mark the individual for the benefit of an enemy sharpshooter. When the individual gets within such close range, visibility of the individual can not be prevented, but his rank should not be glaringly portrayed or so placed that with his rifle in the aiming position his insignia is a bull's eye covering his heart.

Major Embury's remarks relative to the overcoat are pertinent and well taken, and it is believed that the adoption of the trench coat, with waterproof shell and detachable lining, is the most serviceable garment which can be provided for the soldier, serving the dual needs for protection from rain and cold.

The soldier's headgear, however, is difficult of solution, inasmuch as it is now palpable that he must be equipped with a metal helmet. In view of the fact that it is not believed that a helmet can be devised which will be both sufficiently strong to afford casualty protection as well as that from sun, rain, and cold, and of sufficient lightness to the wearer when worn continuously, it is apparent that he must be provided with two kinds of headgear, both of which must be carried on the person. It is believed that the fedora recommended by Major Embury is too susceptible of conversion into multitudinous shapes suiting the varying idiosyncrasies of the wearers. It was because of this habit of enlisted men that the brim of the campaign hat was stiffened. Furthermore, the fedora has no material advantages over the campaign hat for use in cold weather or for stowing away while the helmet is in use, inasmuch as only the most expensive felt hats can be so folded and still retain any vestige of shape. The cost thus becomes excessive without material gain. The campaign hat as now worn is a more soldierly headgear than the fedora, but it is not a practicable war-service hat, in view of the fact that it can not be conveniently carried when the helmet is worn and does not provide winter protection. It would appear, therefore, that to provide the requisites for war service there must be prescribed a small cap which can be carried in the pocket, similar in general character to the overseas cap, but modified so that it can be pulled down over the ears and so that it will have some form of visor for sun protection. The necessity will still exist, however, for some form of smart, soldierly headgear for garrison use, and this should be either the garrison cap or the campaign hat, preferably the latter, but not both.

Admitting, in a measure, the correctness of his statements, it is believed that the writer's criticism anent the slovenly appearance of the American Army in the A. E. F. is not wholly justified. The problem involved in the supply of an army so enormously expanded, as well as the discipline and instruction so necessary thereto, did not permit securing the maximum neatness and soldierly appearance amongst the American forces in France. However, it is believed that, in general, the United States Army compared more than favorably with the troops of other nations in regard to looks, if not comfort. It is believed that the American Marine, not the "blue-jacket," is the best dressed and neatest soldier in the world, and this despite the fact that his uniform is practically identical with that of the army. The more favorable results obtained by the Marines are obtained by greater administrative attention being paid to the uniform, although it must be said in all fairness that this result is naturally more easily attained in a force so much smaller than the Army, which is, furthermore, imbued with a pride in the uniform resulting from constant affiliation with the troops of foreign power, and the very careful inspection made in regard to the appearance of men being

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granted shore leave from ships when visiting foreign ports.

That our army is sorely in need of a more comfortable and suitable uniform can not be gainsaid. It is hoped that more advocates of sensible attire for the soldier will come forward to urge upon the War Department the advisability of what are believed to be essential and necessary changes, despite the well-founded argument of those individuals who oppose all change as precluding the possibility of uniformity in the soldier's attire.

Evarts Tracy

Lt. Col., Engineer Reserve Corps

Major Embury's suggestions for the uniform are extremely well studied, and, from my point of view, the illustration shows a uniform which would be military in appearance, comfortable and, with some modification for the tropics, well suited for all climates.

I have always thought that the British field uniform as worn in the tropics, consisting of light wool shirt, khaki blouse, khaki shorts, similar to our so-called athletic drawers, bare knees, spirals wound directly on the leg, and brown straw helmet, is most comfortable and suitable for such climates, and would be a Godsend to our troops who swelter in their tight breeches and heavy campaign hats.

I have spent considerable time for the past thirty years in the open country in different climates, varying from the tropics to the Arctic Circle, and have experimented to quite an extent with outdoor clothing.

I think everyone knows from personal experience the so-called fedora hat is all Major Embury claims for it, and I have never heard any officer or enlisted man who was not in favor of the open-neck and turn-down collar of the blouse.

Pockets that will hold something without tightening and spoiling the set of the blouse are absolutely essential, and the bellows pocket is the only solution. I should recommend them even larger than indicated in the illustration.

When the staff at G. H. Q. in France studied a new field uniform, they proposed, according to my recollection, larger pockets, but inside the coat, only the slit and flap appearing outside. It is obvious that the contents of such a pocket will bulge the blouse, destroy its hang, and make it tight and uncomfortable, whereas the bellows pocket simply expands on the outside and has no effect on fit or comfort.

The trousers and shoes are excellent, for the reasons Major Embury states. For the shoes, I should have a bellows tongue, and belt-lacing, instead of shoestrings, and the eyelets should be large, one-quarter of an inch at least in diameter, for the sake of quick and easy lacing.

It is very true that the idea of what is military looking or not is a contemporary state of mind, but this uniform is suitable and smart, and it would take no great period of time for either soldier or civilian to realize that it is also distinctly military.

A uniform that the wearer is proud of has a strong bearing on his morale and a distinct psychological influence on the public.

I had this psychological influence brought strongly to my attention last summer.

A powerful roughneck came on board a Yukon River boat, fighting drunk, and started to make trouble. A Royal Northwestern mounted policeman on the boat came up from behind and tapped him on the shoulder. The man, cursing, drew back his fist and turned around, then dropped his hand and went quietly to his bunk.

The next morning he said to the policeman, "By God! I'm glad this isn't Alaska, I get mean when I'm full, and I'd have been in jail with a broken head or worse. I would have licked anybody that touched me, but *I saw your uniform.*"

M. G. Martling

First Lieutenant, Corps of Engineers

The question of changes in the army uniform seems to be constantly arising, and Major Embury's article may be regarded as a more or less typical expression of the viewpoint of those who desire a change. Major Embury states his objections to the present uniform to be as follows:

1. Difficulty of identification of unit,
2. Discomfort,
3. Lack of smartness.

The difficulty of identification is fundamentally a matter of insignia and not of uniform. The difficulty in recognizing the unit to which a man belongs is important if it is proven that such identification is essential at a considerable distance. It would appear to the writer that the definite identification of the organization of an enlisted man, as a general rule, is essential only under conditions where a conversation might be carried on—that is, about the distance mentioned by Major Embury as the limit with the present insignia. The difficulty in obtaining insignia in the A. E. F. is not necessarily inherent in the prescribed insignia, but like many other deficiencies during the war, was due to the total unpreparedness of the United States. An objection to the Springfield rifle on the same basis would be equally valid.

For the identification of the branches of the service, the American forces in Germany are at the present time using small circular discs of cloth of distinctive color slightly greater than, and worn beneath, the button on the enlisted man's collar. They are readily recognized, but are of no particular value, except to add a touch of color to the uniform and are a disadvantage in that they are difficult to keep clean.

Major Embury's comments on the overseas cap would appear to be justified, but it is thought that he errs in being too temperate in his arraignment.

There is no doubt that the uniform furnished the enlisted man during the war was of exceedingly poor quality, both as to fit and material, but this again was due to lack of preparedness and not to the style of uniform in use. Major Embury may feel that "easy, careless gait" is a soldierly qualification. Many prefer that a command display what is commonly termed "military precision," or even what he calls "wooden motions." If freedom of motion is the ultimate ideal of military dress, we should adopt the "sport shirt" and be done with it.

What is or is not "military" in appearance is undoubtedly a matter of custom, but it is a singular fact that of seventy-seven figures in the Encyclopedia Brittanica (Uniforms—P. 556, et seq., Vol. XXVIII), covering army uniforms of the principal nations from 1845 to 1910, but three have low or roll collars. This would seem to indicate that the custom of wearing a high collar is fairly well established at any rate.

Major Embury's suggestion in regard to dress uniforms appears to be sound and worthy of consideration. It is suggested that three uniforms be furnished each enlisted man:

1. A suit of O. D. one or two-piece overalls as at present, for fatigue and drills other than disciplinary.

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2. An O. D. uniform of the present type for disciplinary drills, retreat, etc.

3. A blue dress uniform for ceremonies, leave, etc.

A consideration of Major Embury's suggested uniform as shown by the illustration develops the following objections:

HAT—But little protection from the sun and rain; the horizontal crease collects rain and snow much the same as the overseas cap Major Embury objects to.

BLOUSE—Objections to the present blouse seem to be based chiefly on the following assumptions:

(*a*) That the collar predisposes the wearer to throat trouble.

(*b*) That the collar interferes with breathing when the pack is worn.

(*c*) That the blouse binds across the shoulders when the back and arms are used.

(*d*) That the pockets are too small.

Considering these objections in order:

(*a*) This objection could be definitely sustained or disproven by the Medical Corps. The writer's experience would seem to show that it has no such effect. At the time he was first examined for a commission the surgeon considered his case as somewhat doubtful on account of his throat, but finally passed him. Since then he has worn the uniform every day for nearly four years and has never had any further difficulty with his throat.

(*b*) Elimination of the restriction of the throat by the pack is obtained by the proper adjustment of the pack, and when a man has been taught how to make and adjust the pack properly, further difficulty is minimized.

(*c*) The uniform blouse does bind across the back when it is worn to work in, but up to the present time the writer never saw a coat which would not. Practically all good workmen remove their coats before they attempt to do any work. Contractors of long experience have been known who would not even have a man "on the job" who attempted to work in a coat. It is seriously doubted if it is possible to design a coat which is loose enough to permit free action of the back and shoulders which will not wrinkle, and chafe the back, when the pack is worn. No coat of ordinary material with which the writer is familiar provides room for exertion and is adapted to wear with a pack, and it is seriously doubted if the two features are compatible.

(*d*) Pockets are not an essential part of an enlisted man's blouse, and might well be omitted. He is provided with breeches' pockets for handkerchief, money, tobacco, knife, etc., and his other field equipment can be carried in the pack without disadvantage. Increasing the size of the pocket will not help the appearance of the wearer and will only encourage him to burden himself with additional unnecessaries which may well be thrown away or placed elsewhere. As a matter of fact the pockets in the blouse are practically inaccessible when the pack is worn anyway. The blouse in Major Embury's plate appears to be a hybrid. If pockets are placed on it at all there does not appear to be any good reason why the upper ones should be of the "Stanley" pattern and the lower ones plain patch pockets. The blouse is so loose around the waist that it would "bunch" under the belt, which, aside from its poor appearance, is exceedingly uncomfortable in hot weather. The sleeves are unique, to say the least, for any blouse that makes a pretense of smartness. Just how Major Embury planned to fasten on the buttons at the wrist is unknown but in the place they are, they would be subjected to a great many strains and would be difficult to keep sewed on, as well as extremely uncomfortable in hot weather when they would bind and chafe.

The blouse is apparently patterned after the British officer's tunic, but even its English origin does not appear to warrant copying their chevrons by putting the point down as shown.

The trousers are not as practical as breeches. The loose folds at the bottom have a bad habit of catching in every shrub or briar, and accumulate mud and moisture in large amounts with the slightest provocation. A pair of soaking-wet trousers flapping about the legs are far from comfortable. It is true that trousers have been so worn by men in civil life for years, but it is believed that this was due to the fact that it has been difficult for a civilian to procure breeches at all outside of the larger cities, and then only at a considerable cost. At the present time the tendency seems to be for men on construction work to wear breeches similar to the Army pattern. The objection to the breeches —that they cannot be put on over the shoes—seems to be a matter of taste. Personally, the writer prefers putting on trousers or breeches before muddy shoes, since dragging trousers over muddy shoes covers the inside with mud which works down inside of the sock and chafes the foot, causing more discomfort than wet feet alone do if they are clean.

The boots shown appear to be practical only for cases where a man has but the pair of boots he is wearing. With an additional pair in the haversack, the weight would be materially increased over a pair of shoes, and the soldier's pack at the present time is, if anything, too heavy. Figures are not available but it seems probable that the cost of two pairs of these boots would be considerably greater than two pairs of the present shoes, and one pair of leggings or puttees.

Officers' Reserve Corps strength since February, 1920

Following the passage of the Re-organization Act approved June 4, 1920, appointments in the Officers' Reserve Corps were suspended from June 16 to October 4, 1920. Except for the month of December, when an increase is shown due to action on applications which had accrued during the period of suspension, there has been since April, 1920, a steady decrease in the strength of the Officers' Reserve Corps.

As a result of the July and October examinations, approximately 800 Reserve Officers were appointed in the Regular Army.

By Months.

1920	Number	1920	Number
February	64,436	September	66,832
March	69,098	October	66,353
April	70,186	November	66,346
May	69,149	December	66,513
June	68,232	1921	
July	67,604	January	66,060
August	67,175	February	65,630

—*Office of The Adjutant General.*

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British Views on the Ponton and Other Standard Bridging Equipage

As a Result of the World War

(Reprinted from the *Royal Engineers Journal.*)

[*Note.* American Engineers will find much of interest in this excellent review of the tendencies of British opinion with reference to a proper standardized bridge equipage for the Army, based on the experiences of the World War. As for ourselves, we gained very little practical experience in the use of standard equipage during the war, for the reason that we were not in it long enough to develop any standards to a working basis. We must accordingly give the more weight to the views of our allies.

British progress in the readjustment of bridging standards since the war seems to closely parallel our own in that there has been "a great deal of discussion and a certain amount of experimental work." We need more of both. The decked ponton, characteristic of the British equipage, has never found favor in this country. Unless the boat be very shallow in proportion to its width it is extremely doubtful whether the addition of a deck will "double the available buoyancy." It is certain, moreover, that the addition of a deck will make the boat more difficult to maneuver, and will detract considerably from its usefulness as a ferry.

The French 1915 model ponton supports 11 tons with full submergence, and 8 tons with a freeboard sufficient for safety in swift streams like the Rhine or Rhone.

It would appear that the number of types of bridges might be reduced to three, by the elimination of the bridge for light wheeled transport. While the addition of a new type of bridge does not necessarily add new type equipment, it does seriously affect the problem of adjusting loads to wagons. Furthermore, changing a bridge from one type to another is almost certain to introduce complications, and to require stopping all traffic during the process of reconstruction.

A general summary of the loads to be carried and the other conditions to be fulfilled by any new type of equipage to be adopted, is certainly necessary as a preliminary to a proper design.—ED.]

1. A great deal of discussion and a certain amount of experimental work has been carried out on military bridging during the last two years, and the whole subject needs now to be reviewed.

2. Military bridging can be divided into four phases:

(*a*) The construction of a bridge to enable infantry to fight their way across an obstacle which is closely defended by the enemy.

(*b*) The construction of a bridge to enable field guns and first-line transport (light loads) to cross an obstacle which is under shell fire.

(*c*) The construction of a bridge to enable lorries (trucks) and the 6-inch howitzer and 60-pdr. gun (medium loads) to cross an obstacle.

(*d*) The construction of main-road bridges to take siege artillery and the heaviest military traffic.

It is only proposed in this paper to discuss bridging equipment and to leave out the whole question of improvised bridges. In this way we are at once reduced to two types—the service ponton equipment and stock-span girder bridges. The former will be taken first.

3. As regards (*a*) it is generally agreed that a light floating bridge (of the cork-float type) fills our requirements. The old idea of a bridge of half sections of pontons is too heavy and cumbersome for use under fire. A light floating bridge of this nature requires to be standardized. Many different types were used during the latter part of the war. Some were better than others, but they were all capable of improvement. An inferior design may cost the lives of many officers and men, and we should not be satisfied with any but the very best possible design.

4. As regards paragraphs (*b*), (*c*) and (*d*) we know at the moment that we can produce satisfactory bridges to fulfill our requirements in the following three ways:

(1) By constructing a light bridge by using decked-in pontons at 15 feet intervals and a superstructure of bridging baulks and single chessing.

(2) By constructing a medium bridge with piers which consist of six half sections of decked pontons and 21-foot steel joists with double chessings.

(3) By constructing a heavy bridge with piers which consist of eight half sections of decked pontons and 21-foot steel joists with treble chessing.

We must now discuss the methods by which we can obtain the full use from these three bridges; then when we have collected our ideas as to their correct use we can proceed to discuss the more detailed designs of these three bridges.

5. Now, the suggested method of using these bridges can best be illustrated by examples:

The infantry have forced their way across a river but are hard pressed and require field artillery support. The river is under heavy shell fire and the construction of a bridge will be a difficult undertaking. The lightest and best possible ponton equipment which will carry field guns is required. For this work a ponton equipment in its present form, or something very like it, is necessary. We will now take another example. The infantry have crossed a river and are driving the enemy back rapidly. The river is not under heavy shell fire, and will probably soon be out of range of the enemy's field guns. There is a demolished bridge on the main road across the river. In this case the river should at once be bridged at this point with a ponton bridge to carry medium loads, for it is obvious that lorries will want to cross this river at the earliest possible moment. In some cases a light bridge will be built first and converted later to a medium bridge, but, as a rule, if light bridges are built first to take the field guns they should be constructed clear of the main roads. The medium bridge can then be built without interfering with the passage of artillery wagons over the light bridge. If there should be a shortage of pontons, the light bridge can be broken up at the last moment to form the last few piers in the medium bridge. In many cases no light bridges would be built at all and the first bridge put across the river would be a medium bridge. The difference in the time required for the construction of a light and medium ponton bridge will not be great. A river such as the Aisne at Soissons may be taken as an average case, and is about 200 feet wide; and the difference in bridging this river for light and medium loads would probably not be more than one hour. It is true that much more material and transport is required to bridge such a river for medium loads than light loads, but the total amount is small in either case. Fifteen lorries with trailers would be sufficient to

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bring up the equipment for a medium bridge across this river.

6. The light bridges built with ponton equipment should therefore be considered as emergency or fighting bridges. The approaches would not, as a rule, be required to be timbered or made good, because the bridge should only be in use for a short time, and the site of these bridges might often be chosen from tactical reasons rather than from a point of view of their proximity to a road, or suitability of the approaches, etc. The equipment for the construction of these bridges would be drawn from the Divisional Bridging Train; it would be taken as far as possible by lorry, but might require to be horse-drawn to the site of the bridge.

7. The equipment for the medium bridges should be sent up from the Corps Bridging Train, being supplemented, if necessary, by the Divisional pontons.

8. In colonial warfare the light bridges might be of comparatively greater importance, but the use of lorries and construction of main roads is extending rapidly to the colonies. Moreover, the field artillery and first-line transport may become tractor-drawn, in which case a bridge for light loads will probably cease to be required.

9. As regards sub par. (*d*) in par. 2, we have seen that a bridge to take heavy loads can be constructed from the service pontons (decked-in) by using piers of eight half sections and eight steel joists. In European warfare, when the siege artillery may be close up with the field army, it might be desired to build a heavy bridge straight away instead of a medium bridge. As a rule, a comparatively small number of heavy bridges would suffice; for instance, on a front of three miles we might find, say, three medium bridges and one heavy bridge, some or all of which might be replaced later with girder bridges. In colonial warfare, and even at times in a European war, the army might advance purely as a field army without siege artillery, and medium bridges might cover all requirements.

10. The present service equipment includes a bridging trestle—the Weldon Trestle. This trestle is required in connection with the ponton equipment for the following work:

(*a*) For use in tidal ramps.

(*b*) To save the risk of damaging pontons by grounding on a hard bottom near the banks.

(*c*) For use over swampy ground on the approach to the bridge.

(*d*) For crossing dry gaps or craters on roads.

In pre-war days, when the old medium bridge (present light bridge) was the main military bridge, there was every reason to retain the Weldon Trestle for the work indicated above; but now that this bridge is an emergency bridge, the necessity for the Weldon Trestle is far less apparent. If the water is shallow near the banks and the end ponton grounds, it may be damaged, but the bridge will not fail (especially with the new decked-in ponton, which is considerably stronger in this respect), and when constructing a fighting bridge the risk of damaging a ponton is of small importance compared with the loss of time in erecting a Weldon Trestle.

During the war, Weldon Trestles were used on many occasions as indicated in (*d*), but for this work it seems eminently desirable to erect a trestle which will carry medium loads.

Now, a new trestle has recently been designed of steel, which weighs 40 per cent more than the Weldon Trestle but will carry medium loads (the Weldon Trestle will only carry light loads). This trestle is quicker in erection than the Weldon Trestle, and it is now suggested that this trestle should be adopted instead of the Weldon. It would rarely be used with a light bridge, but would be of great value for medium bridges, and a tower built of two of these trestles would serve to carry heavy loads.

11. As regards girder bridges, a large number of types were evolved during the war, but with two exceptions they all aimed at carrying the heaviest loads over spans which varied in length up to some 150 feet. The two exceptions were the Inglis light and Inglis heavy pyramid bridges. Now a conference was held at Chatham in August, 1920, to consider the retention of the various bridges. The Inglis light pyramid bridge was considered worth retention to assist in the first phases of an advance. The Inglis heavy pyramid was not considered worth retention. Of the various remaining girder bridges it was found necessary to recommend the retention of five different types and the introduction of a further light girder bridge for medium loads. Since that date, a new type of girder bridge (the box girder) has been designed, which may replace all the shorter stock-span girders, and this bridge is adaptable to carry any desired load (light, medium, or heavy). In a few months' time we shall know considerably more about the possibility of girder bridging in this manner, and it is therefore not proposed to discuss girder bridges any further in this paper.

12. We can now consider the detail design of the three types of ponton bridge enumerated in the first part of par. 4. It is generally agreed that it is important to have the simplest possible type of ponton equipment in which every part is interchangeable and adaptable and which contains as few separate and different parts as possible. The decked-in ponton appears to be desirable in almost every way. By using decking the available buoyancy is almost double, and the ponton remains quite easy to row. The swamping of a ponton by the water rushing over the bows in a swift stream is rendered impossible. The additional weight is 600 pounds per complete ponton at present, but this can be reduced—probably to about 400 pounds (or even less). If this can be done, the decked-in ponton appears to be quite satisfactory for all three types of bridge. It has been pointed out that the half ponton is no longer required and that the service ponton should be made in one piece. This, however, has the following disadvantages:

(1) A pier of six half sections can not be made.

(2) If one end of a ponton is smashed, the whole ponton is rendered useless for the time being.

It would therefore appear to be desirable to retain the bipartite ponton. In fact, the present ponton, if decked-in and fitted with strengthened couplings, will provide a very satisfactory boat for every type of ponton bridge.

13. As regards the light bridge, it has been urged that the bay should be made 21 feet instead of 15 feet, so as to simplify the changing from light bridge to medium bridge. Now the light bridge carries a 2-ton axle load, and if it were a matter of strengthening this bridge to carry a 3-ton or 4-ton axle load, it might be possible to carry out the work with little or no obstruction to the traffic. We have, however, to increase the strength of the bridge four times, *i. e.*, to take an 8-ton axle load. It is, therefore, out of the question to do this without obstructing the traffic, but can we introduce any system whereby the change over will be very rapid, so as to cause the least possible obstruction to the traffic? A suggestion has been made that the light bridge should consist of 21-foot bays and piers of two pon-

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tons side by side. This, however, is not recommended for the following reasons:

(1) The construction of the light bridge would become a slower operation and therefore much more difficult under fire.

(2) It is doubtful if the process of changing bay by bay from light bridge to medium bridge would be of any great advantage. On a river which was 200 feet wide the whole operation of changing from light bridge to medium bridge could be carried out in one hour by breaking up the light bridge entirely and rebuilding as a medium bridge.

(3) In most cases the light bridge (if built at all) should be constructed clear of the site for the medium bridge, and this problem would not arise.

14. A continuous girder has been designed by Major Inglis for use with the ponton equipment and will be tested in some six months' time. This will probably provide a very good main-road bridge for wide rivers, but will hardly fill our requirements for hasty ponton medium bridging over average-size rivers in a rapid advance. It is possible that the box-girder design may be satisfactory as a continuous girder in the Inglis pattern bridge. The decked-in ponton will be very suitable for use under a continuous girder.

15. In the equipment which has been tested at Christchurch the following are the only parts required for any of the three bridges:

(1) Decked-in ponton.
(2) Existing pattern ponton saddle.
(3) Existing pattern bridging baulks.
(4) Existing pattern chesses.
(5) Existing pattern ribands.
(6) New design of short baulk.
(7) New design of steel joist saddle.
(8) New design of steel joist road-bearer.
(9) New design of steel kerb.
(10) New design of trestle.
(11) The existing pattern accessories such as anchors, cables, etc.

It is thought that when certain detail improvements have been made and the weight of the decked ponton reduced, this equipment should fulfill all the requirements of the Army.

16. There remains the question as to how and where the ponton equipment should be carried. In the eventual future the transport of an army will no doubt travel on tracks, but for the moment we must keep to lorries and horses. The following is therefore suggested:

(*a*) The Divisional Bridging Train should carry light bridge equipment only (but pontons decked-in); the equipment to be carried in a strengthened type of ponton or trestle wagon towed behind a lorry, but capable of being horse-drawn when necessary. The lorries themselves to carry a bridge equipment of the cork-float bridge type. In this way the Division will be always prepared to meet any emergency with its own bridging equipment.

(*b*) The Corps Bridging Train to carry pontons and superstructure for medium bridge (this is also suitable for a shorter length of heavy bridge) and a small reserve of timber baulks for the light bridge. Also a small reserve of the cork-float type of bridge. Medium bridge ponton equipment would be sent up to Divisions as and when required.

(*c*) Army Bridging Parks and Engineer Stores would hold reserves of every form of ponton equipment, girder bridges, and bridging stores. Any girder bridges could be sent up by lorry to the Corps or Division when required.

17. To sum up, therefore, the following are the recommendations made in this paper:

(*a*) Further detail experiments to be carried out to reduce the weight of the decked ponton and, if successful, that this type of ponton should become universal.

(*b*) The ponton equipment as tested at Christchurch to be standardized after further trials (and possibly minor detail alterations) as the ponton equipment for the Army.

(*c*) That a floating bridge of the cork-float type (but not necessarily cork) be standardized.

(*d*) That the Divisional Bridging Train should carry light ponton bridge equipment in trailers behind lorries. The trailers to take the form of strengthened ponton wagons capable of being horsed. Also that these lorries should carry the standardized cork-float bridges.

(*e*) The Corps Bridging Train to carry medium bridge ponton equipment and the new type steel trestle on the same type of trailer as used in the Divisional Train. This equipment will build up into a shorter length of heavy bridge as desired.

(*f*) The question of girder bridges to be reviewed later when we know more about the possibilities of the box-girder bridge.

Bonuses on Construction Work

By

J. R. Slattery

Major, Corps of Engineers

In *Engineering and Contracting* for January 28th, 1920, there appeared an article entitled *"Application of wage bonus plan to construction operations."* The plan is based upon the establishment of a standard time for the performance of a certain amount of work, and when this set task has been accomplished, the payment of a substantial bonus for additional work done. The article describes how the plan was applied to hand excavation on a railroad cut, carpenter and concrete work on bridges. In each case those in charge of the work decided "on the method and a number of men who could work to advantage, then set the time standard." There was thus determined the number of man-days in which the job should be done. The efficiency of the working party was determined by dividing this number by the actual number of man-days in which the job was done, and a bonus paid if this efficiency was 75 per cent or higher. The following table shows the per cent of bonus paid for various efficiencies:

Efficiency per cent.	Bonus per cent.	Efficiency per cent.	Bonus per cent.
75	1.0	90	10
76	1.6	91	11
77	2.0	92	12
78	2.4	93	13
79	2.8	94	14
80	3.3	95	15
81	3.8	96	16
82	4.3	97	17
83	5.0	98	18
84	5.5	99	19
85	6.0	100	20
86	7.0	101	21
87	7.6	102	22
88	8.4	103	23
89	9.2	105	25

The plan described appears a most excellent one, but there are some irregularities in the increments in percentage of bonus to be paid that do not seem quite reasonable: for example, for an increase in efficiency from 74 per cent to 75 per cent, 1 per cent bonus is paid, but for the next 1 per cent increase in efficiency, the bonus increment is

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only .6 per cent, while for the next 1 per cent (76 per cent to 77 per cent), the bonus increment is only .4 per cent. Again the increment in bonus corresponding to an increase in efficiency from 85 to 86 per cent is 1 per cent, whereas it is only .5 per cent and .6 per cent, respectively, for increases in efficiencies from 84 to 85 per cent, and 86 to 87 per cent. A more logical table would seem to be the following:

Efficiency per cent.	Bonus per cent.	Efficiency per cent.	Bonus per cent.
75	0.	90	10
76	0.4	91	11
77	1.0	92	12
78	1.6	93	13
79	2.2	94	14
80	2.8	95	15
81	3.4	96	16
82	4.0	97	17
83	4.6	98	18
84	5.2	99	19
85	6.0	100	20
86	6.8	101	21
87	7.6	102	22
88	8.4	103	23
89	9.2	104	24
		105 and up	25

The writer has in years past discussed the bonus plan with many contractors and has found them almost universally of the belief that the payment of bonuses promoted the efficiency of work. It is more difficult to find a satisfactory plan for payment of bonuses to government employees than to contractors' employees, but it is believed that the government would benefit greatly by adopting the bonus plan, wherever a reasonable basis for the payment of the same can be determined. In the case of dredging it is thought that a basis could be determined, for any given plant, as follows: Assume that a dredge works at 100 per cent efficiency when it works 20 hours out of every 24. For any given job a reasonably accurate estimate can be made as to about what yardage should be removed per month if the dredge actually worked at 100 per cent efficiency as defined above.

In any given locality the number of months of the year during which actual dredging operations can be carried on is known within close limits. Call this "n" months. The actual cost of dredging operations for the year includes not only the expenses incurred during these "n" months, but likewise the expenditures for care of plant and annual overhauling during the other months of the year. The true cost of any month's dredging, therefore, is equal to the actual operating expense (including cost of repairs, ordinary and extraordinary, during that month), plus $1/n$ of the cost of annual overhauling and care of plant during the lay-up season. At any given time, it is possible to estimate accurately an amount which should cover the monthly cost of operation (exclusive of repairs), and to approximate amounts which should cover cost of monthly repairs, ordinary and extraordinary, and cost of annual overhauling and care of plant during the lay-up season. From these figures there can be determined a monthly operating cost which should not be exceeded by $1/n$ of the total operating cost for a year, and if this monthly cost be divided by the number of yards which it is calculated the dredge should remove when working at 100 per cent efficiency there will result a unit cost that could be used as a basis for determining the efficiency of dredge operation during any month. The per cent of efficiency would be obtained by dividing this basic unit cost by the actual unit cost for the month calculated as follows:

$$\text{Unit cost for month} = \left[\text{Total operating cost per month, including cost of repairs} + \frac{\text{Cost of annual overhauling that year}}{n} + \frac{\text{Cost of care of plant during lay-up}}{n}\right] \div \text{Output for month.}$$

This may possibly appear somewhat complicated, but it is believed that if a study is made of operating costs of any given piece of plant, it will be found that the quantities involved are determined without difficulty and are reasonably convincing. It is considered essential to introduce a factor representing cost of repairs into the basic cost for use in determining efficiency, in order to guard against the danger of a crew's endeavoring to obtain output at the expense of proper care of machinery.

There might be some difficulty in determining the output to the satisfaction of all concerned, but it is believed that if the output was determined by a survey party having no interest in the bonus, and this survey party was in charge of a capable man, there would be little chance of collusion between dredge crew and survey party.

It is probable that most government engineers, who have had to do with the handling of labor during the past year have been impressed with the desirability of finding some way of stimulating labor's interest in work, and have found that neither increases in pay nor discharges accomplish that end. Perhaps an intelligent bonus system will meet the needs.

What the Ancients thought of prohibition

In a report of the Chief of Engineers, U. S. Army, dated October 12, 1814, is an account of his inspection of certain district work, in which he states that if *extra* whiskey is not allowed the troops they will not work. It appears that the "no beer no work" movement contains nothing original.

Value of the world's currency

	Par value	Value in U. S. Nov. 30, 1918	Value in U. S. Nov. 30, 1920	Percentage of present to par value
British Pound	$4.8665	$4.7575	$3.4812	71.5
French Franc	.193	.1833	.0606	31.4
Belgian Franc	.193	*	.0642	33.2
Italian Lire	.193	.157	.0366	18.9
German Mark	.238	*	.0141	05.9
Austrian Crown	.2026	*	.0031	01.5
Spanish Peseta	.193	*	.1314	68.
Swiss Franc	.193	.204	.1565	81.
Danish Crown	.268	.265	.135	50.4
Norwegian Crown	.208	.274	.135	50.4
Swedish Crown	.268	.28	.193	72.
Dutch Guilder	.402	.4212	.305	75.8
Portuguese Escudo	1.08	*	.115	10.7
Greek Drachma	.193	.1937	.0825	42.7
Czecho-Slovakian Crown	.2026	**	.0122	06.
Roumanian Leu	.193	*	.0147	07.6
Polish Mark	.238	**	.002	00.8
Finnish Mark	.193	**	.021	10.9
Russian Ruble	.5146	.14	.008	01.5
Argentine Peso	.4245	.4525	.3425	80.7
Brazilian Milreis	.3244	.2675	.1675	51.6

*There was no active market for these exchanges in November, 1918.
**These currencies were not yet in existence in Novmber, 1918.

—*World's Work.*

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Industry's Supply of Energy

Abstract of Article by George Otis Smith, U. S. G. S.

(From *Mechanical Engineering*)

EDWARD EVERETT HALE charted the course of industrial development when he said that the extent to which the world had changed the laborer who uses his body into the workman who uses his head was the index of civilization. The true measure of industrial progress is found in the amount of mechanical power used to supplement man power. The mechanical engineer has devoted practically all of his energies to perfecting the application of power to man's use, and has given little consideration to the sources of the energy used, or to the estimation of the supply available. In the ancient days of Rome, or Greece or Egypt, hordes of slaves made use of only the simplest laws of mechanics. To-day, it is estimated that the total capacity of our prime movers is approximately 100,000,000 horsepower, or nearly one horsepower to every inhabitant in the United States. Using the equivalent of ten man-power hours to the horsepower hour, each of us now has the equivalent of ten servants to do his bidding.

The load factor, however, of all these prime movers, it is estimated, is not more than 14 per cent. The census of our energy slaves does not include the millions of automotive engines in our pleasure cars, trucks and tractors, which may in rated capacity far exceed that of the prime movers mentioned.

In contrast with the Greek civilization of the past, or even with Oriental life of to-day, we see that the Anglo-Saxon dominance of industry and commerce is founded largely on coal and iron. The invention of the steam engine gave such impulse to industrial development that the industrial scheme changed more in a few years than it had in the eighteen centuries since the boy Jesus worked at the carpenter's bench in his father's shop.

Present supply of energy and its distribution

Engineers of the U. S. Geological Survey estimate 125 billion horsepower hours as last year's output in the United States. Of this amount 82 per cent is credited to steam, a little over 15 per cent to water and the remainder, less than 3 per cent, to internal combustion engines. This power was used as follows: Public utilities, 42 per cent; manufacturing industries, 28 per cent, and steam railroads, 30 per cent.

Our per capita consumption of coal is estimated at 6 tons, which exceeds that of any other country. In order to visualize our coal consumption we may take as a unit the 1,000 tons of coal that represent the output of a mine worker in a year. This is one short train-load of 20 cars. Our industries and public utilities use 350 tons; our railroads burn 250 tons for their own use; 165 tons is used for heating and cooking in the homes of the land; 130 tons goes to coke ovens, and the remaining 105 tons goes for export and operation of coal mines and gas works.

A century ago the country's output was only 40,000 tons of coal, or less than 8 pounds per capita; even 50 years ago we used only 1,700 pounds, as against nearly 6½ tons in 1918.

The world's sources of supply

One of the by-products of our Peace Commission was an inventory of the water-power resources of the world, now being prepared for publication by the U. S. Geological Survey. It shows that only about one-twentieth of the potential power of the world's rivers has been utilized and over half of this in North America, with Europe credited with one-third and the rest divided between Asia, South America, Oceanica and Africa in the order named. In its potential resources, however, Africa ranks not last, but first; it has over 40 per cent of the world's supply of water-power and is followed in turn by Asia, North America, South America, Europe and Oceanica.

Of the better grades of coal resources, North America has more than half, Asia about one-fourth, Europe one-sixth and the rest is divided between Oceanica, Africa and South America in the order named.

Oil resources are more difficult to estimate; they appear to be evenly balanced between the eastern and western hemispheres, but the northern hemisphere appears to have at least five times as much oil as the southern. The continents in order of wealth in oil are North America, Asia, South America, Europe, Oceanica and Africa. More than half the world's oil reserves are believed to be concentrated in two inter-continental areas; one of these includes the North American and South American countries bordering the Carribean Sea and the other includes the countries of western Asia and southeastern Europe with the Caucasus as an axis. Each of these areas comprises only about 2 per cent of the earth's surface, but each is estimated to contain 30 per cent of the world's future supply of oil.

Oil shale can not be utilized as cheaply as natural petroleum but will form an important resource in the future. The United States alone is believed to possess deposits of oil shale that contain at least ten times as much oil as there is natural petroleum available in North America. No other continent is known to have resources of oil shale at all comparable with those of North America.

This rapid review of the world's source of energy shows North America taking first rank among the continents, with Asia a close second and Europe a poor third, although we should remember that Europe has a much smaller area than either of the other two.

Relative importance of coal, oil and water as sources of energy

Even in Europe and North America only about one-fifth of the potential water power has yet been developed. The further development of the use of water power will still involve the use of coal in increasing quantities, as the largest development of water power is practicable only with coal power as a dependable "standby," ever ready to meet promptly any special demand.

As sources of power, oil and natural gas present a marked contrast with water. Hydro-electric energy is more easily distributed and used, but water power development involves large capital outlay, and in any national emergency no quick response in water power is possible. However, once the large necessary investment of labor and material is made in water power, the output of energy continues for generations. Oil and gas on the contrary are

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quickly developed and quickly exhausted. Natural gas, the ideal fuel, is a resource so temporary that its use forms merely an incident in industrial progress. The sorry lesson we have learned from the waste of natural gas may have its value if we apply the truth to our use of oil. Unless we check the increase in the consumption of oil, it too will be but a flash in the pan.

Looking for a moment at the power problem in our own country we see the nation's wealth in water, fuel and oil measured in millions of horse-power, thousands of billions of tons and billions of barrels, but to determine the relative position of water, coal and oil as sources of energy, we must reduce these units to a common denominator. If we take 50 million horse-power as an average figure for the potential water power of the United States, without storage, we find that if fully developed and if used at the average load factor of to-day, our rivers and streams would just about meet the country's present needs, and would supply that amount of power for all time; moreover, with storage and an improved load factor, they could provide a considerably increased output of energy to meet the growing demand.

Now if we assume that the whole power burden should be placed on our coal mines, we can get a direct comparison between our coal resources and our potential water power. There are in the United States accessible and available for future use, an aggregate of about 2,500 billion tons of coal, not including lignite; only about one-fifth of this is in the eastern states, another one-fifth is in the coal fields of the central states and nearly three-fifths is in the Rocky Mountain and western states. The most practicable unit for the conversion of these great resources of coal into power is a new one, the horse-power century, for which the equivalent in eastern coal is 250 tons, in interior coal 300 tons, and in western coal, 350 tons. By applying these h. p. centuries to our estimate of reserves we get a total of 8,161 million horse-power centuries. A million horse-power centuries is seven times the present power output of the United States, so we see that by adopting the best steam practice of to-day the present power requirements of this country could be met with coal for 57,000 years, although we know that long before the end of that period the greater depth of the coal mines and their increased distance from market would alone create power demands for mining and transportation that would considerably cut down the amount of power available for other uses.

We measure the petroleum wealth of the United States by billions of barrels—about 5 billion already produced in the last 60 years and about 7 billion left for the future; again, adopting the best steam practice of to-day in public utility stations of Texas and California—a little less than 32 barrels to the horse-power year—and trying to carry the whole power load of the country with oil alone we find that the oil reserves of the United States, although measured by billions of barrels, would last only 9 years and 3 months.

Without allowing for the fact that steam raising for power is only one of the many uses for coal, these two figures, 57,000 and 9¼ years, are sufficiently impressive to make us fairly receptive to the general truth of Mr. Eckel's statement in his recent book, Coal, Iron and Water: "We have just as much real chance of replacing coal by oil as we have of finding enough gold to use it in place of steel."

Costs of energy

In taking up the question of the relative costs in human energy in making the three kinds of energy available, engineers will appreciate the differences of labor outlay in constructing a hydro-electric plant, opening up a coal mine and drilling an oil well. Each is an engineering project that requires careful planning and the expenditure of money, skill and labor, but in widely different amounts.

Moreover, the water power plant is to last for generations and the coal mine for several decades, but the life of an oil well is measured by a few years. In operation, however, the water power plant is a labor saver, as is illustrated by the balance sheet put out by the Alabama Power Company, comparing a large steam plant with a hydro-electric plant operated under the same management and feeding into the same transmission lines. In terms of 1,000 kilowatt capacity it takes 13½ men to run the steam plant and the coal mine tributary to it. And how many does it take for the corresponding units in the hydro-electric plant? One-sixth of one man; the exact ratio is 84 to 1. Another comparison with coal is afforded by the statement that in Mexico one man can produce and transport to market the oil equivalent to the coal that it would take 10 men in the United States to mine.

Mechanical engineers should bear in mind these approximate comparisons of the labor costs of our energy slaves as they plan for the larger use of mechanical power. They should realize that the matter of full utilization of power resources goes further than material resources or energy supplies: do we not need to raise our intellectual load factor? Is there not too great a gap between our peak practice and our average load? In a word the Engineer needs to be more of a citizen, or as Herbert Hoover puts it, "Organize the engineering mind for expression in public service."

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Army Ponton Equipage Meets an Emergency of Peace Time

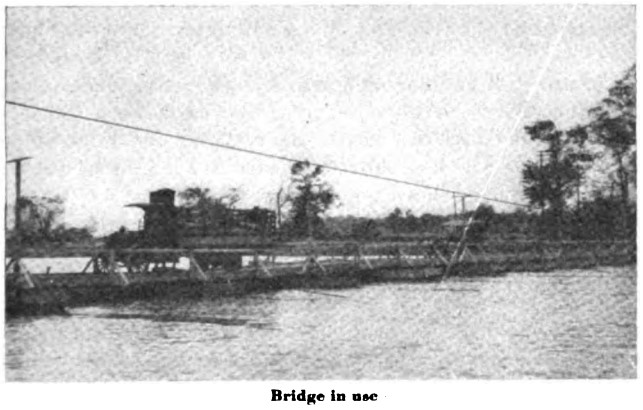
By

J. B. La Guardia
Captain, Corps of Engineers

[*Note.* The ponton equipage is entitled to a prominent place amongst the devices of war which find a useful application to the needs and emergencies of peace. The following instance of the use of the equipage for the relief of a civil community in time of flood is typical of many similar instances in the past.—ED.]

THE city of West Point, Ga., is located on the Chattahoochee River about 90 miles southwest of Atlanta. It is divided into two parts by the river and the two sections of the city were connected by a 3-span steel highway bridge erected in 1890. On this bridge were carried the water main, electric, telephone and telegraph lines.

A heavy rainfall throughout the state of Georgia, total-



Bridge in use

ing 12 inches in four days, December 7-10, 1919, caused the river to rise to a stage of 31 feet above the normal, exceeding by 5 feet the record flood of 1886. This rise flooded a great portion of the city; also, a tremendous amount of drift-wood and debris came down the river, which collected against the bridge, forming an effective dam, and in the afternoon of December 9 the center and east spans were washed away. This break in the bridge left the east (residential) section of the town destitute of water, light, and any means of communication with the business section.

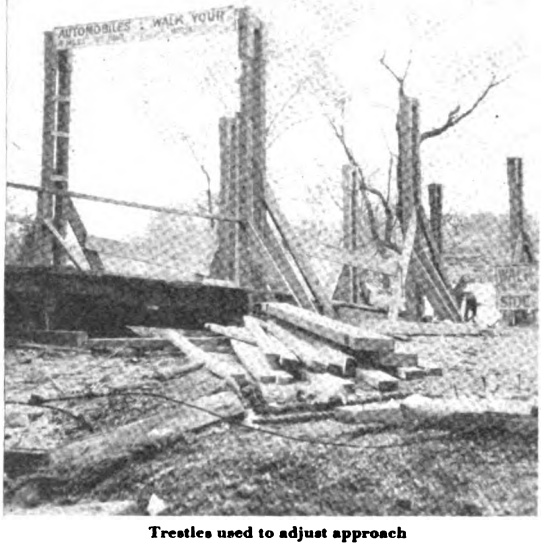
A detachment of 3 officers and 40 men from the 7th Engineers were ordered to West Point. This detachment guarded against looting which was in progress on a large scale, and also assisted in getting food and water to the residential section. The primary object in sending this detachment was to build a ponton bridge across the river. However, a special Act of Congress was necessary to authorize the employment of War Department Equipment for such a purpose. This caused considerable delay, and so on December 19-20 the detachment returned to Camp Gordon, Georgia.

The city of West Point is a distributing center for a large cotton mill and cotton raising section on both sides of the river. Deprived of means of communication offered by the bridge, considerable financial loss would ensue. Steps were immediately taken to construct two flying ferries, and these plied back and forth heavily loaded. At the same time efforts were continued to obtain the authority for the ponton bridge. This authority was obtained and ponton equipment began arriving January 9, 1920.

The bridge was located near the site of the flying ferries, or 800 feet upstream from the old highway bridge. The river at this point is 440 feet wide. The banks are steep and about 8 feet above normal water level. At normal stage the depth of the river varies from 6 to 15 feet. The current then is about 3 or 4 miles per hour, but as the stage rises the current increases and at a stage of 18 feet 6 inches a velocity of 15 miles per hour was measured.

The bridge as constructed varied from the normal type of military bridge in the following respects:

The number of balks used was eleven, eight of these were the usual military type, and three others, placed one on



Trestles used to adjust approach
(Pen line in illustration indicates Mooring Posts)

the middle and two on the outside, were made of 4″×6″ ×20′ notched to 5 inches. This arrangement permitted the nailing of the flooring, made up of 2-inch material, to the middle balk and of bolting side rails to the outer ones. Two wheel treads, 24 inches wide, were placed along the

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The Vicksburg Campaign

(Continued from Page 196)

halted. It was a novel situation. Our pickets were inside the Confederate line and their pickets were inside of ours, but as neither side could fire on the other without giving warning, according to agreement, a parley was held and it was agreed that the two lines should be established as they stood, the Confederates taking the line occupied by our pickets and ours taking the place of the Confederates. That put the two lines about fifty feet apart, each line having the same number of men. About 10 o'clock that night a working party was established behind our picket line armed with picks and spades and before daylight the second parallel was established.

Agreements not to fire on each other were put into effect in other parts of the line and often men and officers met between the lines and settled the issues of the war in the most amicable manner. The Confederate soldiers as a rule put the blame for the war and its continuance on the politicians and women of both sides, saying that if the men of the two sides, excluding ministers of the gospel, could get together, there would be no difficulty in framing a peace that would be satisfactory to both.

The revetments on the inside of our works were sometimes made with gabions and sometimes with fascines or hurdle work, but the men did not like to make gabions, or hurdle work, and so as cracker boxes were plentiful they were more generally used for revetments. Sap rollers of the size laid down in the books, could not be used at all. They were too heavy. They had to be made lighter in order to move them over the hilly ground. This was done in various ways, sometimes they were made hollow, two empty barrels being placed end to end to form the hollow space. When our sap rollers at the railroad redoubt had reached the crest of the counterscarp and it was desired to know the width and depth of the ditch, a looking glass was procured and fastened to a long pole and raised from behind the sap roller and inclined forward. In this way a good view of the ditch could often be had.

We had no Cohorn mortars. If we had had, they would have proved very useful as they could be easily moved about from place to place, but Yankee ingenuity devised a substitute. The stump of a gum tree was bound with iron hoops and bored out to fit a six or twelve pounder shell. This was planted in the ground in rear of our lines with an inclination forward of about 45 degrees and fired as a mortar. It had a range of several hundred feet and was often good for about fifty rounds before it burst. The enemy used fire balls to destroy sap rollers when we approached too close to their ditches. The sap rollers being constructed of light material and exposed to the hot rays of a southern sun, burned readily and it was no easy job to replace them.

On the extreme right of our line, which flank was held by Sherman, the approaches were particularly difficult. His corps occupied the crest of the north and the Confederate the south side of a deep valley. This valley therefore had to be crossed in order to reach the enemy's works. On the side toward the enemy the slope was quite steep and had had a heavy growth of timber on it, but the trees having been felled, lay in a tangled mass, through which troops could not pass and maintain their formation. There was some compensation in this, however; the slope being steep the enemy's bullets passed over the men's heads when they were close up. This slope was too steep, for the most part, to enable approaches to be made in the regular way, but was favorable for mining. However, we had no more miners than we had sappers, consequently here as elsewhere along the line progress was slow.

Near the angle on McPherson's front the approaches were soon pushed up so close to the ditch that further progress could only be made by mining. A few coal miners were found in a West Virginia regiment and they, with the assistance of other men, drove a gallery in under Fort Hill (called by the troops Fort Hell); the soil being stiff, no timbering was necessary. The enemy tried to stop our work by counter-mining, but did not succeed. In a chamber at the far end of the gallery a charge of a ton of powder was placed and fired at 3:30 p. m. on June 25th; as word had been sent along the line that the explosion would take place at that time sharpshooters were stationed along the trenches to give the Confederates a volley when they were up in their trenches in surprise at what was taking place. They were completely taken by surprise and received a deadly volley from our line.

The blowing up of Fort Hill was a complete success and the crater formed was immediately occupied by our men, but the Confederates, warned by the strange noises they had heard in their counter-mines, had prepared a new line of defense some distance in the rear.

In consequence, no decisive results were accomplished, though preparations had been made to take advantage of the surprised Confederates, if a good opportunity presented itself.

On July 1st another mine was sprung at the same place, or rather a little in advance of it, blowing several Confederate soldiers and one negro laborer into our lines. The astonished negro was thrown up about a hundred feet in the air and came down not seriously hurt.

On July 1st the approaches in front of the 13th Army Corps had been advanced to the counter-scarp of the ditch at three places, viz, the Baldwins Ferry Redoubt, the Railroad Redoubt and the Square Redoubt. As further progress could not be made on the surface in the ordinary way, arrangements were made to start mining, when orders were received to suspend that work and put all labor on widening trenches so that infantry could move along in them in columns of fours. At the same time material was ordered to be prepared for filling the ditches so that infantry and artillery could pass over them without losing their formation. The ditches were to be first filled up with bags of cotton solidly pressed into them and then covered with planks and earth. Each man in the front part of the assaulting column was to carry two bags of cotton, which it was found was nearly bullet proof when prepared in this way. The assault was to take place at dawn of July 6th, but as the surrender took place on the 4th, the assault did not materialize. The plan of filling the ditch with bags of cotton was a novel one in siege operation, but cotton was plentiful, though worth about 80 cents a pound.

Grant made a mistake when, on May 22nd, he yielded his better judgment to the importunities of his subordinate, General McClernand, commanding the 13th Army Corps (in the center of the line of investment), who called for reinforcements to support an alleged capture of part of the enemy's works and requested that a diversion be made in his favor by a renewal of the attacks of Sherman and McPherson on their fronts. Grant could see fairly well from where he had taken station, near McPherson's headquarters, what was going on on McClernand's front. From what he could see he did not believe the statement of his subordinate, but the latter was nearer the scene, and it was his troops that had made the alleged capture. McClernand's assertion was so positive in a second dispatch that Grant

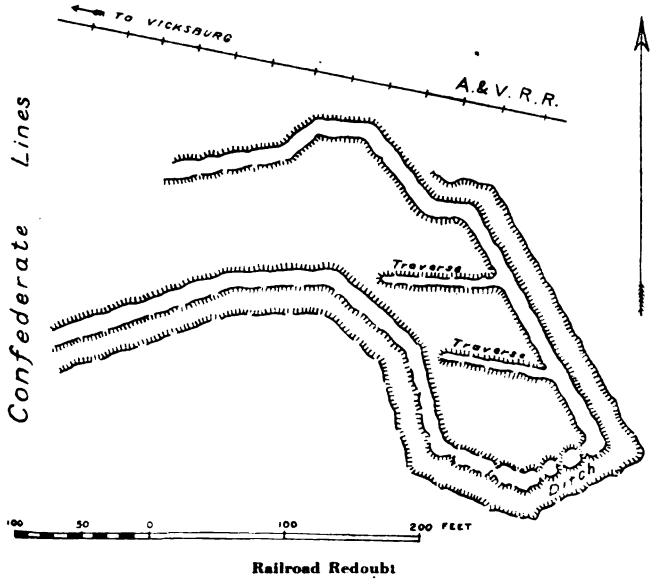
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did not feel that he could, under the circumstances, safely ignore the request. It was necessary that action be immediate. There was no time to investigate, so he ordered Bloomer's Brigade of Quinby's Division to be sent to McClernand's assistance, and at the same time ordered the two corps commanders (Sherman and McPherson) to renew their attacks, and notified that he could use McArthur's Division then on the way up. The result was that several hundred more men were unnecessarily sacrificed.

The railroad redoubt

The works that McClernand claimed to have captured were the lunette on the Baldwin Ferry Road and the Railroad Redoubt on the left of the railroad leading into Vicksburg. Our men did get as far as the ditch of the lunette and the outer slope of the parapet of the Railroad Redoubt, but they could go no farther. We could not see the lunette from where we stood, on account of trees and the height of intervening ground, but we could see distinctly what took place at the Railroad Redoubt, for it was only about five hundred yards distant, with a clear space between us and the enemy. The writer was with General McClernand all day of May 22, being a member of his staff. He remembers that General McClernand received a piece of an envelope purporting to come from Colonel Stone of the 22d Iowa Infantry, who was at that time in the ditch of the redoubt, saying in substance that he held part of the fort and needed the support of reinforcements, or words to that effect. When we saw prisoners (about a dozen) come out of the end of the redoubt, General McClernand remarked in substance that we had possession, for there were Confederate prisoners coming into our lines. The writer remarked, in substance, "Yes, General, there are prisoners coming in sure, but we have not possession of the works," and in support of his statement, called attention to the fact that just at that moment one of our soldiers lying on the superior slope of the redoubt, rolled back in the ditch, killed by a Confederate soldier inside.

The Railroad Redoubt was three-sided; the flanks projecting forward being longer than the outer face. It was open in rear, but had two traverses nearly parallel to the outer face, reaching from one side to the other with a narrow passage of about two feet in width left for communication. The two traverses divided the redoubt into two separate compartments, so that the men in one could not communicate with those in an adjoining one except by way of the narrow passage referred to. The outer face of the redoubt being nearly parallel to our line of battle, had been battered down considerably in the bombardment that preceded the attack. Big shells had cut furrows in it three or four feet deep, leaving but little of the original parapet standing, so that a man creeping in these furrows would not be seen by the enemy. Some of our men, after reaching the ditch, succeeded in entering the outer compartment referred to. (See sketch.)



Railroad Redoubt

Among them was First Sergt. Joseph Griffith of Company I, 22d Iowan Infantry. At that time there was a Confederate lieutenant and about thirteen men in that compartment still alive, but all of them had discharged their guns. All of our men who gained entrance into this compartment were killed or got back into the ditch except Sergeant Griffith, who laid down in a gulley, or furrow, made by our artillery. As he did so he picked up a repeating rifle, which it is supposed was dropped by the first lieutenant of his company, who is said to have gone into action with such a rifle, and who was killed in that compartment. Sergeant Griffith at once levelled this rifle at the Confederate officer and ordered him to make his men lie down. The officer did so, and the men lay down on the ground. Griffith then ordered the lieutenant to make his men come out one by one, creeping past him in the furrows referred to as made by our artillery. One by one they crept out and dropped into the ditch. As the latter was full of our men they were easily taken care of until all were in the ditch. Colonel Stone then directed Griffith to take the prisoners to McClernand's Headquarters, which he did.

The slope of the hill on which the redoubt was built formed a natural glacis. About 100 feet from the ditch there was a depression in the surface like a terrace on a slope, and from this terrace the slope dropped off to the bottom of the ravine or bayou. From the terrace to the bottom of the ravine a man could, by stooping low, avoid being seen by the Confederates in their works, but from the ditch to the terrace they were in plain view; and in running this distance they came under fire. One of the prisoners was killed by their own sharpshooters in running this distance. A little later Griffith arrived at headquarters with his prisoners—one lieutenant and twelve or thirteen men—and from Griffith was learned how the Confederate prisoners were taken, and, what seemed most strange to us on the hill at first, how they happened to be coming into our lines.

When Griffith related the manner of his capturing so many prisoners, substantially as stated above, the writer turned to the Confederate officer and asked him if he had surrendered with all those men to that boy (Griffith was only 19 years old at that time). He replied in an angry tone, "What the hell could we do? My men had all discharged their guns and he had that rifle."

It may be of interest to officers of the Corps of Engineers to know that shortly after this battle Griffith was appointed first lieutenant in the 22d Iowa Volunteer Infantry by General Grant, an appointment he had no authority to make; the appointment was, however, subject to the approval of the Governor of Iowa, but he did not hesitate to approve it. In October following, Griffith was given an appointment as cadet at the Military Academy, West Point. He was graduated in 1868, and appointed second lieutenant of Engineers. He resigned from the Army in 1870 and died in 1877.

This exhibition of courage on the part of Sergeant Griffith proved to be a most unfortunate incident, for it seemed to convince General McClernand that we had actual possession of a part of the enemy's works, and *it* may have been the chief cause of his sending word to Grant to that effect. From a technical point of view, McClernand was within

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the bounds of truth when he stated that we had possession of "*a part* of the enemy's works." The ditch was unquestionably a part of the enemy's redoubt, and we had possession of it for several hours, but it was because the ditch was a safer place than the outer slope of the parapet or the natural glacis in front of it. The ditch was, in fact, a trap. We could not advance, nor could we retreat. Like the man having hold of the bear's tail—we could not hold on and dared not let go.

Grant undoubtedly assumed, as he had a right to assume from the dispatches he received, that McClernand had possession of something of value. The statement in each dispatch was indefinite and liable to misconstruction. It was misconstrued by Grant; whether or not McClernand wished to convey an impression that he had gained more than the actual facts warranted is a question that can never be determined, but the important fact remains that the dispatches in question did convey the idea that McClernand had gained possession of something of such importance that support only was needed to break through the enemy's line.

These dispatches to Grant (there were two of the same tenor), which caused him to issue the unfortunate order to resume the attack on the other corps fronts, did not tend to heal the feeling of antagonism that existed between these two men.

The commander of a field army has a right to expect from his subordinate commanders intelligent and cordial support. There was no visible friction between them, but this episode was a straw that tended to break the camel's back. It undoubtedly increased the feeling of antagonism. McClernand was a disappointed man. He expected, and was given to understand that President Lincoln had selected him to command the army that was organized to undertake the task of capturing Vicksburg, so that when he found he was only a corps commander in that army he doubtless experienced keen disappointment. It would hardly fail, in such a man as McClernand, to intensify the feeling of hostility already existing in his heart. This finally led to his being relieved from his command and sent home.

It came about in this way, McClernand published a congratulatory order to the 13th Army Corps, in which he claimed that that corps, under him, had done most of the hard fighting of the campaign, and minimized the achievements of the other two corps. As a matter of fact all had done their full duty, and no one had a right to claim for one corps an undue share of the honor. Politician-like, McClernand, though brave and possessing some qualities that tend to make an efficient commander, could not apparently divest himself of the habits acquired in the political field. He did not see the difference between the politician and the soldier. He not only issued the order referred to, but had it printed in the northern newspapers in violation of the Army Regulations, which forbid that sort of thing. Grant knew nothing of the order in question until he saw it in a copy of the *St. Louis Republican*. He then sent a letter to McClernand with the copy of the order cut from the paper and asked if he, McClernand, had published it?

McClernand replied in a rather petulant way that he had, and that he was prepared to substantiate all the statements made in it. Grant then issued an order relieving him from the command of the 13th Army Corps and ordered him home, from which place he was to report to the Adjutant General of the Army. He then assigned Maj. Gen. E. O. C. Ord to the command of the 13th Corps, subject to the approval of the President. General Ord continued in that command during the remainder of the Vicksburg Campaign.

The Vicksburg Campaign, besides being the most successful, was one of the most important military events of the Civil War. Its results were far reaching and most disastrous for the Confederacy. With Lee's failure at Gettysburg at the same time, the war should have then ended, for it was evident to the people of the South, as well as the North, that a further struggle to disrupt the union of states was hopeless.

We now found that our prisoners amounted to no less than 31,600 men, including the sick. The Confederates had expended nearly all their ammunition and had reached the point of starvation. They had made a gallant defense, but there could be no fight in men who were starving and almost wholly out of ammunition. Our Commanding General, with characteristic generosity, granted liberal terms to the enemy, which, while it saved their honor, destroyed their capacity for further mischief.

Regulation of the Middle Mississippi River

(Continued from page 204)

dredge, which afterwards was named *Alpha* and was the first of the Commission dredge fleet, was non-propelling and did not differ materially in its principal details from similar dredges which were built later. The hull was of wood, 130 feet long by 36 feet wide. The machinery consisted of a centrifugal suction pump with 30-inch suction and discharge pipes, and a centrifugal jet pump with 15-inch suction and discharge. There were four Mississippi River type boilers, 38 inches diameter and 28 feet long. The material was discharged through a floating pipe line, 30 inches diameter, in sections 33 feet long, the total length varying from about 600 to 1,000 feet. The hourly capacity was about 600 cubic yards of sand. This dredge succeeded in opening a small channel in 7 days through a bar 1,600 feet long, the gain in depth being 2 to 3 feet.

In 1896 a jet dredge (*No. 1*) was built in the St. Louis District to deepen the channel over bars by directing streams of water against them, the current being depended upon to carry the agitated material away. This dredge had two 15-inch centrifugal pumps, with two Mississippi River type boilers 42 inches diameter and 28 feet long. The suction led over the side, and the discharge, which consisted of four 12-inch pipes with flattened nozzles, led over the bow, the machinery being mounted on a wooden barge. This dredge worked downstream, the boat being dropped down from the upper to the lower side of the bar, with the jets in operation. River dredges at the present time work upstream. The cost of the dredge, not including the barge on which it was mounted, was about $18,480.

In 1896 there was also begun in the St. Louis District the construction of three non-propelling suction dredges, *Nos. 2, 3* and *4*. *Dredge No. 2* was of wooden hull, 135 feet length and 28 feet beam. It had a single 20-inch pump of 450 cubic yards capacity per hour, three Mississippi River type boilers, and cost about $22,000. *Nos. 3* and *4* were of steel construction, 160 feet length and 40 feet beam. Each carried two pumps of 20-inch discharge and capacity of 600 cubic yards of sand per hour, six Mississippi River type boilers, and cost about $102,400.

Dredges *Nos. 1* and *2* have been dismantled, as with the construction of larger and more powerful dredges, these earlier forms were found to be uneconomical. In 1906 the capacity of *Nos. 3* and *4* (now called *Selma* and *Thebes*) was increased by replacing the two small pumps on each dredge with a single pump with 28-inch diameter discharge, utilizing the original engines.

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In 1906-7 two steel hull, self-propelling dredges, the *Fort Gage* and *Fort Chartres,* larger and more powerful than any heretofore built in the district, were completed. They are of steel, 197 feet length and 45 feet beam. Each has a pump of 32-inch discharge and capacity of 1,500 cubic yards of sand per hour, six Mississippi River type boilers, stern wheel, 24-inch, non-condensing, high-pressure engines, and cost about $177,000.

Working in two shifts of eight hours each, the non-propelling dredge requires a crew of 9 officers and 39 men, and the propelling dredge of 11 officers and 37 men.

The gross cost per cubic yard of dredging done during 1920 varied from 18.2 cents for non-propelling dredges to 11.9 cents for the larger self-propelling type.

During the dredging season, which lasts ordinarily from July to December, with the aid of the regularization works, these four dredges maintain, with but occasional interruptions, an 8-foot channel 200 feet wide between St. Louis and the mouth of the Ohio River.



St. Louis Harbor hurdles, Pillsbury dike series. Shore end looking downstream. Drift caught by hurdles

The district obtains accurate information as to prevailing depths from soundings made by its own boats, including the snagboats, and from the lighthouse tender and commercial boats.

As the localities which are likely to become troublesome are well known, they are carefully observed, and when the river approaches a stage when depths may become insufficient, surveys are made of these localities and preparations are made for dredging.

Soundings are made on lines or ranges across the river with sufficient frequency to show accurately the condition of the bottom, which is shown on the map by contours. Ranges are ordinarily located at intervals of 1,000 feet, with such additional ranges as may be necessary in the shoalest water. Longitudinal ranges, following closely the steamer channel, are also sounded.

From the map, the proposed dredge cuts are located and indicated by buoys or shoal marks. Success or failure depends very materially on the skill with which these locations are made. The axis of the proposed channel to be dredged must coincide with the direction of the current, otherwise the channel will be quickly obliterated. It is desirable to have the initial cuts made through the bar as quickly as possible, in order to receive the assistance of the current in scouring out the artificial channel. Cuts should be made as deep as the suction head will permit, in order to augment the volume and velocity of the current, whose action is largely depended on to aid in the formation of the channel. The channel is made of requisite width by parallel cuts.

During the past season the time required to open channels varied from 3 to 8 days and from 32 to 73 hours actual dredging time.

Surveys, maps and gauge records

Complete surveys have been made throughout the district, including the entire area between the limiting bluff lines. The first of these surveys was made by the Mississippi River Commission between 1880 and 1888, and included triangulation of the secondary order and precise levels. Lithograph maps of this survey are issued in two editions, the larger scale, 1:20,000, showing soundings, with contour intervals of 5 feet in the bottom and 20 feet in the bluffs, triangulation stations and bench marks; the smaller edition scale, 1:63,360 (1 inch to 1 mile), shows topography, but omits the foregoing details. Prior to this survey three reconnaissances were made towards the end of the eighteenth century with another about 1821, and subsequently five or more surveys were made in somewhat greater detail. The Board on Examination and Survey of the Mississippi River in 1909, issued lithograph maps of the district, scale 1:20,000, from the northern city limits of St. Louis to the Ohio River, based on more complete topography than any of the foregoing.

In addition to these more complete surveys and maps, the St. Louis office has made a large number of surveys for the purpose of planning and locating improvement works and for dredging. As far as practicable, the entire district is covered annually. Bank and bar lines and improvement works are located and soundings are made. Extended topography is not taken, nor are contours drawn.

A survey party consists of about fifteen men, supplied with necessary instruments and tools and quartered on a small office boat. One or two small motor boats are used for making soundings.

Topography is usually taken with the plane table, and is mapped on the scale of 1:5,000. This is usually confined to the shore and bar lines, as the areas back of the shore lines undergo very little change from year to year. Triangulation and levels are based on the Mississippi River Commission Surveys, intermediate stations and bench-marks being established as required or to replace others lost or destroyed.

Tracings are made from field maps for locating construction maps or localities to be dredged, and in the office, reductions to scales of 1:10,000 and 1:20,000 are made for record on the permanent maps or standard sheets, of which there are thirty-seven. Note books, which are usually confined to triangulation, leveling and soundings, are indexed and filed, and the necessary computations are made.

Observations of the velocity and discharge of the river are made as required. A favorable cross-section, and the one usually utilized, is located at the Engineer Depot in St. Louis. The method by rod floats is employed.

The stages of the Mississippi are observed daily at a

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number of stations. At St. Louis a gauge is maintained by the Mississippi River Commission, with continuous readings since 1861, and a second gauge is maintained by the U. S. Weather Bureau. The City of St. Louis maintains gauges at two water-works stations in the northern part of the city. The Commission also maintains gauges at Cape Girardeau and Cairo. The Weather Bureau publishes in the daily newspapers the readings of the gauges at St. Louis, Chester and Cairo. The Mississippi River Commission publishes annually in pamphlet form the readings of the St. Louis, Chester, Grand Tower, Cape Girardeau and Cairo gauges. The St. Louis Engineer Office maintains eight gauges between St. Louis and Cairo, and keeps a record of their readings, as well as those of all other gauges in the district, but does not publish them.

Removal of snags and wrecks

Before this work was inaugurated the navigation of the river was very much interfered with by numerous snags, logs, etc., which had lodged in the channel, and to which a new accession was brought down on each rise of the river, thus constantly adding new and unknown obstructions to those already there. A large number of wrecks, dangerous to navigation, also obstructed the channel. For the removal of these obstructions, appropriations were made as early as 1824, and the project adopted consisted of building boats suitable for removing the snags, etc., and operating them whenever the stage of water was favorable for the work and funds were available.

The total amount expended for this purpose can not be definitely given, as, previous to the appropriations made by act of March 3, 1879, a bulk sum was appropriated to be applied to several streams as their needs required.

Congress, by act of March 3, 1879, appropriated the first specific sum for removing snags, wrecks, etc., from the Mississippi River, and that appropriation was followed by others until 1888, when, by the act of August 11 of that year, an annual expenditure not to exceed $100,000 for this purpose was authorized. Under this act operations have been carried on annually since 1888.

At the present time snagging in the Mississippi River below the mouth of the Missouri and in the Old and Atchafalaya Rivers is performed under the St. Louis Engineer District by the snagboats *H. G. Wright* and *J. N. Macomb,* built in 1880 and 1874, respectively. The boats are of similar construction. A description of the *Macomb,* and of the general method of operation, follows:

The boat is of iron, 178 feet long and 90 feet wide over wheel guards; it has twin bows separated by an open space 12 feet wide, called a well, which extends 65 feet aft from the stems. The speed of the boat is 8½ miles per hour in water, with engines of 600 horsepower. A steel butting beam 22 feet long, 7 feet wide, and 16 inches thick spans the space between the bows near the stems at the surface of the water. The end of a snag is lifted onto this beam by means of a sweep chain, which is hung as a loop from one stem to the other, or by means of tackle hung from an A-frame support at the bow. Four steam capstans, each capable of a direct pull of 35 tons and a speed of 30 feet per minute, supply the power for operating the appliances and for pulling the snag to its inclined position upon the beam. To aid in this, there is added a powerful purchase fitted with a cast-iron drum, winding a "Samson" chain with links made of iron 2¼ inches in diameter. This chain is tested at 75 tons, but is often broken in the work to which it is subjected. The combined pulling power of this purchase and the four capstans is 215 tons; but this is quite insignificant when compared with the work accomplished by butting, using the whole boat as a hammer of 800-tons weight. The snag being drawn upon the beam and an after roller, which also bridges the well, it is sawed into logs by powerful steam saws, one working over the roller and one over the forward edge of the butting beam. The after saw reduces the body of the tree to logs that are dropped anywhere, as they will float away, but the large root, matted with clay and gravel and sometimes 20 feet in diameter by 3 or 4 feet thick, is carefully dropped into some deep hole or a place well out of the channel of the river.

In cases of great difficulty the hydraulic jet and dynamite are occasionally employed as auxiliaries in loosening the root of the snag.

For breaking up submerged wrecks or other similar obstructions, a steel hook is mounted upon an A-frame with feet hinged upon the twin bows. This hook is lowered and dragged over the obstruction, acting as a plow. There is also used in a similar manner a large steel grapnel, attached to the "Samson" chain, with from three to five flukes similar to those of an anchor. In destroying wrecks, the various pulling and lifting devices are used. Occasional work requires the services of a diver, and the use of explosives.

Drift heaps accumulating at bridge piers and similar obstructions are destroyed by pulling out key pieces or the use of explosives.

Large trees near caving banks are cut to prevent their becoming snags.

The matted masses of trees upon caving banks are usually removed by the snagboats as a preliminary to bank revetment at the particular point, but in stretches not to be revetted, these masses are left until they menace navigation.

The snagboat crew consists of from 40 to 45 officers and men. Schedules of patrol are arranged so that one boat is in the upper while the other is in the lower part of the river.

The snagging season generally extends from July to March, but at the present time, due to high costs and limited funds, it is not possible to operate both boats throughout the entire season.

During the full active season each boat will destroy about 1,500 to 2,000 snags, 8 to 10 drift heaps, and 5 to 8 wrecks, and will cut a number of trees near caving banks varying from a few hundred to 10,000. At present the practice of cutting trees is practically abandoned. In doing this work, the boat will traverse from 4,000 to 8,000 miles.

As a result of the consistent policy followed for many years in conducting this work, most of the old wrecks have been removed from the channel, the number of snags is gradually decreasing and few vessels are now wrecked through striking obstructions in the channel.

Decorations Awarded by War Department

The tabluation shows the decorations awarded by the War Deparment to officers and enlisted men of the United States Army to January 31, 1921, for service in the World War:

	Commissioned	Enlisted	Total	Per cent awarded Com.	Per cent awarded Enl.
Medal of Honor	20	53	73	27	73
Distinguished Service Cross.	1,562	3,619	5,181	30	70
Oak Leaf Cluster	76	16	92	83	17
Distinguished Service Medal.	703	2	705	99.7	.3
Total -------	2,361	3,690	6,051*	39	61

*Does not include Navy and Marine personnel attached to the Army.
—*Office of The Adjutant General.*

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Army Ponton Equipage Meets an Emergency of Peace Time

(Continued from Page 269)

entire length of the bridge. Wooden hand-rails were built. Also provisions were made for installation of an electric lighting system.

The bridge was built by the method of successive pontons, using saddle boats for the first and last boats. The Engineer detachment consisted of one officer and twelve men. The city furnished twenty-five laborers. Work was begun about 8 a. m. and, except for two bays, the bridge was completed by 6 p. m.

During the construction the river had risen 4 feet and it was predicted that it would rise higher. This rise in the river necessitated the lifting of the approach bay off the saddle boat. The river continued to rise and finally reached the stage of 18.6 feet, equivalent to a difference in stage of 14.0 feet.

The debris coming down the river fouled the anchors in spite of all efforts to prevent it. This forced the cutting loose of ten of the thirteen anchors in the bridge. To replace the loss of these anchors two hemp ropes were placed across the river taking turns around the mooring post and making the ends fast on shore. Later a 1-inch steel cable was added. This was undoubtedly instrumental in saving the bridge, for when work on realigning the bridge was begun there was a sag of about 30 feet in it. The bridge was straightened out by recasting the upstream anchors and moving the bridge into place by parts.

The current of the river during the first part of the work varied from 4 to 6 miles per hour. During the realigning it was estimated to be about 10 miles per hour.

A fluctuation from 6 to 10 feet in the stage of the river is a common occurrence. A rise of 6 feet will begin to overflow the banks. Because of these facts the ordinary

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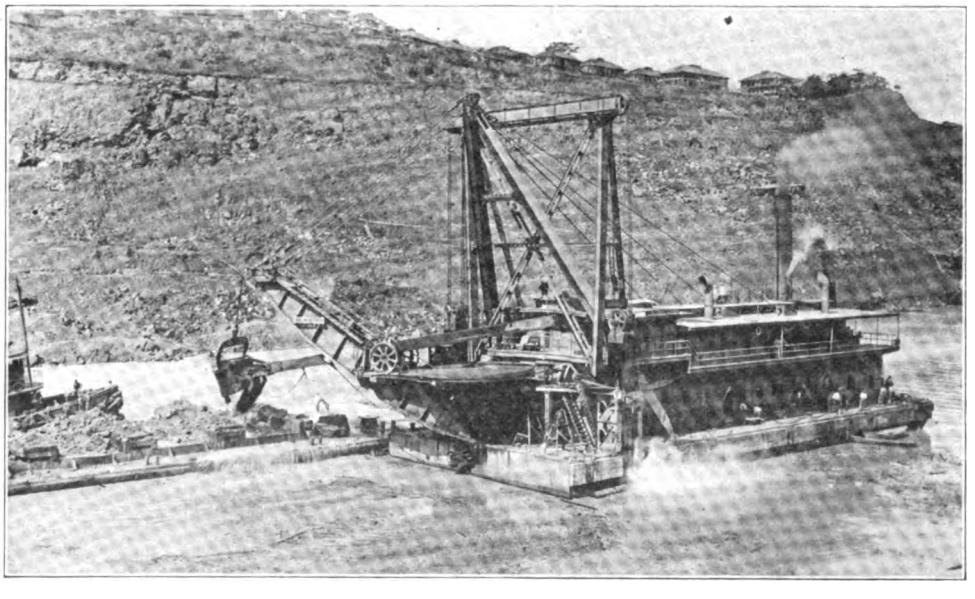
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construction of the approach bay was found impracticable for the following reasons:

1. The inclination of the approach bay is excessive and tends to submerge the saddle boat and pull the flooring system off the abutment sill.

2. The bridge approach being in a cut soon is under water and the bridge therefore becomes inaccessible.

To obviate these difficulties it was recommended that adjustable shore trestles be used permitting raising and lowering of abutment sill, and that the approach be maintained by the use of suitable horse-trestles and sectional flooring.

Also in view of the difficulty encountered by the fouling of anchors, it was decided to do away with the up-



How some of the boats looked after the flood

stream anchors. A steel cable was stretched across the river about 150.0 feet upstream and high enough to be clear of debris at high waters. To this the boats were tied by ½-inch steel rope.

The bridge thus constructed gave very satisfactory results, continuing in use as long as roads to it were open.

However, misfortune seemed to be pursuing the city and on March 28, 1920, it was hit by a cyclone, causing considerable damage in the city and destroying the ponton bridge. The investigation tended to show that the entire bridge was blown upstream by the wind, tearing the stern mooring post off the saddle boats and two other boats in midstream. When bridge settled back into place a number of boats were submerged, some partially, some almost

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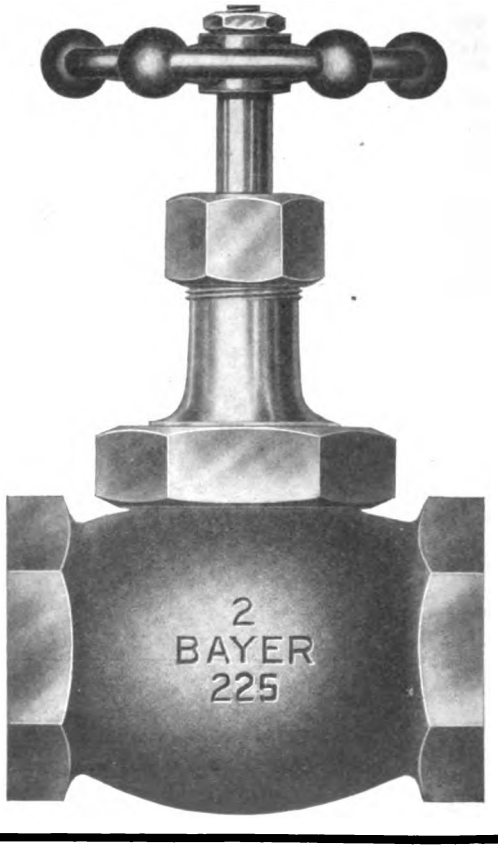
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completely. About five boats had the bow mooring post torn out. The confusion in the town made the obtaining of help impossible. Darkness, the rising river, the tremendous amount of debris, all worked for the destruction of the bridge and during the night it broke loose and went crashing down against the piers of the old bridge. A detachment of twenty men was rushed to the scene. As soon as practicable they began to salvage what boats could be located and make such repairs as were necessary; of the twenty-six boats that were in the bridge prior to the cyclone, only nine could be used in the second bridge, the



All mooring posts gone

others being too damaged to salvage. The second bridge was built in the same manner as the first and has given service since the middle of April, 1920.

It is safe to say that the emergency which confronted this community could have been met only by a ponton bridge.

Sizing Up Your Subordinates

Have you noticed how nearly like the complex modern factory your assistant is? If he has well-selected food and good digestion, you expect him to have sufficient strength. Take that as "boiler" efficiency. If he has normal muscles, joints and senses, you expect him to move quickly, steadily and accurately. Take that as "engine" efficiency. If currents of thought flow through him as he moves through the field in which he is placed, you expect these thoughts to flow to the terminals. Take that as "generator" efficiency. If he knows signs or sounds that have meaning to you, you expect him to bring his thought to you clear, full and direct. Take that as "transmission" efficiency. If you set him to a task or approve his purpose, you expect him to cut deep and clean and feed as fast as the desired finish will permit. Take that as "tool" efficiency.

With these suggestions you get the obvious similarity. More careful examination would develop a closer relation. Now, when you write a letter of recommendation or, that bugbear of administration—an efficiency report—do you test this assistant in the usual way? Do you determine his boiler, engine, generator, transmission and tool efficiencies? Do you even guess at them as by comparison with others? If you have not done so, you will next time. And suppose you do. Will you *average* them and give him an overall *average* figure that tells no more than the average of his grades at school in mathematics and clay modeling? You will not. You will multiply them just as you always multiply efficiencies of the elements in a connected series when you want to know the overall plant efficiency.

Now, when you have made this multiplication, you see why some of your men with good points don't make good. The energy from their food never reaches the job. If you should average their ratings, the high peaks would fill up

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the low places. Get the facts, get the factors, get the product, and you will see why a plugger brings home the goods. Perhaps you will see then why persistence (of a man with a good idea) so often seems to you to be obstinacy (in a man with a poor one). When effort and accuracy are involved, give each a rate and remember that a blind man can not see, no matter how hard he tries. Rate him zero on sight and rate him high on what he has. The product will show the true state of affairs. Then when you report on a man, report on *what he does*—in terms of what he might be *expected to do*. The boss can multiply *the factors that interest him* almost as well as you can, and *he can pick them out of your report* if you put them in.—R. M. Copeland, Capt. C. of E.

How far will wages fall?

The outstanding feature of the business situation at present, as contrasted with that during November and December, is the note of optimism that comes from the New England and Middle Atlantic manufacturing centers with regard to a revival of business in the early spring. Coupled with this is the feeling that the sooner contemplated wage reductions are made the sooner will industry hit the road to normality. The wage cuts of 22½ per cent in the cotton and wool industries have been followed by the opening of a number of mills in Maine, Massachusetts, and in the South.

At the moment the situation is a double deadlock between the consumer and retailer on the one hand and the wage-earner and the wage-payer on the other. The retailer having previously filled his shelves with high-priced goods, was loath to take a loss commensurate with changed market conditions, even though this would result in clearing his shelves. His maintenance of high prices, certainly over the holiday season, had an undoubted influence in the so-called consumers' strike.

The retailers are now, in many instances, adding to their stocks by purchases at present low prices, and putting all their goods on the market at a price somewhere between the former high and the present low. They are in this manner averaging their loss and pursuing the policy of the Swede, who, looking at the stream, averred that he could not cross it in one jump, but that he could in two.

The other deadlock is being met by wage cuts. These wage reductions range from 10 per cent to considerably higher. In the morocco industry in Delaware, cuts of as high as 50 per cent have been made, while in many cases the reductions are about in proportion to the decline in the cost of living; in others, they are much greater. What the wage-earner as a consumer is gaining in his struggle with the retailer, he is losing in his struggle with the wage-payer. This is about what is happening in the deadlock which the writer has indicated.

How far will wages fall? Will wages recede to the pre-war level? This is the question on everybody's tongue. Labor has generally shown a willingness to accept lower wages with the prospect of continued employment.

An English statistician seeking information on the same question, recently made a study of the movement of wages in the building trades. The building industry was chosen for study because it has existed with almost the same occupational subdivisions over a long period of time. The records of the prices paid for labor in the construction and repair of government buildings, such as Westminster Ab-



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bey, Westminster Palace, the Tower of London, Hampton

Daily rates of wages, shillings and pence, in building trades, 1252-1920.

Period	Carpenters Masons Bricklayers and Joiners	Plumbers	Plasterers	Laborers
	s d	s d	s d	s d
1252	0 2¾			0 1¾
1285	0 4 ot 0 6		0 5	0 2 to 0 3
1292	0 5 to 0 6	0 4	0 6	0 2 to 0 3
1323-5	0 4 to 4 5	0 8	0 4 to 0 5	0 3 to 0 3½
1361-2	0 5 to 0 6		0 5 to 0 6	0 3 to 0 3½
1400	0 5 to 0 6		0 5 to 0 6	0 3 to 0 3½
1450	0 6	0 4 to 0 7		0 4
1530	0 6 to 0 8	0 8	0 7	0 4
1540	0 7 to 0 10	0 8	0 8	0 5
1558	0 8 to 1 0	0 9 to 1 0	0 9 to 1 0	0 5 to 0 9
1588	1 0	1 0	1 0	0 8
1603	1 0 to 1 4	1 0 to 1 2	1 0 to 1 4	0 8 to 0 10
1612-3	1 3 to 2 0	1 4 to 1 6	1 0 to 1 6	1 0
1660	2 0 to 2 6	2 2 to 2 6	2 4 to 2 6	1 4 to 1 6
1686	2 6 to 2 8	2 8	2 8	1 8 to 2 0
1699	2 6	2 6	2 6	1 8
1778	2 6 to 3 0	3 0	3 0	1 8 to 1 10
1797	3 4 to 3 85	3 0	3 6	2 3
1803	4 9 to 5 07	4 0	4 4 to 4 6	2 5
1826-47	5 0	5 0	5 0	3 0
1861-65	5 10	5 10	5 10	3 6½
1872-3	7 1	7 1	7 1	4 4½
1873-78	7 6	7 6	7 6	4 9½
1914	9 7	10 0	9 7	6 8
1920	L 1 3 4	1 L 3s. 7d.	1 L 3s. 4d.	L 10s. 10d.

Court, and Buckingham Palace exist for about 700 years back. These records are preserved in the Public Record office, the Exchequer, the Audit Office, and the Office of Works of all sums paid out by the Royal purse. The results of this study are shown as above.

In the course of the study the rates paid to bricklayers, masons, carpenters, and joiners were found to vary only slightly and were, therefore, grouped together. Plumbers appear to have received better rates throughout than most of the allied trades. Plasterers were also paid quite well, particularly during medieval times, when their work was almost that of an artist. Prior to 1800, wage rates showed a wide range, due to variations in skill; sometimes a difference of as much as 40 per cent in the rate paid is indicated between the highest and lowest paid craftsman, same trade.

The rates indicated in the table show a general rise in wages with occasional recessions. These recessions have not necessarily been at the ends of war periods, but seem rather to have been contemporaneous with periods of lessened industrial activity. In other words, the law of supply and demand has been a governing factor.

But it is significant that such recessions as have taken place have not been permanent. In the long run the trend of wages is upward. Standards of living are rising continually. Men do not change over night, but, viewed conditions, economic conditions cannot lag long behind. Furthermore, with continuous advancements in industry national and individual wealth increases. Wages will tend to grow; the criterion is not money wages, but purchasing power.

Prices to-day as compared with those prevailing in previous centuries show marked increases. Higher prices for goods are reflected in high prices for labor, and higher prices for labor inevitably mean higher production costs, and so higher prices. It is a circle which can not be broken.

We may, therefore, say that while reductions in wages that are now taking place are tending toward industrial stability and are beneficial so long as they help to pull industry out of the mire of inactivity, neither wages nor prices will recede to their pre-war levels.—*100 Per Cent.*

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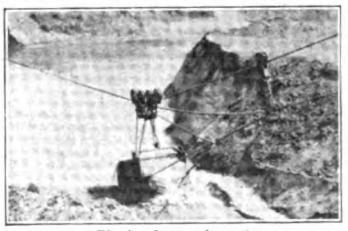
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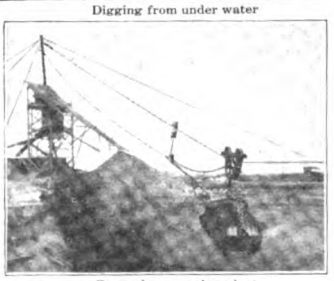
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Experiences in pile driving

Col. Charles R. Gow, of Boston, Mass., recently discussed his experiences in pile driving before the Boston Society of Engineers. The Back Bay marshes near Boston are reclaimed flats, having a gravel filling 15 to 18 feet deep overlying the same thickness of mud, with blue clay underneath, into which pile must be driven in order to obtain a satisfactory bearing. The presence of the mud layer makes it necessary for piling to penetrate the underlying clay in order to obtain a satisfactory bearing. Investigation has shown that a large proportion of piles driven failed to penetrate the top gravel stratum, owing to the gathering of stones and pebbles ahead of the pile tip preventing further penetration. Some piles became broomed and mushroomed; some failed by diagonal shear or telescoping; others had their lower portions broken off and deflected laterally almost at right angles. Sharpening the tips of piles was an aid in overcoming this difficulty.

Attempts to drive wooden piles through stone riprap usually resulted in brooming the pile into a mass of pulp.

High frictional resistance in upper strata often results in stopping piles before good bottom is reached; the result is an apparently stable foundation, which later yields slowly under pressure and causes settlement. Piling driven in sandy or gravelly soil usually has better resistance than where the supporting medium is of clay, as the latter is apt to be stiffer when first encountered than at a greater depth. The application of the *Engineering News* formula to piling driven in clay in the vicinity of Boston does not give satisfactory results. Penetration at the end of the driving is frequently much greater than it is after the pile is permited to remain undisturbed for a few hours. The closing in of the clay around the pile, filling the depressions and crevices, greatly increases resistance to further penetration; for example, one 40-foot pile when driven to grade gave a 10-inch penetration, indicating a safe carrying capacity of only 4 tons; a test load, applied a considerable time after the driving, showed no settlement at 12 tons and only a slight settlement at 18 tons; so a 12-ton load was adopted. In another case, piles which gave values of not more than 2 to 3 tons by application of *Engineering News* formula, subsequently supported test loads of 10 to 12 tons without appreciable settlement. In another case, penetration into soft clay for last blows of 5 to 7 inches was reduced to ⅛ to ¾ inches after the piles had set for 24 hours. Piling subject to vibratory forces will often yield when a static load of the same amount produces no effect; deeper penetration and lighter loading are therefore necessary when vibratory forces are present.

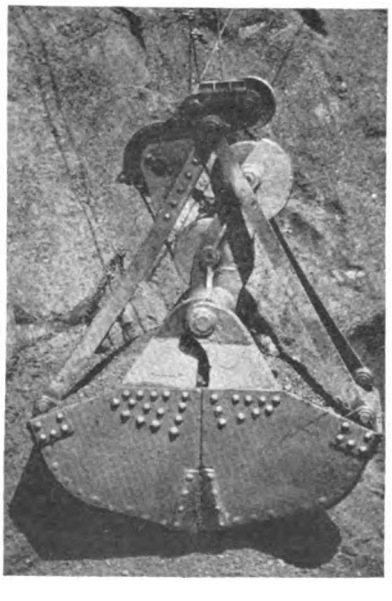
Splicing of piles may be done by the following methods: First, ordinary carpenter's splice, where the ends are halved into one another and bolted; second, metal sleeve; third, butt end spliced with outside cleats like splints; fourth, doweling the two ends together. The last method is satisfactory when deflection of the pile is improbable; in other cases the splice must be as strong as the balance of the pile.

To increase the bearing power of piling in soft material, laging the pile vertically with 2 by 4 or 4 by 6 strips is often resorted to an order to increase the surface exposed to frictional contact.

When piles must be driven through water in locations where the bottom is difficult to penetrate, they may be rendered stable by depositing riprap around them; in some cases it is desirable to remove the hard material by dredging, and to back fill the space after the piles have been driven.—*Eng. and Cont.*

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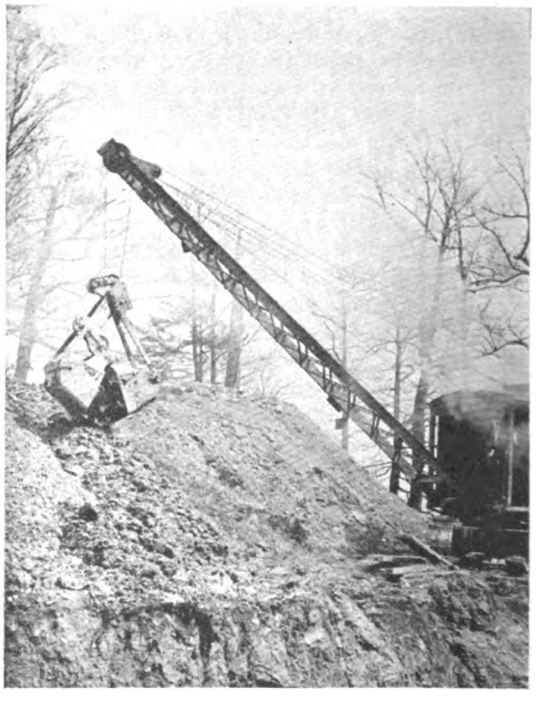
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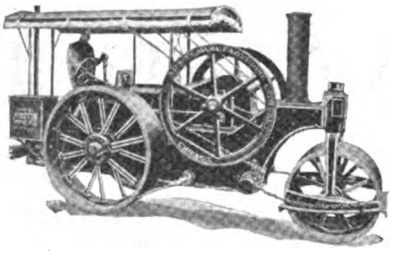
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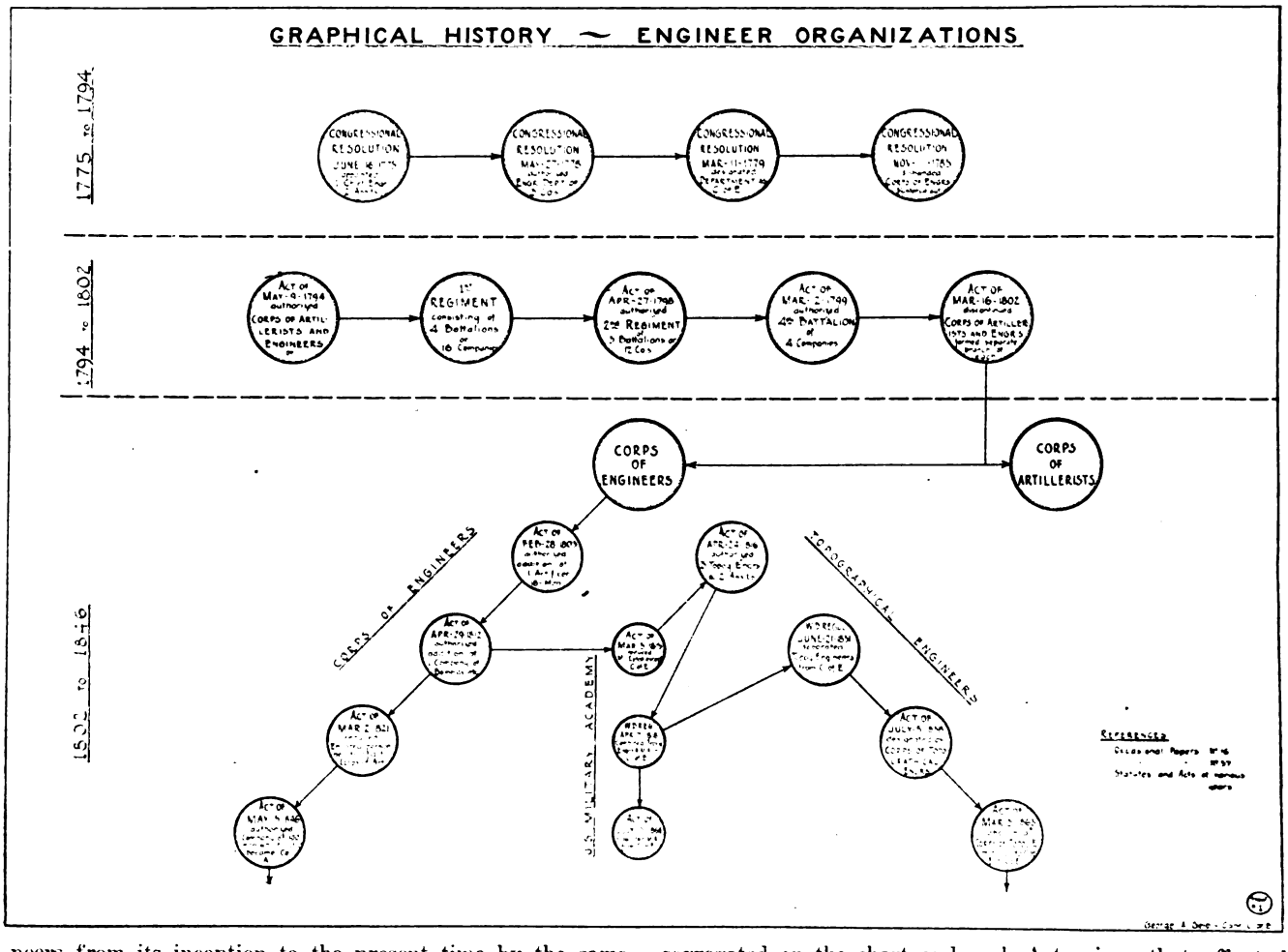
A Graphical History of Engineer Organizations

By

Geo A. Geib

Captain, Corps of Engineers

THE use of graphics in the presentation of facts, statistics, production and various other items has been so readily accepted as the most efficient method of analyzation that the writer has endeavored to present the growth, expansion and history of the Corps of Engineers from its inception to the present time by the same means.

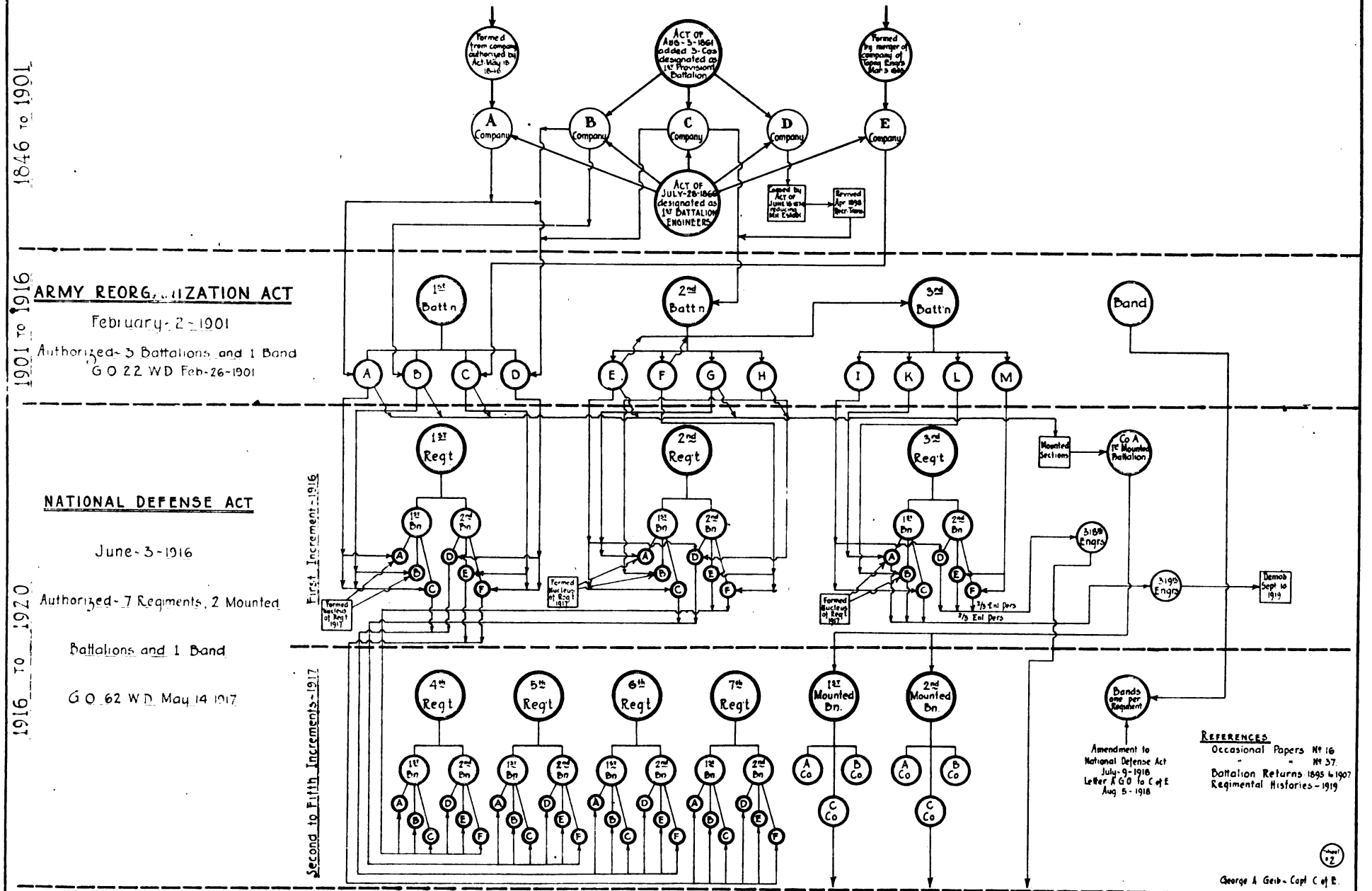


To go into the detail of the formation of each individual company would be a difficult task on account of the incomplete records of such organizations, so an attempt has been made merely to show the formation of regiments and battalions as a whole, and the "flow" of personnel since 1901.

It will be noticed that the formation of the Corps of Engineers dates back to 1802, when, by the Act of March 16, separate Corps were formed of Artillerists and Engineers. From that period on, the Corps of Engineers, Corps of Topographical Engineers, and U. S. Military Academy were practically one, but as various acts were passed to govern the status of Topographical Engineers and the Military Academy the three departments were segregated on the chart and such Acts given that affected their status. On sheet No. 1 it will be noted that the Act of May 15, 1846, authorized one company of 100 men. This was carried along to sheet No. 2 for the sake of indicating the origin of "A" Company in the First Provisional Battalion, as the Act of August 3, 1861, authorized only three companies. The same applies to the origin of "E" Company, which was formerly the Corps of Topographical Engineers. The actual beginning of the First Provisional Battalion then really began when "A" Company

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GRAPHICAL HISTORY ~ ENGINEER ORGANIZATIONS



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was first formed under Act of May 15, 1846, hence the period on sheet No. 2 is designated 1846 to 1901.

Upon the formation of the three battalions under the Act of February 2, 1901, the companies of the First Battalion were organized in widely scattered localities and acted independently. However, the 2nd and 3rd Battalion companies were organized later by transfers to headquarters and then distributed to the various companies, which is shown by the flow emanating from headquarters to company.

The "flow" of personnel in the subsequent expansion of the Corps under the National Defense Act is shown from companies to companies, but there is no doubt that such flow might have been transmitted through regimental headquarters instead of as shown. The equal distribution of the personnel is assumed to have been the process of the formation and the quota assigned to each company acting as a nucleus; for instance, in the case of Companies "E" and "F" of the Second Regiment forming the Fourth Regiment.

The 1920 status of all engineer organizations is also given for reference purposes only, and which will be carried out along the same lines as soon as the authorizations of proposed units are received.

The Library references are—

"History of Engineer Troops, U. S. Army," Occasional Papers 27.

By Maj. Rees and Lieut. Youngberg.

"Historical Sketch of the Corps of Engineers," Occasional Papers 16.

By Brig. Gen. A. A. Humphreys.

Monthly Returns and Muster Rosters of Various Companies, 1895-1907.

Regimental Histories, 1919.

Statutes and Acts at Large.

CHIEFS OF THE CORPS OF ENGINEERS OF THE ARMIES OF THE UNITED STATES

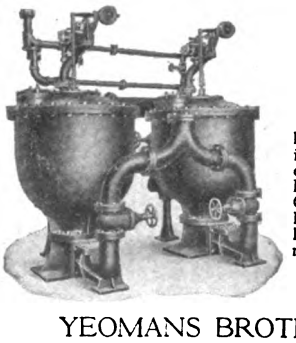
Name and Rank	*Title*	*Assumed Duties*	*State*
Richard Gridley, Col.	Chief Engineer (Grand Army)	June, 1775	Mass.
Rufus Putnam, Col.	Chief Engineer (Grand Army)	Aug. 5, 1776	Mass.
Louis Le Béque Du Portail, Col.	Chief Engineer	July 22, 1777	France
Louis Le Béque Du Portail, Brig. Gen.	Chief Engineer	Nov. 17, 1777	France
Louis Le Béque Du Portail Maj. Gen.	Chief Engineer	Nov. 16, 1781	France
Stephen Rochenfontaine, Lt. Col.	Commander Corps of Artillerists and Engineers	Feb. 26, 1795	France
Henry Burbeck, Lt. Col.	Commander First Regiment Corps of Artillerists and Engineers	May 7, 1798	Mass.
Jonathan Williams, Lt. Col.	Principal Engineer	July 8, 1802	Penna.
Jonathan Williams, Lt. Col.	Chief Engineer	Apr. 19, 1805	Penna.
Jonathan Williams, Col.	Chief Engineer	Feb. 23, 1808	Penna.
Joseph G. Swift, Col.	Chief Engineer	July 31, 1812	Mass.
Walker K. Armistead, Col.	Chief Engineer	Nov. 12, 1818	Va.
Alexander Macomb, Col.	Chief Engineer	June 1, 1821	N. Y.
Charles Gratiot, Col.	Chief Engineer	May 28, 1828	Mo. Ter.
Joseph G. Totten, Col.	Chief Engineer	Dec. 7, 1838	Conn.
Joseph G. Totten, Brig. Gen.	Chief Engineer	Mar. 3, 1863	Conn.
Richard Delafield, Brig. Gen.	Chief Engineer	Apr. 22, 1864	N. Y.
Richard Delafield, Brig. Gen.	Chief of Engineers	July 13, 1866	N. Y.
Andrew A. Humphreys, Brig. Gen.	Chief of Engineers	Aug. 8, 1866	Penna.
Horatio G. Wright, Brig. Gen.	Chief of Engineers	July 3, 1879	Conn.
John Newton, Brig. Gen.	Chief of Engineers	Mar. 13, 1884	Va.
James C. Duane, Brig. Gen.	Chief of Engineers	Oct. 14, 1886	N. Y.
Thos. Lincoln Casey, Brig. Gen.	Chief of Engineers	July 23, 1888	N. Y.
Wm. P. Craighill, Brig. Gen.	Chief of Engineers	May 11, 1895	Va.
John M. Wilson, Brig. Gen.	Chief of Engineers	Feb. 8, 1897	D. C.
Henry M. Robert, Brig. Gen.	Chief of Engineers. Did not assume command of the Corps of Engineers and charge of the Engineer Department	Apr. 30, 1901	S. C., Ohio
John W. Barlow, Brig. Gen.	Chief of Engineers. Did not assume command of the Corps of Engineers and charge of the Engineer Department	May 2, 1901	N. Y.
George L. Gillespie, Brig. Gen.	Chief of Engineers	May 3, 1901	Tenn.
Alexander Mackenzie, Brig. Gen.	Chief of Engineers	Jan. 23, 1904	Wis., Ill.
William L. Marshall, Brig. Gen.	Chief of Engineers	July 8, 1908	Mo.
William H. Bixby, Brig. Gen.	Chief of Engineers	June 13, 1910	Mass.
William T. Rossell, Brig. Gen.	Chief of Engineers	Aug. 12, 1913	Ala., N. J.
Dan C. Kingman, Brig. Gen.	Chief of Engineers	Oct. 12, 1913	N. H.
William M. Black, Brig. Gen.	Chief of Engineers	Mar. 24, 1916	Pa.
Lansing H. Beach, Maj. Gen.	Chief of Engineers	Feb. 10, 1920	Iowa

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The Plattsburg Camp Idea Revived

Regulations for the Citizens' Military Training Camps, as definitely authorized by Sec. 47d of the National Defense Act, have now been issued by the War Department. To the uninitiated, the regulations are quite complicated, but may be summarized about as follows:

(*a*) There will be three types of camps—Red, White, and Blue.

(*b*) The Red Camp is for training in the duties of a private. Any able-bodied citizen, from 16 to 35, of average intelligence can secure admission.

(*c*) The White Camp is for training in the duties of a non-commissioned officer. The camp is to be attended by citizens between 19 and 35 in the following order of preference:

(1) Enlisted men of the Organized Reserves.

(2) Civilian graduates of the Red camp, or men who have had equivalent military training.

(*d*) The Blue Camp is for training in the duties of a junior officer. The camp is to be attended by citizens from 21 to 35 years of age who have the required education, technical and general, and the qualifications requisite for a commission in the Officers' Reserve Corps. This is the course which will probably be of direct personal interest to most readers of THE MILITARY ENGINEER.

The Blue student body will consist of (1st) a quota of warrant and non-commissioned officers of the Regular Army; (2nd) selected members of the National Guard for whose payment funds are available; (3d) members of the Organized Reserve for whose payment funds are available; (4th) if any vacancies exist, a quota of selected civilians. Members of the National Guard and Organized Reserves for whose payment funds are not available may attend as civilians.

The basic instruction in the Blue Camps, applicable to all arms, includes Administration, Manual of Guard Duty, Military Law, Field Service Regulations, Pistol Marksmanship, Map Reading, Sanitation and Personal Hygiene, and Physical Training.

In addition to basic instruction, the Engineer Sections of the Blue Camps will receive instruction in Engineer Equipment, Military Engineering, Engineer Reconnaissance, Technique of Engineer Weapons, and Tactics and Troop Leading. Every endeavor will be made to make the courses interesting as well as instructive.

All students receive transportation to and from camp, subsistence, clothing, and equipment. Members of the Regular Army receive their ordinary pay. Men attending as National Guardsmen or members of the Organized Reserves receive the usual active-duty pay. Civilians are not paid. On the conclusion of a camp, a student who has satisfactorily completed the course receives a certificate that he has the requisite military training for appointment as an officer in the Officers' Reserve Corps.

The training camps will be of one month's duration each. Full information on the subject can be obtained from commanding generals of corps areas, under whose command the various camps are to be.

For this summer the War Department desires to initiate the movement by special emphasis on the Red Camps. It is expected that these will appeal to boys and young men of 16 to 19 years of age. Through them and through their parents the Army hopes to get in close contact with the people and to demonstrate that military training and military environment will develop the young men physically, mentally, and morally. To this end special attention will be paid to medical supervision, to the character of food served, to the physical training, and to the recreation and amusements provided.

In general terms the programs for the Red Camps provide for basic training in infantry and demonstrations covering, in a general way, the tactics and technique of the other combat branches of the Army. The purpose of these demonstrations is to permit of the candidates gaining a conception of the duties and functions of the various branches in order that, should they enlist in the Organized Reserve or take further military training at the White and Blue Camps, they will have sufficient knowledge of the service to permit of making an intelligent decision as to the branch in which to serve.

White and Blue Camps may be held if a sufficient demand should develop for the more advanced instruction, but if such camps are conducted they will be on a rather small scale and will be frankly experimental in nature, with a view to gaining experience for future years.

It will be noted that no provision is made for the training of Reserve Officers in these camps. Nor will any Reserve Officers' Training Camps be established during the summer of 1921, due to lack of funds and other considerations. A limited number of experienced Reserve Officers will probably be needed as instructors at the Red, White, and Blue camps. No Reserve Officer will be called for such duty without his consent.

Experience as an instructor in one of these camps will be of the greatest benefit to the Reserve Officers who undertake it.

Engineer Reserve Officers who desire detail as instructors at these camps should make application to the commander of the corps area in which they reside. Those detailed will be on active duty status and will receive the pay and allowances of their grade.

Following is a list of the corps areas:

Number	Headquarters	Territory
First	Boston, Mass.	New England States.
Second	Governors Island, N. Y.	N. Y., N. J., and Del.
Third	Fort Howard, Md.	Penn., Md., Va., and D. C.
Fourth	Fort McPherson, Ga.	N. C., S. C., Ga., Fla., Tenn., Ala., Miss., and La.
Fifth	Fort Benj. Harrison, Ind.	W. Va., Ohio, Ind., and Ky.
Sixth	Fort Sheridan, Ill.	Mich., Wis., and Ill.
Seventh	Fort Crook, Nebr.	Minn., Mo., Iowa, and N. D. Neb., Kan., Ark., and S. D.
Eighth	Fort Sam Houston, Texas	Okla., Texas, Colo., N. M., and Ariz.
Ninth	The Presidio, San Francisco, Calif.	Pacific Coast and Rocky Mountain States.

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United States Field Artillery Association

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Address—

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Roads in Morocco

[The following remarks are based on an article on The Construction of Roads in the French Protectorate of Morocco, written by M. Joyant, Ingenieur en chef des Ponts et Chaussées and published in the September-October (1920) number of the "Annales des Ponts et Chaussées."—ED.]

For political reasons it was impossible for the French government to commence railway construction in Morocco prior to the World War. During the war it was equally impossible for economical reasons. On the other hand, from the inauguration of the protectorate in 1912, France was privileged to construct roads; and when trade was handicapped by the outbreak of war, it became very desirable to afford as much useful employment as possible to the natives of the protectorate.

This memoir describes road work in Morocco from 1912 to 1919. The work was subject to the following conditions, rather unusual in our road work at home, but quite possible in any future Latin-American occupation:

(a) Labor was abundant, of good muscular power, and cheap; but not highly skilled.

(b) Animal traction was available on very favorable terms.

(c) Road machinery and gasoline were scarce and very expensive.

The author of this article presents a graphic description of the work done, together with a defense of the system against criticisms evidently made by men at home. The following passage, which is translated almost literally, may recall some of the old criticisms which pioneer engineers have always had to face from wise men in an office building:

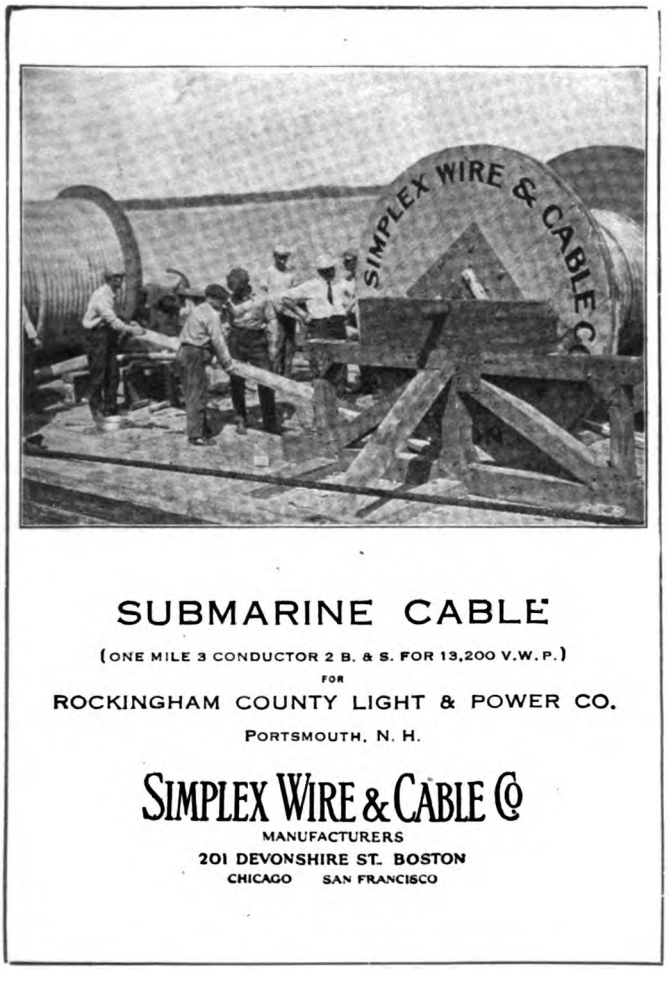
"Many proposed the construction of roads with re-enforced concrete; some, to reduce expense, proposed to build, with re-enforced concrete, only the tracks for the wheels; with a further effort of the imagination, they would have given a special shape to the wheel tracks and the wheel tires, and thus re-invented railways Certainly re-enforced concrete is an excellent material, but, in a new country, without means of transportation, and without industrial production, it is contrary to common sense to wish to use, on the construction of roads, great quantities of imported materials, like cement and iron, instead of rock taken from the ground in the vicinity."

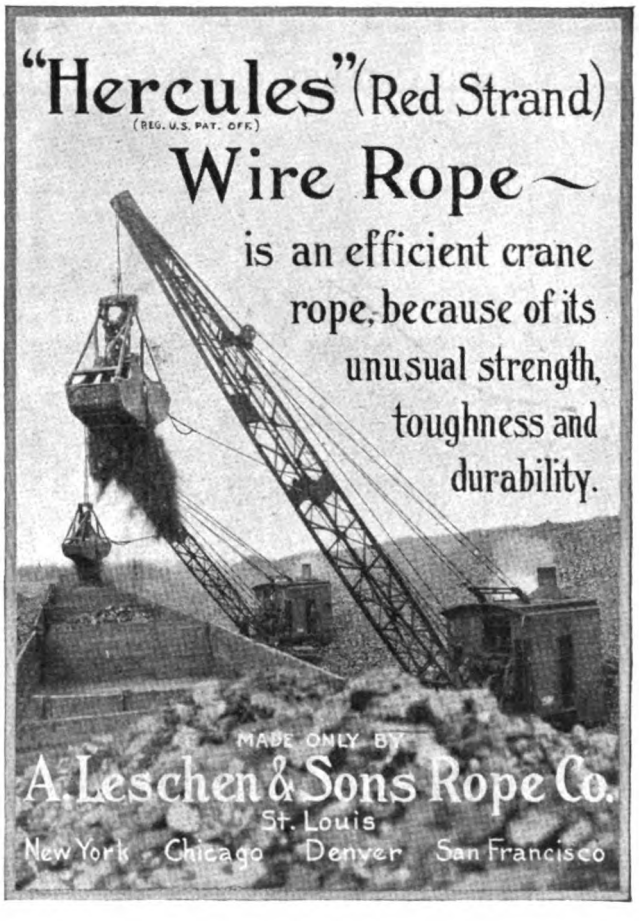
The roads were built almost exactly according to the classical French system, with which so many members of the A. E. F. are familiar. Some little discussion is even given to the selection and planting of the shade trees. In the location of the roads, it was not, however, necessary to follow ancient routes, but the routes between the rather distant towns were selected so as to pass as close as possible to existing or potential rock quarries. The author of the article makes a conclusive defense, alike against those who would have selected the routes on purely topographical grounds, and those who would have preferred a greater mileage of unpaved roadway.

The article ends with the following synopsis:

1. As soon as a simple trail becomes unsatisfactory, it is necessary to build a real road, and the classical methods of construction retain their value.

2. In locating the road, not only topography, but also the ease and rapidity of construction must be considered. The transportation of rock is the most difficult part of the work,





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and becomes prohibitive, in cost, when the quarries are more than 10 km. (6¼ miles) from the scene of the work.

3. The construction of a road system can advantageously precede the building of a railroad (except in regions not provided with rock), when railroad work is postponed for political or economic reasons. But a road will not long be sufficient for the needs of traffic along the principal arteries of a country.

Rubber—Its Growth, Protection and Preparation

The Motor Transport Training School at Camp Holabird, Maryland, has issued a lecture on Rubber compiled by Mr. A. J. Hopkins, from which the following is extracted:

The elastic properties of rubber were early known to the natives of the jungles, but it was only after the discovery by Charles Goodyear, an American, in the fore part of the nineteenth century, of the secret of rubber vulcanizing, that rubber began to play an important part in the affairs of civilization. To-day there is scarcely an article in the world more universally used than rubber.

Early attempts to use it gave little result, because of the fact that rubber melted in summer and stiffened like stone in winter. The rubber industry was about to pass away when Charles Goodyear discovered that crude rubber mixed with certain chemical ingredients, the chief of which is sulphur, and subjected to a certain degree of heat, became pliable and unaffected by changes in temperature. This discovery was one of the most important of modern times and deserves to rank with the discovery of electricity, the invention of printing, gunpowder, and other great benefits to mankind that have advanced civilization.

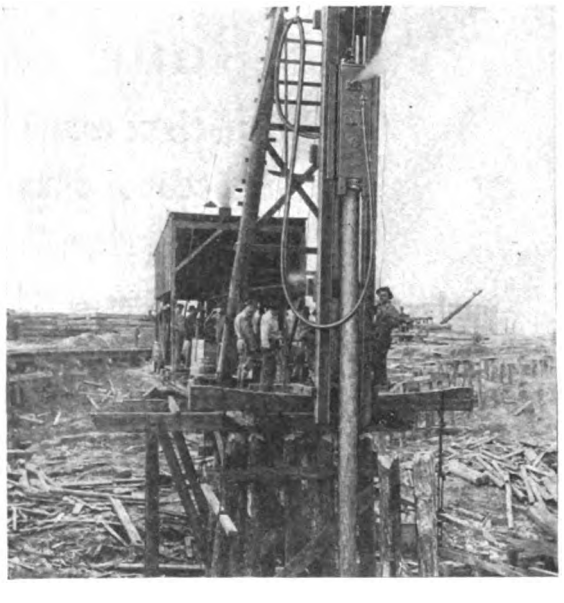
Crude rubber is gathered from certain species of trees, shrubs, vines, and roots; it is not the sap of the tree, but a free chemical compound contained in the sap. Upon tapping the tree a milky fluid issues forth at the rate of about three-fourths of an ordinary teacupful at each tapping. This fluid is called latex. It is slightly alkaline and contains 58 per cent of water and 35 per cent of rubber, with traces of sugar and mineral salts. After straining and adding a weak solution of acetic acid to the latex, the rubber, a white, tough, elastic mass, coagulates and floats, when it is removed and washed and dried in long, narrow sheets called crepe. It is sometimes smoked by a process somewhat similar to the smoking of hams after being rolled into thin sheets. In 1918, the total rubber production was 296,579 tons, of which 80 per cent was cultivated and 20 per cent wild.

Cultivated rubber is obtained from the Strait settlements, southern India, Ceylon, Malay Peninsula, and Indo-China. Wild rubber comes mostly from South America and Central Africa, in a belt about ten degrees north and south of the equator. The most important wild rubbers are the Baras and Castillons of the Amazon region.

Errata: The Vicksburg Campaign

On Page 190, first column, last paragraph, "There were more below" should read "There were *none* below." Page 192, second column, third paragraph, insert "now" after McClernand at beginning of paragraph. Page 196, second column, fourth paragraph, "Capt. Fred Irvine" should be "Capt. Fred. Prime." Page 271, first column, seventh and eighth lines, should read "and notified McClernand that he could use McArthur's Division, then on the way up from Warrenton."

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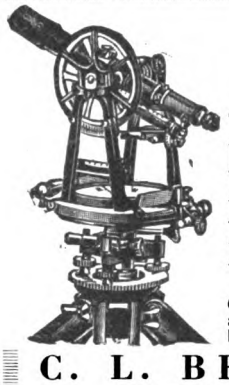


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Methods of Providing Mechanical Protection for Piles

It has long been recognized that creosoting, while valuable in preventing decay and deterring marine borers, is not a long-lived preventative of damage by the latter in infested waters. Various methods of affording mechanical protection to piles are presented in an appendix to the annual report of the Committee on Wood Preservation, Amer. Ry. Assn. Bul. 233.

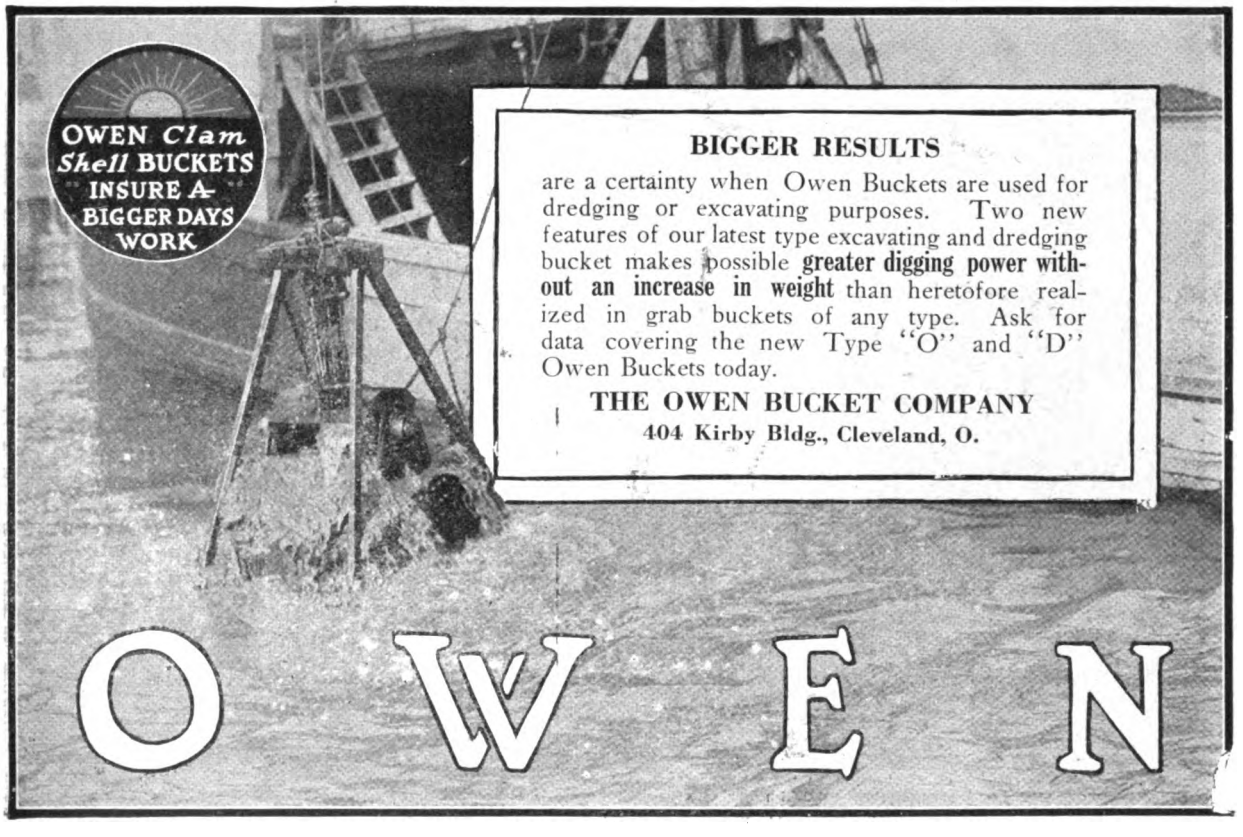
Cast-iron Cases have been used for many years on the coast of the Gulf of Mexico. The cast-iron sections are made in halves, to be placed and bolted together after the piles are driven and capped. As the castings of each section are bolted together, the completed casing is lowered to the mud line by the addition of other sections, if necessary, and forced into the mud. The space between casing and pile is then filled with sand and capped with cement mortar to prevent the washing out of the sand. The casing must go far enough into the mud to insure a permanent seal to retain the sand filling. As long as the casing remains intact the protection is complete. Cast iron corrodes slowly, and with heavy casings protection has been afforded by this method for 30 years in several instances. The present high cost of cast iron is the chief objection to the method.

Vitrified Pipe Cases can be used in a similar fashion when not exposed to wave action nor the pounding of drift. They have been used extensively along the Gulf and Pacific coasts. The pipe sections in one piece are placed over the pile before it is capped. The sections are cemented together, lowered into the mud, and sealed with cement mortar cases. Any serious defects are shown by escaping sand, and broken sections can be replaced by sections made in halves and joined together by special lugs, copper wire, or treated wooden plugs. Annual inspections have been found sufficient, as the borers are not able to make trouble-some headway even though breaks in the casings occur in the intervals. The weakness of the casing is the chief objection to the method.

Reinforced Concrete Cases are less fragile than vitrified pipe and less expensive than cast iron. The cases can be made in one piece for placing before the piles are capped, or in halves for placing at any time after the piles are driven. The halves may be locked by leaving reinforcing wires exposed in each half to be twisted to the wires of the other half and covered with cement mortar. In these cases the concrete covering of the reinforcement is usually thin, and experience has not fully developed the thickness necessary to insure the reinforcement against corrosion. The lack of extended tests in service is the chief objection to this method.

Concrete Jackets Cast in Place have been used lately in the harbor of Charleston, S. C., where the teredo, which is less active than in the waters of the Gulf, is successfully controlled by careful creosoting. The limnoria, however, is very active, cutting off the piles near the low-water line, but rarely working dangerously on treated piles at depths greater than 2 feet below low water. Under these conditions, protection from 3 feet below low water to 4 feet above high water is satisfactory, and for this purpose the jackets have been used. They have been applied as follows:

Six-penny nails were driven into the piles 6 inches apart in rings 8 inches apart. The nails projected 3 inches and the rings extended the length desired for the jacket. No. 10 gage iron wire, for reinforcement, was twisted around the nails and stretched longitudinally and laterally, at about 1½ inches from the pile. The forms were made by ⅛-inch wood veneering bound against the heads of the nails with wire which stretched enough to allow the mortar to cover the heads of the nails in most cases. 1:2:4 concrete, with ¾-inch stone, was used, and no great difficulty in placing it in forms 4 feet long was experienced. To keep the filling



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from falling out, bagging was placed around the bottom of the form if it did not rest in the mud. Jackets placed in 1915 have shown no signs of failure except for some breaking away of the concrete at the bottom of the jackets, believed to be due to leaking of the bagging at the time of placing the concrete. On work now going on, jackets 3 inches thick of plain concrete are being placed, using No. 24 galvanized iron for the forms. The difficulty of securing good concrete for considerable depths under water are the chief objections to this method.

Gunite coatings for wooden piles were placed in Seattle in 1919, but the committee believes that it is too early to report upon the success of the work. If the coating proves durable, it will afford a rapid and cheap means of securing the protection desired.

Nails studding the exposed surfaces were used by the Romans long ago as protection against teredo, and are still used in European waters. Effective protection does not seem to require complete covering of more than one-fourth of the exposed surface. The expense of this method is its chief objection.

Sheet Metal in the form of copper or zinc sheets have been used, and afford complete protection as long as the sheets are intact. Copper is not affected by salt water, but the zinc soon corrodes. It is suggested that some of the brands of rust resisting sheet iron will withstand the effects of sea water for considerable periods, but complete data is not available. The chief objection to the method is its expense.

Coatings of Tar, Asphalt, etc., and similar materials, either alone or in combination with fabrics of various kinds, are efficient as long as they remain intact, but they are likely to be broken by handling or the pounding of drift, etc. Unreliability is the chief objection to this method.

Bark left on piles affords protection against marine borers, and the life of untreated piles is considerably prolonged in infested waters by leaving the bark on. This protection is, however, incomplete, and it precludes other treatment, to prevent decay, etc., which are its chief disadvantages.—*Engineering and Contracting.*

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The Engineer and the English Language

"An engineer who is inarticulate," said a well-known New York engineer in speaking of the value to members of his profession of a thorough knowledge of English, "is quite as useless as one who is professionally incompetent." This is a terse and vigorous expression of a truth which all experienced engineers recognize, that the man who has not the power to give his ideas clearly to others, the man whose thoughts are locked in his brain simply because he has not the ability to communicate them, suffers under a handicap which no amount of professional knowledge can possibly overcome. The engineer is not a hermit in his profession, shut off from all intercourse with others; his work is indissolubly bound up with that of other men, and he finds himself constantly obliged to communicate with them. The men employed by an electric-light company, from the president down to the humblest clerk, are individuals each busied with his own particular task, to be sure, but each contributing toward a common end—the success of the company. and because of this common aim they are in constant communication with one another, by word of mouth, by letter. by written report. It can, then, be readily perceived that the failure on the part of any individual employee to make himself clearly understood by other employees will often affect very seriously the efficiency of the whole machine. An incomplete, indefinite, or ambiguous report from a foreman, for example, may temporarily delay the progress of an important piece of work. The more clearly and effectively the communication of ideas is carried on, the more efficiently will the common work of all be accomplished. And the employee who is best able to express himself clearly and exactly is the one who will stand the best chance, other things being equal, of advancement. The young engineer who writes the clearest, most accurate report, the foreman who can explain exactly and in a few words just what he wants done, are the men whom the superintendent is bound to notice. There is more than one instance on record of promotions which have come solely as the result of the ability to write a good report.—*Composition of Technical Papers, Prof. Homer Andrew Watt.*

Engineers in the Italian Army

The engineer officers in the Italian army either serve with engineer troops or are assigned to engineer directing offices in the different territorial army corps districts or are on detached service, such as general staff, etc.

The service with troops includes instructing troops in fortifications, road building, bridge building, all branches of military engineering, and, in addition, much of the work done by our signal corps—for example, telegraph, telephones, and wireless. The engineer officers serving with troops, command and come in constant contact with troops of their own branch of the service.

Engineer officers assigned to the various territorial army corps engineer directing offices (Direzione di genio de corpi d'armata) have charge of the work which must be done by military engineers within their corps districts. These officers come more in contact with civilian laborers, contractors, technicians, etc., than they do with the different branches of the military service. When practicable, however, engineer troops are used under the direction of the corps engineers, especially when the work to be done is of such a nature that it will be good instruction for the troops.

Military engineers are not engaged on public works necessary to the commercial or industrial life of the nation. In Italy, the government has an organized service called the Civilian Engineers (Genio civile), which is a part of the ministry of public works. The "genio civile" attends to all works necessary to the commercial and industrial life of the nation. It also looks after the improvement of rivers, harbors, canals, railways, and highways, with the following exceptions:

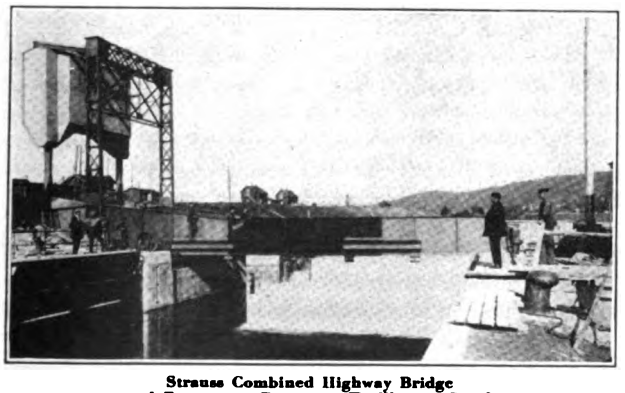
(*a*) Military highways are attended to by the territorial army corps engineer directing offices.

(*b*) In case of earthquake, flood, or other calamity, many of which occur in Italy, the engineers help in every way.

(*c*) In harbors where there are naval arsenals or bases, the army engineers have charge of all constructing work which is of a purely military or secret nature. For this purpose there is stationed at each big naval arsenal, naval yards, etc., an army engineer officer who has charge of all building work for the navy, except the work of a purely naval character, such as ship building, ship repairs, and work on armament.

The territorial army corps engineer directing offices are charged with all construction required for the military establishment, including fortifications, barracks, quarters, warehouse depots, etc. This work is usually done by civilian laborers, contractors, etc., under the direction of military engineers. However, when the work is of a secret nature, such as parts of fortifications, arsenals, etc., it is usual to have engineer troops do this sort of work.

Military engineers are not connected in any way with peace-time mapping operations. The mapping is entirely done by the Instituto Geografico, which is a branch of the war department. The Geographical Institute consists of army officers on detached service and civilians. Some of these army officers, of course, are engineers, but the officers with best qualifications are chosen for the Geographical Institute, no matter to what branch of the service they belong.



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Alaska Railroad Location Surveys Through Broad Pass

[In March, 1914, Congress authorized the President to acquire or construct, and to operate, a system of railways in Alaska. The estimated cost of the proposed system was $35,000,000. The work has been carried on under the Secretary of the Interior. Surveys were begun in the early spring of that year, and construction began in the spring of 1915. The route adopted extends from Seward to Fairbanks, approximately 470 miles, with a branch about 40 miles long to the Matanuska Coal Field. The Alaska Northern Railroad Company, a private enterprise started in 1904 and abandoned in 1909, when it had been built about 70 miles from Seward, was purchased for $1,500,000 and rehabilitated at an additional cost of about $1,800,000. The section through Broad Pass is expected to be completed this year, and will complete the project, for which the total appropriations have amounted to $52,000,000.—ED.]

The Broad Pass District on the route of the Alaskan Government Railroad lies between Indian River and Jack River, 61 miles (from mile 266 to 327), and includes the main divide, Broad Pass, between the Pacific Coast and the interior rivers, as well as the minor summit, Chulitna Pass, between the Susitana and Chulitna Rivers. Broad Pass is nearly 8 miles wide, and attains an elevation of 2,362 feet above sea level. It is flanked by high mountains to the east and west with low rolling ridges, partly timbered and partly covered with heavy arctic and reindeer moss, in the pass itself. Small lakes and muskeg swamps abound.

After crossing the Susitna (mile 264) the line follows the Indian River canon, crosses Chulitna Pass (mile 274), leaving Indian River to the east, climbs on a compensated grade, maximum 1.75 per cent, to the high benches east of the Chulitna River, and crosses Hurricane Gulch (mile 284) on a steel bridge 700 feet long and about 300 feet high, with a main arch span of 284 feet. It then descends on a 1.5 per cent grade to the Chulitna valley bottoms, crosses the East Fork of the Chulitna (mile 292), climbs on a 1.75 per cent grade to the benches between the East and Middle Forks and crosses the latter at mile 306. It then climbs on a 1 per cent grade to Broad Pass summit (mile 310), descends on a 1 per cent grade to the crossings of the Cantwell River (mile 317) and Windy Creek (mile 323), and follows Jack River to its confluence with the Nenana River at mile 327.

The working season for survey parties extends from about June 1 to October 1. A locating party usually consisted of a locating engineer, assistant engineer, transitman, topographer, levelman, draftsman, office man, two rodmen, four chainmen, one rear flagman, two cooks, ten axemen, four packers, one hunter, and a pioneer crew of six men to build trails. From Indian River (mile 266), pack transportation was employed requiring four packers with 36 horses and mules. Trails were heavy, and there were many difficult fords, so that the pack trains averaged from ten to twelve miles per day with a load of 200 pounds per animal. Each animal was fed 10 pounds of oats daily, and foraged on native grass until it was killed by the September frosts. The animals suffered from mosquitos and flies in spite of all protection that could be devised, the most effective being the application of grease around ears, eyes and nostrils, and the building of smoky fires ("smudges"), in the smoke of which the animals could stand when not grazing at night. The pack rigging consisted of saw-buck pack saddles with Humboldt rigging.

The equipment and personal effects of the party were held to a minimum. The tonnage included one 16 by 24 foot dining tent, one 14 by 16 foot cook tent, one 14 by 16 foot office tent, and a 9-foot square mosquito-proof sleeping tent of light-weight duck or silk with cloth floor and draw-string cloth door for each three men. Two sheet-iron coal stoves weighing 125 pounds each, a sibley stove for the office tent, granite-ware cooking utensils, a knock-down drafting table, and two stationary boxes carried on a single pack animal, were the principal items of camp equipment. The individual equipment of each man was limited to 50 pounds. Subsistence consisted of ordinary staples from the United States, supplemented by fresh meat, bear, caribou, mountain sheep, supplied by the hunter, fresh fish, and native blueberries in the late fall. The instrumental equipment was of the ordinary kind.

A reconnaissance by the locating engineer was made to fix the preliminary line to follow as nearly as possible the probable final location. The preliminary line was accurately run. Hand-levels and plumb-bobs were used in chaining, and all angles were doubled. The leveler took elevations at every 50-foot station and at all breaks necessary for an accurate profile. The topographer followed with a rodman, two chainmen, and an axeman, taking actual 5 or 10 foot contours and slope notes, except where sufficient information could be given by a few side notes. No attempt was made to make an elaborate topographical map of the country. As the final location usually followed the preliminary line closely, accurate local topography within a short distance of the preliminary line was all that was required.

On the located line, well-made stakes were set at 50-foot intervals, substantial hubs were set at points of curvature and at necessary instrument points on tangents. The draftsman made all maps and kept traverse books of the courses of all preliminary and the located lines. His computations were checked by the office man, who also kept complete profiles showing alignment, instrument points, grade, grade points, bench marks, side slopes, and timber and vegetation notes.

Much of the topography was very rugged, timber was frequently, and underbrush usually, rather dense, and about two-thirds of the days were rainy, so that progress was slow, though work was done daily in rain, sunshine or snow. Progress on preliminary lines and levels varied from 2,000 feet to 2 miles, and on location lines and levels from 1,500 feet to 1 mile daily.—*Engrg. News-Record.*

R. O. T. C. Enrollment

On February 1, 1921, the total number of units and student enrollment therein amongst the colleges was as follows:

		Students
101	Infantry units with	33,649
20	Field Artillery units with	5,513
19	Coast Artillery	2,696
19	Corps of Engineers	2,827
11	Cavalry	1,810
11	Signal Corps	1,307
8	Motor Transport	670
6	Air Service	253
5	Dental Corps	215
5	Medical Corps	109
3	Ordnance	354
3	Veterinary	94
211	Units; total enrollment	49,497

Accurate measurements were recently taken of 273 students under military training in one R. O. T. C. unit, and again after an interval of three months. The average results were as follows: Gain in weight, 8.84 pounds; gain in chest expansion, 1.24 inches; loss in waist measurement, 2.08 inches; gain in height, ½ inch.

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Prize Map Problem

(Continued from Page 245)

The following comments are presented in the hope of provoking discussion.

Form of Orders. In one of the selected solutions the required instructions to the engineer troops are given as a field order. It is believed that this is the correct procedure, the desirability of which can not be overemphasized. The engineer troops in a division are usually so scattered, in the field, that the officers can not be assembled to receive verbal instructions. In the haste of arranging the next day's operations the division engineer is tempted to issue separate instructions to the various fractions, with the consequence that no one knows what the other is doing, and co-operation is lost. A field order is in a form which gives the whole program in the simplest manner, and its use should be habitual. Each detached unit of the regiment should regularly send a runner to the next higher unit, at a fixed hour every evening, to receive the orders for the following day.

The distribution of the order should not be limited to engineer troops. The Chief of Staff, certain of his assistants, and the infantry and artillery brigade commanders have a vital interest in the proposed activities of the engineers, and each should receive his copy. These must, of course, be distributed by cyclists or runners furnished by engineer headquarters.

Mission. To check up the substance of the order, it is necessary to consider the mission of the engineers, for the order announces the decisions made to insure the accomplishment of the mission. The general mission of the engineers is to assist, by all means at their disposal, the other arms in the accomplishment of the intentions of the commander. It is not therefore generally necessary for the higher command to prescribe a definite mission for the engineers, but it will often specify particular tasks which it regards of especial importance. The conference which the division engineer attended was for the purpose of outlining to-morrow's operations to the staff, in order that the latter might begin immediately the arrangements for its execution. The division field order will follow, and will prescribe the details of the execution.

After learning at the conference the general plan of operations, the division engineer can decide the detailed mission of the engineers. In to-morrow's advance, the 16th Infantry Brigade will lead. It will undoubtedly be assigned some artillery to deal with any enemy strong points that may be encountered. While the infantry and machine guns will not probably need any assistance from the engineers, the artillery will probably need help in crossing some of the streams, if the enemy detachments have been at all active in demolition.

No need for assisting the cavalry is foreseen.

Bridges and Roads. It is probable that there will be considerable work in repairing or reconstructing bridges before the divisional transport can pass. The mission of the engineers in this regard must, it is important to note, be considered as that of getting the transport through, rather than of constructing the bridges as a strictly engineer task. We need not expect to find any road craters of importance, for the enemy has scarcely had time to prepare them; but he may well have left delayed action mines in bridge abutments and along the railroad.

Water. The most pressing question is water. The water-tank train at hand is of insufficient capacity to supply even the men, unless it makes two or three round



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trips per day. The division engineer must try to get more tank trucks and must also arrange for a systematic search for every possible source of local supply, for developing the supply when found, and for facilitating its distribution by placing signs, by improving approaches, and by controlling traffic blocks and jambs at such places. It is possible that the cavalry will organize its own search for water in the upper reaches of the streams, but it will be well to arrange for co-operation in this important matter.

The Railroad. It is a safe bet that the enemy has destroyed the railroad to the limit of his ability, and it can not be counted on for the delivery of material until it is repaired. It is very possible, however, that from lack of time and means this destruction has not been so thorough but that it can be speedily repaired. Every mile that the railroad can be operated south of Oceanside will be so much clear gain for the division. It is true that the telegram which the division engineer has received from the corps engineer indicates the latter's intention to see to the repair, but it is not clear that the corps engineer is in a position to undertake the work to-morrow. The division engineer can not dismiss the subject with the thought that it is not his business to repair the railroad. It is his business to assist his commander in every possible way. He should call up the corps engineer, and if the latter has not the work immediately in hand, arrange for its undertaking with divisional personnel. In any case, the line will be thoroughly examined by an officer or competent master sergeant.

The Engineer Train. The decision of the commander to organize a defensive position, if superior enemy forces are encountered, requires that the entrenching tools and material in the engineer train be ready for prompt issue. Wagons carrying this material will not, therefore, be available for any other use.

Marking Roads. In addition to correcting the road maps, arrangements must be made for marking roads and places so that messengers and troops can quickly and easily find the way. The main highway needs no marking, but reliable sign posts should be placed on the cross-roads connecting with the interior highway, which may become of supreme importance to the division; and signs should be placed to show plainly the names of towns, etc. As the tanks are coming up, warning signs should be placed at bridges which they, or other extra-heavy vehicles, cannot safely pass.

Summary. The detailed mission of the engineers includes:

(a) Preparation of any necessary stream crossings for the artillery with the leading brigade, with such promptness that the brigade will not lose its artillery support.

(b) Repair of any bridges that have been destroyed, or the substitution of emergency crossings. The handling of traffic at these and other critical points until it can be taken over by the military police.

(c) An organized search for delayed-action mines wherever they are likely to be found.

(d) An organized search for all sources of water, its prompt development where found and the provision of facilities for its distribution.

(e) A thorough examination of the railroad and, if so indicated after conference with the corps engineer, its repair as far south as possible.

(f) The provision of entrenching tools and material promptly when needed.

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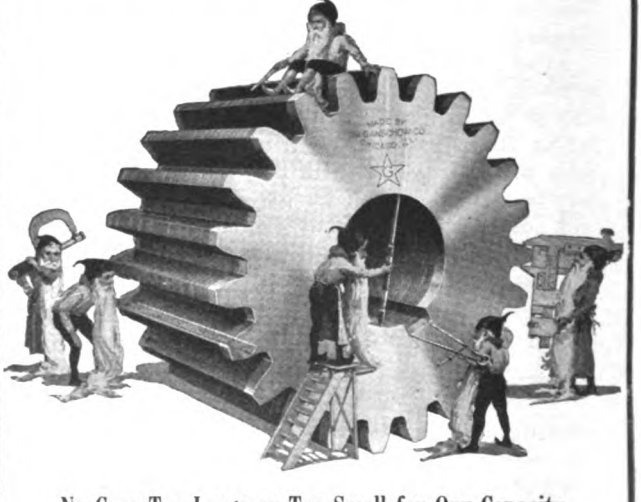
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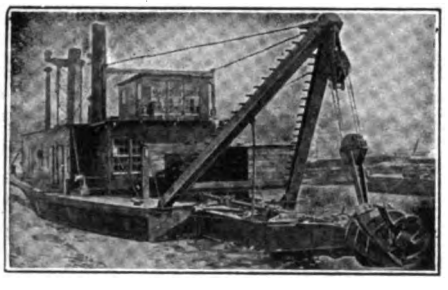
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(g) The correction of road maps, and the thorough "signboarding" of roads and places.

(h) The meeting of any unforeseen emergencies.

Means. The means at the disposal of the division engineer are his regiment, one battalion of which will, however, be without its tool wagons and other transport tomorrow; the material and tools with his engineer train; the local resources at Oceanside, those which he can find along the route, and such additional material as he can secure, by train or truck, from Los Angeles. He will not get his ponton train for several days unless he can arrange to have it shipped by rail, or to have it towed by motor trucks. In the latter case the wagons are likely to arrive in wrecked condition.

Decision. His decision must include the disposition of his troops and transport, subject to the approval of the higher command in its features affecting the other units; the specific missions to be assigned to any engineer units; alterations in the material carried in his transport, and additional material and transport to be secured from the division staff, or from the corps engineer.

As the details of the work required are largely unknown, he must, as indicated in the selected solutions, keep detachments to a minimum and hold the bulk of his force in hand to meet developments. On the other hand, he should designate in advance all necessary detachments, in order that the subordinate commanders may fully plan and organize the execution of their duties. Obviously, there must be one fraction with the advanced troops, to execute the first emergency work and send back early warning of further work required. As indicated in most of the solutions, one company will be appropriate for this purpose. Correct organization would seem to require that it be attached to the leading infantry brigade, and be under the orders of that commander, but its mission should be clearly stated in division orders.

It is thought that a platoon should be left at Oceanside, to take care of the procurement, care and loading of any supplies that may be sent for. One company will probably be all that can be spared for railroad repair, if that duty falls to the division troops.

Relations with Higher Authorities. The higher command will be interested only in the assignment of the company to the leading brigade, and in the position of the bulk of the regiment, and its transport, in the column. For the latter, it is thought that a position immediately following the leading brigade and its attached artillery will be appropriate.

The division engineer will give G-3 a draft of the necessary paragraphs in the division order covering these dispositions, and secure his approval of the proposed use of the engineer troops. The point is well brought out in one of the selected solutions that he would at the same time inform him of the contents of the corps engineer's telegram.

Next, I think, he would call up the corps engineer, settle the railroad repair question, ask for additional water-tank trucks, request that a carload of road plank be sent to Oceanside, and see what could be done toward hastening the arrival of the bridge train.

Drafting the Orders. He would then give directions to his supply officer for unloading from the trucks and wagons material not needed for the following day, and the loading of such material as road plank. I think he would put at least one truck, loaded with plank, at the disposal of the company commander with the leading brigade.

The field order for the regiment would next be drawn up. This would include so much information concerning the

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enemy, our own troops, and the plan of action as may safely be distributed, always bearing in mind that a copy is likely to fall into enemy hands through the capture of its holder; it would outline the disposition of engineer troops, following the draft given to G-3, and would give the mission of each fraction, so far as assignable at the time. Certain missions are assignable, and the officers concerned should be informed of them at the earliest possible hour, so that they may make their own arrangements. Thus the mission of fully developing local water resources, of reporting on the condition of the railroad, of searching for mines, etc., might be assigned to the 2nd Battalion (less its detached company). If thought necessary, the reservation might be made that, say, one complete company of this battalion would be held ready for bridging or other work to be later indicated by the division engineer.

The order would include a statement of the special material to be carried by the engineer train, dispositions for furnishing the 1st Battalion with tools, etc., and would, of course, end with instructions where messages should be sent.

As the order would probably be issued prior to the receipt of the division order, it would specify that the time of departure of the main fraction of the regiment, and possibly other details, would be announced later.

Sufficient copies would be prepared so that battalion commanders would have only to transmit them to company commanders with a supplementary memorandum assigning the duties between these units.

Supply Question. The division engineer has then to confer with G-4, the assistant chief of staff for supply, presenting to him the plan for water supply, informing him of the measures taken, and requesting the necessary assistance in extra truck assignment. I doubt whether he would be justified, in view of the uncertain requirements, in asking for extra trucks at this time; but he should arrive at a definite arrangement for getting additional trucks if bridge and road material in considerable quantity must be sent up in order to allow the divisional transport to proceed.

Organization. I think it very clear that the division engineer must have a well organized and well-trained staff to attend to all these details in the limited time available. The best organization is, I think, a matter worthy of considerable discussion.

Questions for Discussion

(Continued from Page 252)

within the limits of the various corps areas, and few, if any, competitions between engineer units have been staged. It is believed that it would be beneficial to organize a competition between the engineer units, and to make this competition an annual event. In connection therewith some trophy would be necessary, to be contested for each year, and to have engraved thereon the name of the team winning the event annually. In addition, it would be highly desirable to give medals to the members of the winning teams. There are no funds in the hands of the Government available for this purpose, and it would be highly fitting if the Society of American Military Engineers were to donate a trophy, to be known by the name of the Society. However, the Society treasury has no funds for this purpose, and will have to depend upon the efforts of the local sections or of individuals to defray the costs.

It is desired that this matter be brought to the attention of the local branches and of individuals with a view to getting an expression of opinion which may form the basis of further action early next fall, when Society activities are resumed. Medals may possibly be provided by local branches, each medal to bear the name of the branch, but this would necessitate arrangements to "endow" the medal or, by other means, to insure that it will be available annually. The following questions should, therefore, be decided, viz:

(*a*) Shall the Society establish a marksmanship trophy to be competed for annually by engineer units of the R. O. T. C?

(*b*) How shall funds be raised for the purpose?

(*c*) To what extent can you or your branch contribute?

(*d*) Does your branch wish to make provision for a medal for an individual contestant in addition to contributing its share of the team trophy?

II. *Student branches.*—In connection with R. O. T. C. units, and in connection with other institutions where there are no engineer units of the R. O. T. C., it appears advisable to undertake the establishment of student branches somewhat after the manner of other engineering societies. This can be done under the present constitution and by-laws, inasmuch as students pursuing engineering courses can be elected to associate membership. These students, however, can rarely afford to pay the full membership price, and it has been suggested that the executive committee of the Society may authorize reduced fees—about one dollar ($1.00) per student—with the understanding that the journal shall be issued only on the basis of present subscription price—that is to say, one journal to be issued for each five members in the student branch. Is there any objection to such procedure?

III. *Society ribbon and medallion.*—The Society emblem has met with a very favorable reception, but it has been pointed out that a number of the members will prefer to wear the Victory Button or some other emblem. It has been suggested that a narrow ribbon—to be passed through the button-hole out across the lapel and fastened in the back—would be desirable. It has also been suggested that a badge, to be suspended from a ribbon somewhat after the matter of a Victory Medal or the badges of the various military societies, might be adopted by the Society. For this ribbon, the engineer colors have been suggested—that is to say, a scarlet ribbon with white edges. However, to conform to heraldic practice and "tie in" the emblem with the World War, it has been proposed to place along the extreme outer edges a narrow black thread and a similar narrow black thread down the center of the scarlet stripe. The black being taken from the colors of the former German Empire will tie the emblem in with the World War, will distinguish the ribbon from a great many others in existence, and the black on the extreme edges of the white will serve to define the ribbon when produced in lithographic form on a white page. For the pendant medallion, it is proposed to use the emblem recently adopted, but enlarged to the diameter of the Victory Medal. The ribbo for the lapel will not exceed three-sixteenths of an inch in width, and may be slightly narrower.

Certain objections have been raised to this scheme. They are based on the fact that a ribbon thus worn often signifies an official decoration, as the Legion of Honor and various other foreign decorations. Certain members of the Society feel that an unofficial body, such as The Society of American Military Engineers, should not adopt a device of the same general nature. Do you advocate a ribbon? Do you advocate a badge as described?

IV. It has also been suggested that a diploma or certificate of membership be prepared to conform to the practice of the more prominent engineering and scientific societies.

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The engraving of a suitable plate would involve a considerable expense, and the cost of preparing each diploma thereafter will add to the total cost. It is roughly estimated that diplomas of this kind may cost anywhere from sixty-five cents to a dollar each. How many members would probably desire diplomas of this kind?

It is desired that these matters be considered by the members, that they be discussed by the local posts, and that the opinions, either of individuals or of local posts, be forwarded to the Secretary of the Society not later than June 15, in order that action may be taken in accordance with the censensus of opinion.

Philadelphia Post

Maj. Gen. Charles P. Summerall, Commanding General, 1st Division, Camp Dix, N. J., was the speaker of the evening at the meeting of the Philadelphia Post on March 24, 1921. His subject was "The relation of the Engineers to the Infantry." General Summerall reviewed the work of the engineers at the front with combatant units in the recen war. He reviewed in some deail the work of the engineers with the 1st and 2d Divisions, and paid high tribute to the efficiency and valor of the engineer troops.

Before the meeting, General Summerall was the guest of the Post at a small informal dinner served at The Engineers Club of Philadelphia.

Col. W. B. Ladue, Corps of Engineers, commanding the 1st Engineers at Camp Dix, and the Commander of the Philadelphia Post, presided at the meeting.

Maj. Gen. W. C. Langfitt, retired, formerly Chief Engineer, A. E. F., addressed the April meeting on the work of the American railway troops with the British in France. General Langfitt's address was both instructive and entertaining. He compared the work of the American, Britisn and French railway units, both standard and light railways, in France, and pointed out wherein each excelled. General Langfitt's address covered the staff organization, the equipment, and the operation of standard and light railway work at the front in France. General Langfitt is commander of the New York Post of the Society of American Military Engineers, and discussed the plans which the New York Post has under consideration for keeping alive the interest of its members in military matters, and instructing them in the duties which they will be called upon to perform in case of war. It was suggested, that as the cities of New York and Philadelphia are not very far apart, and as communication is very good between the two cities, possibly the members of the two Posts might find it instructive and beneficial to co-operate to a certain extent, and to attend each other's meetings from time to time.

Prior to the meeting, General Langfitt was entertained at dinner by the Post at The Engineers Club of Philadelphia.

Col. W. B. Ladue, Corps of Engineers, commanding the 1st Engineers at Camp Dix, and the Commander of the Philadlphia Post, presided at the meeting.

St. Louis Post

On April 21 a dinner was held at the Missouri Athletic Club. The following were present:

Colonel Jonah, Major Jones, Colonel Perkins, Colonel Abbott, Lieutenant Frost, Major Skelly, Major Lockwood. Lieutenant Thorburn, Mr. Perry, Mr. Porter, Mr. White, Mr. Hastain, Mr. Moynhan, Mr. Buchanan.

Immediately following dinner, Colonel Jonah opened the meeting, introducing Colonel Burgess, Corps of Engineers, U. S. Army, who gave a very interesting talk on the subject of "A Volunteer Regiment of Railway Engineers." Following Colonel Burgess' talk there was an informal discussion between Colonel Burgess, Colonel Abbott, Colonel Perkins and others in connection with ways and means to make the St. Louis Post useful to the Regular Army plant.

Boston Post

On March 11 the first steps were taken toward the formation of a local Post of the Society. The following officers were elected:

President, Col. T. H. Dillon; Vice-President, Col. W. H. Root; Secretary-Treasurer, Lewis A. Armistead.

The board of directors consists of the following, in addition to the three officers of the Post:

Col. D. C. Jackson, Col. J. F. Osborn, Col. S. D. Grigham, Maj. Alexander Macomber, and Maj. M. F. La Croix.

There are several hundred engineers residing in this vicinity who are eligible for membership in the Post, and it is expected that a large number of them will affiliate.

Silver Button Winners

The enthusiastic efforts put forth by members to win silver buttons has been most gratifying and has resulted in nearly 100 new members within the past four weeks. The time limit of sixty days does not expire until June 1, and all members are urged to put forth every effort the last four weeks of our "drive." Twelve members have already secured three or more paid members; four have secured two paid members, and forty have secured one paid member. Following is a list of Silver Button winners, with total number of members secured by each:

L. R. Lohr, Camp Humphreys, Va.	8
J. D. Schmidt, Custom House, New Orleans, La.	4
R. C. White, 1022 Railway Exch. Bldg., St. Louis, Mo.	4
Frank J. Clark, 42 Cedar St., Dobbs Ferry, N. Y.	3
W. H. Peters, Fort Jay, Governors Island, N. Y.	3
Wm. P. Cowles, 3237 Portland Ave., Minneapolis, Minn.	3
F. B. Wieners, March Field, Calif.	3
E. B. Murray, Camp Travis, Texas	3
B. B. Browne, Camp Grant, Ill.	3
F. W. Green, 6203 Washington Ave., St. Louis, Mo.	3
L. J. Canfield, Missoula, Mont.	3
L. E. Atkins, Urbana, Ill.	3

Silver Button winners who have not already notified us of the character of emblem desired—that is, pin, button or brooch-pin—should do so without delay.

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The Engineer R. O. T. C. Unit at Virginia Polytechnic Institute

The V. P. I. Engineer Unit was among the first Engineer Units established, and due to its most excellent record among the other seventeen units assembled at Camp Humphreys in 1920, is rated very high. The enrollment in the Advanced Course of the Engineer Unit of Va. Tech is the largest in the United States. At the summer camp for Engineer Units in 1920, the V. P. I. contingent carried off a lion's share of the military honors and held its own with larger technical schools in the solution of technical problems of various kinds that are a part of the summer camp curricula.

While the work of the Unit at college is planned so as to utilize the academic training that the student receives in his college course, it is not a repetition of the college work, but often calls for thorough training and ingenuity. In addition to the application of academic subjects, many purely military engineering subjects are taught. These subjects are as follows:

Military Topography and Map Reading

This is based on a mechanical method not used in the college work, but very useful for certain life problems met by the engineer. A thorough course is given in this during the junior and senior years and at the summer camp, where more time is available. This method, which requires only a simple sketching board, properly understood and executed, enables the student to make a map of any terrain with such accuracy that it will compare very favorably with that made by the transit and level.

Military Bridges

In this course the academic work on bridge construction is utilized in solving military bridging problems. It also includes a study of the purely military bridges, such as ponton, spar, and improvised bridges.

Military Roads

In this course the student is not concerned with the design of any particular road, but rather with the necessity of having good roads in military operations; their upkeep under the heaviest traffic known, and the proper regulation of roads during operations of troops.

The remainder of the junior year is spent in studying organization of engineers, demolition of explosives, field fortifications, and minor tactics.

The work of the unit during the senior year includes a short review of the work of the junior year and a study of the following subjects:

General Construction

This includes all forms of construction from cantonments, warehouses, wharves, and depots to water supply, electrical power, sewage disposal, refrigeration, etc. These subjects are covered by having the students prepare papers on them, which papers are discussed in class.

Army Organization and Mechanical Equipment and Ordnance

In the ordnance course, the problems involve a knowledge of statics, dynamics, hydraulics, thermo-dynamics, and strength of materials. These problems prove interesting, impart a knowledge of ordnance material, and serve as a review on the subjects involved in the solution of the problems.

Eligibility to join the Engineer Unit depends on the academic course that the student is pursuing, all engineering courses being approved for entrance into the unit. The work of the unit as outlined above is of practical value to all students of engineering not alone for military but for civilian pursuits, and the successful completion of the unit course entitles the student to a commission in the Engineer Officers' Reserve Corps and membership in the American Society of Military Engineers, which has at present 4,000 members, over 3,000 of whom are engineers in civil life and most of whom belong to the Engineer Officers' Reserve Corps in grades of rank from brigadier general to second lieutenant.—*Special R. O. T. C. Edition of "The Virginia Tech."*

List of Applicants for Membership

(Continued from Page 250)

Claterbos, Lieut. Louis J., 5th Engineers, Camp Meade, Md.
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Clinton, Lieut. Col. Delmar S., Army and Navy Cub, Manila, P. I.
Collins, Lieut. Hubert Walter, 1st Engineers, Camp Dix, N. J.
Colton, James S., Apartado 652, Tampico, Tamaulipas, Mexico.
Cook, C. Clyde, Proctorville, Ohio.
Cuno, John B., 930 F Street, N. W., Washington, D. C.
Damon, Capt. S. L., Camp Travis, Texas.
Dumont, H. R., Lock E, Canton, Ky.
Dunn, Prof. T. S., Georgia School of Technology, Atlanta, Ga.
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Ellman, Capt. Paul M., 1436 Girard Street, Washington, D. C.
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Freiling, Henry J., care of Clinton Light and Water Co., Clinton, Mo.
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Goodloe, Henry B., 26 Cortlandt Street, New York City.
Griffiths, Lieut. David W., Engineer School, Camp Humphreys, Va.
Grower, Lieut. Roy W., Dept. Military Science, U. of C., Cincinnati, Ohio.
Hadorn, Fred L., 5332 Lexington Avenue, Hollywood, Calif.
Hahn, Lieut. Cornman L., Engineer School, Camp Humphreys, Va.
Harding, Lieut. Chester K., Camp Humphreys, Va.
Harris, Capt. W. E., 6th Engineers, Camp Pike, Ark.
Harwood, Lieut. E. C., 5th Engineers, Camp Meade, Md.
Hesp, Lieut. William V., Camp Humphreys, Va.
Higgins, Lieut. Wilson B., 7th Engineers, Camp ackson, S. C.
Higgins, Lieut. Wilson B., 7th Engineers, Camp ackson, S. C.
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Hunter, Capt. Robert C., 6th Engineers, Camp Pike, Ark.
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Jarvis, Capt. Clarence S., 4th Engineers, Camp Lewis, Wash.
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King, Wilbur F., Box 750, Montgomery, Ala.
Knappen, Lieut. T. T., 12th Engineers, Camp Grant, Ill.
Lambert, Lieut. Henry G., 12th Engineers, Camp Grant, Ill.
Landberg, Rudolph, 5860 Osage Avenue, Philadelphia, Pa.
Langeler, M. Bert, 423 18th Street, Milwaukee, Wis.
Lee, Capt. Wm. R., 3735 Harriet Avenue, Minneapolis, Minn.
Leehey, Lieut. Donald J., 5th Engineers, Camp Meade, Md.
Levine, Samuel, 4th Naval Air Station, Lakehurst, N. J.
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Lynde, Capt. Charles C., Box 54, Station "A," Cleveland, Ohio.
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Medding, Capt. Walter L., 7th Engineers, Camp Jackson, S. C.
McCullough, Lieut. A. S., 2d Engineers, Camp Travis, Texas.
McKee, Capt. C. E., 8th Engineers, Mounted, Fort Bliss, Texas.
McQuigg, Col. John R., 14142 Euclid Street, Cleveland, Ohio.
Maier, Edward H., 11 S. Laurel Street, Bridgeton, N. J.
Miller, Lieut. H. T., 7th Engineers, Camp Jackson, S. C.
Millis, Capt. Ralph, Camp Humphreys, Va.
Montgomery, Lieut. A., 9th Engineers, Mounted, Fort Sam Houston, Texas.

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Polhemus, Staff Sergt. David A., West Point, N. Y.
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Robinson, Lieut. Bernard L., 12th Engineers, Camp Grant, Ill.
Rodgers, Philander K., Cor. Wood and Water Streets, Pittsburgh, Pa.
Ross, Capt. Lewis T., 8th Engineers, Mounted, Fort Bliss, Texas.
Schimelfenig, Maj. C. A., care of Chief of Ordnance, Washington, D. C.
Seybold, Lieut. John S., Camp Grant, Ill.
Shadd, Henry L., 30 Church Street, New York City.
Sharp, John H., 5439 Greenwood Avenue, Chicago, Ill.
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Smith, Capt. Hiram J., care of Mr. John B. Hawley, Fort Worth, Texas.
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Snow, Lieut. Beverly C., Engineer School, Camp Humphreys, Va.
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Townsend, Thomas G., 50 E. 58th Street, New York City.
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Trippe, Maj. Harry M., 12th Engineers, Camp Grant, Ill.
Troland, Capt. Girard B., 464 Huntington Avenue, Boston, Mass.
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Van Winkle, Walter H., Jr., 459 Mt. Pleasant Avenue, Newark, N. J.
Walker, Capt. Benamin W., S. 312 Cedar Street, Spokane, Wash.
Walsh, Capt. Joseph P., 245 E. 19th Street, New York City.
Ward, Capt. Stuart C., Alaska Road Commission, Juneau, Alaska.
Watson, Lieut. John R., 508 Sears Building, Boston, Mass.
Weaver, Capt. Theron DeW., 608 Army Building, 39 Whitehall Street, New York City.
Weeks, Maj. F. R., Fort Crook, Nebr.
Wheeler, Lieut Wm. H., 4th Engineers, Camp Lewis, Wash.
Whipple, Capt. Stephen C., Camp Lewis, Wash.
Whitehurst, Capt. H. C., Norfolk General Intermediate Depot, Norfolk, Va.
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Wood, Capt. John Elliott, District Building, Washington, D. C.
Wood, Lieut. W. A., Jr., 8th Engineers, Mounted, Fort Bliss, Texas.

Addresses Wanted

The Secretary of the Society would be pleased to receive any information concerning the present addresses of the following named members, whose mail has been returned unclaimed:

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Edgar Wilson, 904 S. Magnolia, Palistine, Texas.
Col. J. M. Wright, 1051 Spruce Street, Philadelphia, Pa.
Capt. J. M. Young, care of District Engineer, New York City, N. Y.

Personals

The monthly dinner-dance given by the Twelfth Engineers at Camp Grant, Illinois, on the evening of April 5 was one of a series of enjoyable entertainments given by this popular regiment.

Decorations in red and white, the colors of the corps, were prettily displayed in the Jewish Welfare Hostess House, where the affair took place.

Covers were laid for 51 guests. Those present were: Gen. and Mrs. George Bell, Jr., Col. and Mrs. T. H. Jackson, Maj. and Mrs. Trippe, Capt. and Mrs. Alva H. Perkins, Capt and Mrs. Fred T. Bass, Capt. and Mrs. Hastie, Capt. and Mrs. Leroy W. Cummings, Col. and Mrs. Tanner, Col. and Mrs. Gillem, Maj. and Mrs. Hauser, Maj. and Mrs. Alcott, Capt. and Mrs. Stork, Major Olmstead, the Misses Gillem, Col. and Mrs. Reichman, Miss Reichman, Colonel Game, Capt. and Mrs. Hall, Lieut. and Mrs. Smith, Maj. and Mrs. Wood, Judge and Mrs. Early, Maj. and Mrs. Abraham, Colonel Parker, Miss de Witt, Maj. Short, Lieutenants Lambert, Knappen, Joslyn, Seybold, Robinson, and Hannis.

Dancing was enjoyed until 11:30 p. m. Music was furnished by the Twelfth Engineer orchestra.

Preparations have begun for the annual training hike of the regiment, which will begin about June 1. Supplies are being requisitioned and stored, transportation vehicles overhauled, and individual equipment replenished. Camp Douglas, Wisconsin, has been selected as the site of the encampment.

Every phase of military engineering activity forms part of the outlined schedule of exercises. It is anticipated the maneuvres will consume a period of two months.

Participation with National Guard units at Camp Douglas will enter into the daily program. Each State organization will receive ten days' training in conjunction with the regular troops.

Transfers of officers out of the command has caused some changes in the duties assigned to members. Col. T. H. Jackson, Commanding Officer of the regiment, is now Camp Engineer; Capt. Alva H. Perkins has been appointed Adjutant; and Capt. Leroy W. Cummings is performing duty as Regimental Supply Officer and Property Officer.

Facilities for the recreation of the command have been made a feature of news in the local press.

Practically all the equipment of a well-appointed club is the property of each organization. The endeavor of the officers to have their units possess the best reading and amusement rooms in the cantonment finds a desirabe reflection in the high morale of the members.

A description of the work of the topographical section of the Twelfth Engineers and an interview with the members made up an article in one of the Rockford newspapers recently.

"Engineer officers insist that all products of their corps must at least equal the highest commercial standard. To exceed that standard is the ambition of the 'Topog' men," said the author.

The Inter-Fraternity Conference, with headquarters in New York City, representing forty-six of the leading men's college fraternities of the United States, has indorsed the Reserve Officers' Training Corps and urges all its fraternities and individual members to actively support the units in their colleges.

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Military Instruction

No. 1: MAY-JUNE, 1921

EDITOR

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Corps of Engineers

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Maj. Robert P. Howell
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MILITARY ENGINEERING

Maj. Roscoe C. Crawford
Corps of Engineers

GENERAL SUBJECTS

Maj. Cleveland C. Gee
Corps of Engineers

Military Art, Note 1

The Importance of Military Art to Engineer Officers

War—fighting—is a great game, the most fascinating game in the world. You try to outguess the enemy and, by superior intellect and courage, force your will upon his. At each move human lives are at stake and the fate of the nation may depend upon the outcome of the whole game. It is said that, prior to the launching of the Union attack at Fredericksburg, Lee was standing with Jackson on the heights on the south bank of the Rappahannock, watching the assembly of the Federal troops on the north bank. Suddenly the Confederate commander turned to Jackson and said: "General, it is a good thing that war is so terrible, otherwise we should become too fond of it."

Outside of its fascination, however, the study of tactics, that is, fighting, is something that the army officer will always have with him. The Infantry Drill Regulations says: "Success in battle is the ultimate object of all military training," and this is true, not only of the infantry, but of all branches. All of your strictly engineering work; the construction of immense depots at the base ports; the docks and terminals; the railroads and storehouses; the roads leading to the front; all along the line, until small squads of resolute engineers precede the infantry to cut the hostile wire; everything is contributing to that main effort—success in battle.

Engineer officers are, broadly speaking, both staff and line and come in contact, at one time or another, with all branches of the service. The regimental commander is, ex-officio, division engineer, and lower-ranking engineer officers are generally present at division and higher headquarters as assistants to one or more of the assistant chiefs of staff. Battalion and company commanders, sometimes lieutenants, have to co-operate with infantry and artillery commanders in the matters of defensive works, roads, camouflage, etc., etc.

There is also another phase of this question. In spite of the diabolical, death-dealing devices of war which "Christian" nations have invented—the powerful and accurate artillery, the poisonous gases, the bombing planes, the murderous machine guns—in spite of all these inventions, the infantry remains the Queen of Battles. In the final analysis, it is the man with the gun in his hand, the rifle with the gleaming bayonet at the muzzle, the strong right hand at the small of the stock, and the stout heart of the infantry soldier, that wins battles.

Now engineers, in addition to their other duties, are supposed to be able to fight as infantry when the occasion arises. When the assaulting line is held up or the enemy's offensive becomes too strong, the division commander is going to throw in all troops that can fire the rifle in the effort to clinch the victory or stave off defeat, and, as engineer officers, we would not have it otherwise. Those of you who have been assigned to regular organizations which served in the hottest fighting of the World War and have talked with the old non-coms., may have noticed what were the operations of their units in which they took the greatest pride and of which they delighted to tell, over and over again. Not the store-houses and roads they built, nor yet the bridges they constructed, sometimes under fire, for the other troops to advance, creditable as all these performances were. No, they love to tell of the time when, the infantry being sorely pressed, the "Old Man" threw in the sapper regiment, and they took the enemy's strong point and held it against all counter-attacks, with the orginary rifle as their only weapon. And, much as we might, from an impartial standpoint, deprecate such use of technical troops, we glory in their deeds and take a just pride in recounting them.

So you see from numerous standpoints how important the study of Military Art is to the engineer officer. And this importance is emphasized by the persistence with which it sticks to you and by the increasing proportion of your time which it occupies as you ascend the army educational scale. In the Basic Course at the Engineer School it occupies about one-quarter of the total time allowed (exclusive of the exempted subjects). We attempt to teach only the tactics and administration of a single company, acting alone or as part of a battalion, to have the student "learn the tune" of these tactical exercises. In the Company Officers' Course, more than half the total time is allotted to Military Art and we take up the tactics of all branches, with emphasis on the infantry regiment. In the Field Officers' Course more than two-thirds of the total time is devoted to Military Art and we study the tactics, administration and supply of units as large as the division. At the School of the Line and the Staff School at Fort Leavenworth and at the General Staff College at Washington Barracks, all the time, properly speaking, is devoted to Military Art.

It is recommended that the reader begin at once to cultivate an interest in this tactical game. Learn the rules and play the game for all it is worth. Develop your imagination and your powers of visualization. You will find such

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assets a source of pleasure and of profit even if you are never called to an active military career.

Problems in Minor Tactics

The map problems published in THE MILITARY ENGINEER will be based upon those used in the Basic Course at the Engineer School at Camp Humphreys. Solutions will appear in the succeeding number, but it is earnestly recommended that readers solve these problems upon receipt of the journal, and compare their solutions later with the approved solution published. It should be borne in mind that the approved solutions published do not purport to be the *only* correct solutions of these problems. Your solution may differ widely in form from the approved solution, and still be equally as reasonable, provided you have conformed to the tactical principles involved.

MAPS—

All problems will be laid upon the Gettysburg maps, published by the General Service Schools. The "General Map" will be needed for all problems; in addition, each problem will call for certain individual sheets of the detail map, on a scale of three inches to the mile.

These maps will be supplied without charge by THE MILITARY ENGINEER upon application.

ORGANIZATION—

The troops involved in these problems are presumed to be organized as shown below:

Infantry Battalion:

Hdqrs.
Co. "A" (Rifle Company).
Co. "B" (Rifle Company).
Co. "C" (Rifle Company).
Co. "D" (Machine Gun Company); 2 platoons; each platoon, two sections; each section, 2 guns.

Infantry Rifle Company:

1 Captain,
2 First Lieutenants,
2 Second Lieutenants,
200 enlisted, including 8 privates, replacements, organized as follows:

Captain, in command.

Co. Hdqrs. (1-21):	First Platoon: Each 1 officer and 57 enlisted.	Sec. Platoon: Same as first except 2d Lt.	Third Platoon: Same as second.
First Lieut.	Platoon Hdqrs.:		
First Sgt.	First Lieut.		
Gas Sgt. (s)	1 Sgt. (1)		
Mess Sgt. (s)	4 Pvts. (r)		
Supply Sgt. (s)			
2 Cpls. (1 clk.)	First Section:		
(1 agent)	1 Sgt. (2)		
2 Buglers (p)	4 Cpls. (3)		
4 Cooks (p)	21 Pvts. (4)		
3 Mechs. (p)			
3 Shopmen (p)	Second Section:		
4 Privates (r)	Same		

Notes:

(s) Pay-roll designation, "sergeant."

(p) Privates and privates first class, several with specialists' ratings.

(r) Runners and agents.

(1) Platoon sergeant.

(2) Section leader.

(3) Includes 1 one section guide and 3 squad leaders.

(4) Grouped, with 3 corporals, into 3 squads; one private in each squad armed with automatic rifle and one with grenade discharger.

For diagram of formations of the platoon see p. 48, Infantry Drill Regulations, 1919.

ADDITIONAL DATA—

(1) The commanding officer of an infantry company (both rifle and machine gun) is mounted and has a mounted orderly.

(2) The wheeled transportation of a rifle company consists of:

(a) Two ration-and-baggage wagons (escort type), containing raw rations, forage and the company office equipment and records. These loads would be distributed between the two vehicles in accordance with considerations of weight and bulk. When fully loaded, raw rations for the entire company for two days and forage for all company animals for two days are on hand in these two wagons.

(b) Rolling kitchen, capable of carrying one day's rations for the entire company and two days' grain for its animals.

(c) Water cart, capable of carrying 160 gallons of water (ordinarily sufficient to replenish the canteens and to supply water for two or possibly three meals) and grain for its animals for two days.

(3) Each individual man, when fully equipped, carries reserve (canned) rations for two days and each man armed with the rifle or automatic rifle, 100 rounds of ammunition (in his belt).

(4) The battalion combat train consists of four escort wagons, carrying small arms ammunition placed in bandoliers (60 rounds to a bandolier) and packed in boxes which are easily opened without tools; 120 rounds per rifleman and a corresponding amount for each automatic rifle and machine gun will be assumed to be carried in these wagons.

(5) The road length of a rifle company (column of squads, without elongation) complete with train is 160 yards; without wagons 85 yards.

(6) When the term "camp" is used it will mean a shelter-tent camp, two enlisted men or one lieutenant to each tent, and one small pyramidal tent for the company commander and the company office.

(7) The Gettysburg maps, general and 3-inch, are distributed to each officer but not to the non-commissioned officers.

ESTIMATE OF SITUATION—

Whenever an "estimate of the situation" is required in the solution of map problems, students will follow the form below, omitting such points as are not applicable to the particular case in hand.

(A) MISSION.
(B) THE ENEMY FORCE:
1. Strength and Composition
2. Position
3. Movements
4. Probable intentions
(C) OUR OWN FORCE:
1. Strength and Composition
2. Position
3. Supporting troops
(D) PLANS OF ACTION.
(E) THE DECISION.

Influence of: Terrain, Weather, Climate, Soil, Morale, etc.

This form is intended merely as a reminder of the points to be considered in making the estimate. *It is not a blank form*, to be filled out with the data presented in the problem.

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In forming his estimate, the commander must first of all *determine his mission* and thereafter he must *keep it constantly before him.*

In considering the "Enemy" and "Our Own Forces" the commander should eliminate those factors which do not affect his Mission. Some factors, usually those presented in the General Situation, may be ignored entirely. Others are dismissed with a brief statement showing why they do not affect the Mission. The remaining factors should be *discussed,* frankly and impartially.

Having determined, in a general way, how the strength, position, etc., of the "Enemy" and "Our Own Forces" affect his Mission, the commander next considers the various Plans of Action by which he might carry out his Mission. Here the terrain, weather, etc., will usually begin to have considerable influence on the MISSION. The influence of such factors, when appreciable, should be discussed. If, however, they are normal they may ordinarily be ignored.

Oftentimes an analysis of the Plan of Action will show that it consists of certain well defined elements. These should be set forth and then decided, either separately or interdependently, as circumstances require.

The advantages and disadvantages of the different Plans of Action should be discussed and one set off against the other. The further influence of enemy, our own forces, weather, terrain. when applicable, should likewise be considered. From this discussion the commander decides which Plan to adopt.

Occasionally a Plan of Action may be decided in toto. Usually, however, a certain predominating element is first decided, leaving one or more subsidiary questions still to be considered. A much briefer discussion will generally decide them.

Having determined upon the important elements of the Plan of Action, the final step in the Estimate of the Situation is to summarize them and set them forth in the DECISION, showing how the commander purposes to carry out his Mission. The Decision should be brief but complete—leaving minor details to be shown in the Orders. (A mere paraphrase of the Mission is in no sense a Decision.) As a rough guide for the requisite amount of detail, it may be stated that a Decision should be such that a competent staff officer, thoroughly conversant with the command and acquainted with the personality of the commander, can take it and write out an order for the commander's approval.

Map Problem No. 1. A March

Maps: Gettysburg General Map.
Gettysburg 3-inch map, Kingsdale and Taneytown sheets.

General Situation.

Alloway Creek and the Monocacy River, south of the mouth of the creek (near Harney) divide two small hostile states on the verge of war.

The Blue main forces are assembling at Westminster. The 1st Infantry (the only regulars possessed by the Blues) has been started toward the border.

The main Red forces (all reserves) are assembling at Waynesboro. Little is known definitely about their border troops, but they are believed (by the Blues) to be weak and poorly organized.

Special Situation.

On June 1st the Blue regular troops reached the localities shown below, with instructions to remain there until further orders:

1st Infantry (less 1st Bn.) at Littlestown.
1st Bn. 1st Inf. (less Co. "A") at Taneytown.
Co. "A" 1st Inf. at Silver Run (near center of eastern boundary Kingsdale sheet).

At 10:30 p. m., June 3d, Captain A, commanding Co. "A," receives the following message by motorcycle:

Hdqrs. 1st Bn. 1st Inf.,
TANEYTOWN, 3d June, ——, 9:45 p. m.

C. O. Co. "A,"
SILVER RUN.

1. The Red government declared war late this afternoon.
2. Our secret service reports that the enemy has assembled one battalion of infantry at GETTYSBURG and about one hundred (100) cavalry at EMMITSBURG. Civilians say that Red mounted patrols, ten to fifteen men, were at BRIDGEPORT and HANEY this afternoon.
3. Our forces at LITTLESTOWN and here are ordered to remain in their present locations.
4. March your company to TANEYTOWN to-morrow, the 4th instant, arriving at the school house, in the center of town, not later than 11 a. m.
5. Please acknowledge receipt.

M——
Major, 1st Inf.

The season is June. Weather has been rainy but is now clear. Roads are slightly muddy. Streams are full. Crops are just beginning to come up and leaves on the trees are about half size. Average temperatures: maximum, 80 degrees; minimum, 60 degrees. Sunrise, 4:40 a. m.; sunset, 7:20 p. m.

Required.

1. Captain A's estimate of the situation.
2. His orders, as given.
3. His message, if any.

NOTE.—The company is camped in the open field southwest of the road-fork and northeast of hill 744. Present orders provide for reveille at 5:30 a. m. on the 4th.

References.

The following lesson assignments are suggested for reading, prior to the solution of a problem similar to the foregoing. Texts marked with an asterisk are War Department publications; the others can be purchased from the General Service Schools:

(a) Technique of Modern Tactics, pp. 5-9 and 19-28.
Estimate of the Situation (General Service Schools pamphlet).
The Commander—Decisions (General Service Schools pamphlet).
(b) Technique of Modern Tactics, Chap. II.
Combat Orders (G. S. S.) Pars. 1-65; 77, 78, 84, 98, 104, 116, 118, 122-129.
*Field Service Regulations, Part II, Article III.
Mechanism of Solving Problems (General Service Schools pamphlet).
(c) Technique of Modern Tactics, pp. 56-65, p. 229, F. S. R. pars, 37-49 inc.
(d) Technique of Modern Tactics Chap. VI, F. S. R. pars. 96-114, inc.

Whatever one attempts he should be familiar with the methods which have characterized good practice in that particular line of endeavor. When confronted with a specific case the individual searches for the underlying principles which find application therein, and it is here that his resourcefulness and originality are called into play.—*Technique of Modern Tactics.*

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General Subjects, Note 1

Scope

This Course is proposed to cover the following subjects:

Military Administration, Military Courtesy, and Customs of the Service; Organization; Military Law; Military Hygiene; Infantry Drill Regulations; Interior Guard Duty; Rules of Land Warfare; Theoretical Instruction in Target Practice and Combat Exercises; and Hippology.

In order to give Reserve Officers an idea of the scope of the subjects to be covered, it is proposed to publish test questions in these subjects from time to time, with references to the texts to be studied in connection therewith. The following number of THE MILITARY ENGINEER will contain an approved solution of the tests published.

A test in one or more of these subjects will be published in each number of THE MILITARY ENGINEER. The tests will be designed to enable each Reserve Officer who so desires to determine for himself whether or not he has a general working knowledge of the subject, rather than an intimate detailed knowledge such as might be expected upon completion of a school course of a course of study.

The following is a list of references on which the tests will be based:

Subject.	Text.
Administration, Military Courtesy, and Customs of the Service.	A. R. pars. 49-67, 265-300, 316-321, 327-330, 355-364, 378-392½, 775-790, 922-943, 1024-1036, 1057, 1115½, 1128, 1136, 1273-1307½, 1493 and W. D. Doc. 864 (all inclusive).
Organization.	Charts prepared at The Engineer School.
Military Law.	Manual for Courts-Martial, 1921.
Military Hygiene.	Elements of Military Hygiene —Ashburn; Spec. Regs. No. 28.
Infantry Drill Regulations.	Infantry Drill Regulations, 1919, Pars. 101 to 296; emphasis on extended order.
Interior Guard Duty.	Manual of Interior Guard Duty (complete).
Rules of Land Warfare.	Rules of Land Warfare (complete).
Theoretical Instruction in Target Practice and Combat Exercises.	Small Arms Firing Manual (complete).
Hippology.	Elements of Hippology, Marshall (complete). Cavalry Drill Regulations, Pars 965 to 977 and 987 incl. Engineer Field Manual, Part VI, Pars. 1 to 21 incl.

Questions on Military Administration

No.	Wt.	Question.
1.	16.	By whom are company non-commissioned officers appointed in the following cases: (a) In a company of engineers serving as part of a regiment? (b) In units not organized into regiments or separate battalions?
2.	8.	By what authorities may company non-commissioned officers be reduced to the ranks?
3.	14.	(a) What officers constitute the company council of administration? (b) What are the duties of this council?
4.	6.	What is a roster?
5.	18.	You are a Captain in command of a company marching at route step, what should you do— (a) When you pass an officer of junior grade? (b) When you pass an officer of senior grade? (c) When you meet a platoon commander by a lieutenant?
6.	18.	(a) How (by what procedure) is an officer placed in arrest? (b) What should an officer do when placed in arrest? (c) What determines whether an enlisted man charged with an offense shall be placed in arrest or in confinement?
7.	20.	What are the general duties of the Corps of Engineers in time of peace and in time of actual or threatened hostilities?

Questions on Military Law

(Pages 1-153, Appendices 3-27. Manual for Courts-Martial, 1921.)

No.	Wt.	Question.
1.	9.	Name the three general classes into which military jurisdiction is divided.
2.	9.	How many members has each of the following: (a) General Court-Martial, (b) Special Court-Martial, (c) Summary Court-Martial.
3.	8.	What are the limits of punishment of a summary court-martial as regards— (a) Confinement, (b) Restriction to limits, (c) Forfeiture of pay, (d) Detention of pay.
4.	6.	Who may prefer charges?
5.	5.	May military authorities force an officer to pay a personal debt?
6.	6.	Under what circumstances may an offense ordinarily capital be tried by a special court-martial?
7.	12.	Show by a simple tabulation how questions arising in open court are decided, the law member being present.
8.	10.	What proportion of votes of the members present is required for each of the following (answer by tabulation, as [a] ⅗): (a) Conviction of absence without leave, (b) Sentence to death, (c) Conviction of crime which may involve not more than 20 years' confinement, (d) Sentence to 10 years' confinement, (e) Sentence to life imprisonment.
9.	6.	What is a peremptory challenge?
10.	12.	Name the four classes of pleas likely to be met with in court-martial procedure.
11.	5.	Upon whom is placed the duty of summoning civilian witnesses?
12.	6.	What is a warrant of attachment?
13.	6.	How early in a trial may the court arrive at a finding of not guilty?

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VOL. XIII JULY-AUGUST, 1921 NO. 70

The Military Engineer



Smoothing the path for the Infantry. Foot-bridge of rowboats across the Marne, built by the Engineers of the Yankee Division

Principles Governing the Use of Combat Engineers
The Monongahela
Combat Operations of the 110th Engineers

Journal of the Society
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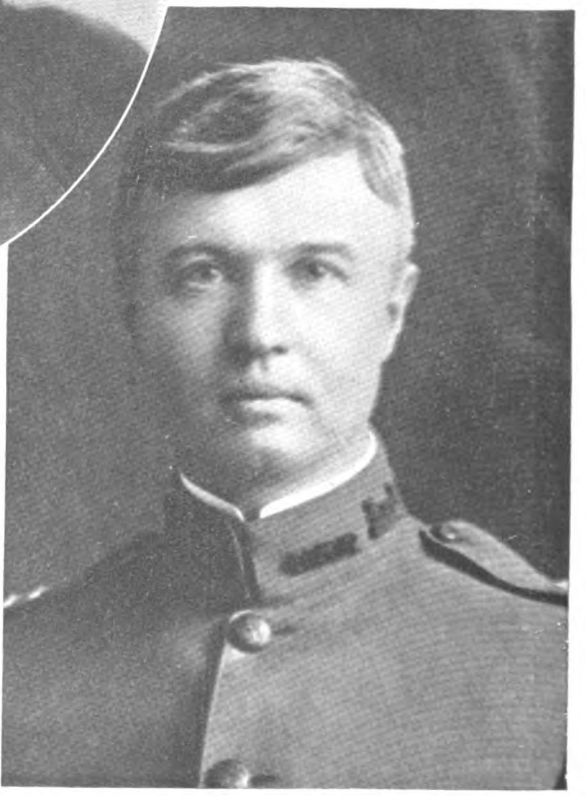
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The Monongahela

A Successful River Improvement

By

J. Franklin Bell

Major, Corps of Engineers

[NOTE.—A failure to appreciate the economic conditions which make for a successful waterway improvement has resulted in many disappointments and the waste of many millions of dollars both in our own and in other lands.

There are three principal avenues of transportation employed by man, which are the highway, the railway, and the waterway. Each of these has its proper field, and when one of them attempts to invade the proper field of the other, an economic waste is the inevitable result.

Somebody once made a statement to the effect that a ton of goods could be moved a given distance by water more cheaply than by any other method. This usually true statement has probably been the cause of much waste. It is true, so far as the mere cost of movement is concerned.

But there are many items which go to make up the cost of water transportation. Some of these are:

(1) The cost of the waterway itself, and of its maintenance. When the route is provided by nature it is free of charge. When it is a purely artificial route, such as a canal, every foot of which must be built, the investment of money in the route must be reckoned with. The cost of a water route may vary from nothing at all to very much more than the cost of the most expensive railroad.

(2) The cost of transhipment. If the places from which the goods or commodities come and those to which they are delivered are not on the waterways it is necessary to tranship to rail, at one or both ends, and this transfer of goods is a very expensive process. The fact that it is too frequently overlooked is one of the chief reasons why the waterways have so often proved economic failures.

(3) The capacity of the waterway. Deep-draft vessels are more economical than shallow-draft vessels for the large-scale operations. If the waterway is very shallow, so that large vessels cannot be used, if it is very narrow and crooked, so that it limits the size of vessels, limits their speed, and causes expensive accidents and delays from grounding, etc., the cost of movement is greatly increased. Locks in a canal or canalized river naturally cause delay and restrict capacity.

(4) There are certain other considerations which affect the cost of movement by water, such as storms at sea or on the lakes increasing the cost of insurance, fogs and darkness which railroads do not have to worry about, freezing up for several months in the winter, during which time the floating plant earns no return, varying depths and widths, which make it impossible to devise any one type of vessel suitable to all parts of the waterway, etc.

When conditions are such that the total cost of water transport is only the cost of actually moving the freight by water, then water transport is usually cheaper than any other form, provided the route has a sufficient capacity. If we can approach very close to this ideal condition our waterway will be a success. If the conditions are such that we cannot even approximate to this ideal, and that has too often been the case, then the waterway is certain to be an economic failure. It should always be possible to foresee this.

It is usually a question of the length of haul by water. As a rule, under even moderately favorable conditions, the cost of moving freight by water *is* less than by rail. So every mile that we move by water we save money. But if we have an expensive transhipment to rail at each end we may eat up all this saving and find that it would have been better to have made the whole trip by rail, since the railroad car can usually reach both the mine and the factory direct, and no transfer of its contents is necessary. Thus suppose, for example, that we have a trip of 1,000 miles to make, either all rail (as is always possible) or partly by rail and partly by water. Let us assume that it costs 1 cent to move a ton of goods one mile by rail and ½ cent to move it one mile by water, and that it costs 50 cents a ton to tranship from rail to boat or from boat to rail. Then if we move part of the way by water it will cost us a dollar for two transhipments, at the two ends of the water route. Every mile we move by water we save ½ cent. So if we move 100 miles we just pay the cost of transhipment. If the water haul be less than 100 miles it would be cheaper to make the entire journey by rail. If the water haul be several hundred miles, the saving effected by using it would be considerable.

These economic principles and their application are illustrated in the case of the Monongahela River, and are well brought out in the article following.—ED.]

THE Monongahela River is one of the busiest waterways in the world. It is formed by the junction of the Tygarts Valley and West Fork Rivers about a mile south of Fairmont, West Virginia, and flows in a northerly direction 128 miles to a junction with the Allegheny River at Pittsburgh, Pa., and is now canalized throughout its entire length by means of 15 locks and dams. The drainage area is about 7,400 square miles in extent, and the discharge at its mouth varies from 160 to about 200,000 second feet, a very wide range. In its natural condition the river was navigable at moderate stages only as far as Brownsville, Pa., 56 miles above the mouth, but there was in early days a considerable traffic of flat boats and rafts which could be floated from near the headwaters down the river for several months annually. It was on this river that the early settlers loaded the supplies necessary to take with them on their flat boats to the "far west" of those days, viz: Ohio, Kentucky and Indiana.

History of the Improvement

The history of the improvement of this stream is as follows: Under authority from the State of Pennsylvania, March, 1836, a private corporation—the Monongahela Navigation Company—constructed 7 locks and dams, which extended navigation from Pittsburgh, Pa., to a point near the Mason and Dixon Line, about 85 miles above the mouth of the river. The first locks were small—50 by about 160 feet, with available depth of about 6 feet on the sills.

Under the project adopted in 1872 and completed in 1899, two additional locks and dams, Numbers 8 and 9, were built by the United States, with practically the same dimensions as those of the Navigation Company, thus extending slackwater navigation to Morgantown, W. Va., 101 miles above Pittsburg. In 1897, the 7 locks and dams built by the Navigation Company were acquired by the United States by condemnation proceedings. Since that time, in order to meet the growing needs of a demand for coal, the system has been enlarged and extended as follows: Twin locks of standard dimensions, viz, 56 by 360 feet, with depths on miter sill of 8 feet, were built at the following dams in the years indicated:

No. 2 in 1906	No. 1 in 1915
No. 3 in 1907	No. 4 in 1917
No. 5 in 1910	

and a single standard lock added at No. 6 in 1916.

The construction in 1903 of six additional locks and dams above Morgantown, W. Va., 56 by 182 feet available area, with 7-foot depths on miter sills, extended slackwater navigation from Morgantown, W. Va. to a point on the West Fork River, about 4 miles above Fairmont, W. Va., making a total distance of 133 miles from the mouth of the river at Pittsburgh, Pa.

To date no enlargements of Locks 7, 8 and 9 have been made, but by reason of new coal fields being developed in these pools, a survey of the river was authorized by the River and Harbor Acts of 1919 and 1920. There is under consideration the reconstruction of No. 7 and No. 8, both

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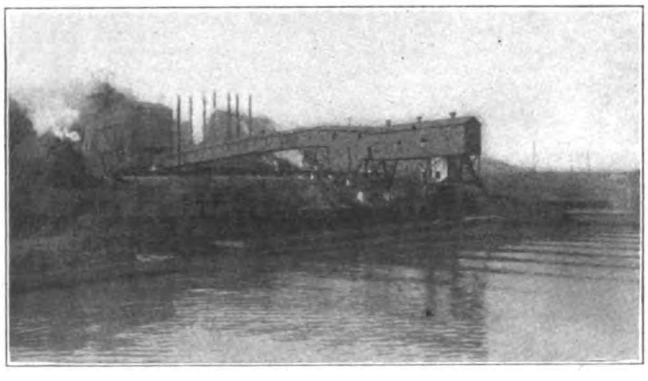
at new sites, with the elimination of present Dam 9 in connection with a new and extensive project under which an 8-foot depth will be available up to Dam 10 at Morgantown, W. Va., 101 miles above Pittsburgh. Such plan, if adopted, will provide pools from Pittsburgh to Morgantown, with lengths as follows:

Pool	Length in miles	Pool	Length in miles
1	9.2	5	11.9
2	12.6	6	16.2
3	17.4	7	6.8
4	15.5	8	9.9

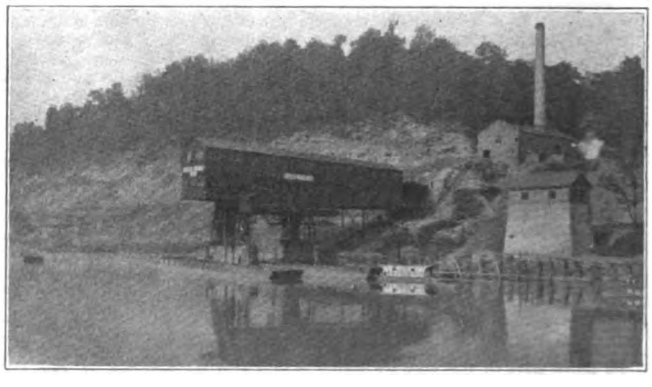
Development of Traffic

Soon after the Navigation Company's property was taken over by the United States, reconstruction of the more important locks and dams was begun, as stated above, under a plan which contemplated affording the greatest possible convenience to the coal traffic then, as now, the principal business transacted along the river. At that time the movement of coal on the river was from mines situated in Pools 3, 4 and 5, to industries on both sides of the river below those pools, some being below Lock No. 1, and others a distance down the Ohio River or up the Allegheny. With a view to permitting comparatively large tows to be locked through without being divided, the new locks were made 56 feet by 360 feet in available dimensions with a minimum depth of 8 feet of water on the sills, and the plans provided for twin locks to be constructed at the busier localities as the need arose. As a result of this project, at the present time, as stated, twin locks of these standard dimensions exist at Dams 1 to 5, inclusive, with a single standard lock at No. 6, and these have been able to accommodate the coal and other traffic hitherto developed. In recent years, the readily accessible coal in Pools 3 to 5 has been opened up, and, due to the growth of the by-product coke industry especially, there has been a steady and rapidly increasing development of coal lands in the pools above, particularly in Pool 6. As is well known, all manufacturing industry in this vicinity has been expanding at a rapid rate, and this has, during the past ten years or so, caused a correspondingly marked increase in the coal traffic of the Monongahela River. Without attempting to go back further than 1898, reports show in that year a coal traffic of about 5,700,000 tons; in 1903 it was 10,000,000; in 1908, due to the then existing business depression, it had fallen to slightly over 8,000,000. From the latter date, a steady growth has manifested itself, so that in 1913 the traffic was 10,300,000 tons, in 1918 about 12,900,000 tons, and in 1919 it was 14,700,000 tons, while during the first 6 months of the calendar year 1920, the traffic through the locks at Dam 3 was approximately 11,000,000 tons, of which 9,500,000 tons was coal.

The importance of this traffic is so obvious as to render it unnecessary to enlarge upon it. It might be said, however, that many of the great steel plants in the country are located on the Monongahela, Allegheny and upper Ohio Rivers, and that some of these depend exclusively upon the Monongahela River for their coal. It is estimated by the District Engineer at Pittsburgh that out of the total length of 454 miles on both banks of the three rivers, the Allegheny, the Monongahela and the Ohio above Steubenville, Ohio, centering at Pittsburgh, 84 miles, or about 20 per cent, are now occupied by industrial plants, largely engaged in the manufacture of steel or of some of its products. Since many of these plants have been designed with a view to using river coal, they do not have the necessary space for the railroad yards and other railroad facilities to permit them to use coal carried by rail. It was assured by the manager of a very large concern that fully one-third of the entire area occupied by his plant would have to be devoted to railroad yards to enable it to operate on rail coal.



Loading coal. A washer, conveyor and tipple. The coal is crushed, washed, carried by belt conveyor to the tipple and loaded into barges. Capacity, 2,000 tons daily



Loading coal. A characteristic coal-loading plant or tipple. Capacity, 3,500 tons daily

A breakdown in the river service might readily lead to almost unendurable inconvenience for the industries that now depend on river coal, and this inconvenience would ramify and affect a very large fraction of our entire population, dependent as it is upon steel and its varied products. Accordingly, it is a matter of grave concern that every reasonable provision be made against the interruption of this traffic, and this is the purpose of a report recently called for by Congress.

The principal coal traffic on the river is carried on by the larger steel companies. The barges used are quite definitely standardized, being 175 by 26 by 11 feet depth of gunwale, with 1,200 tons maximum capacity on 8½ feet draft, and 1,000 tons on 7½ feet. To show the magnitude of their operations, it may be said that one large steel corporation owns 216 steel barges and 11 steamboats, and another 133 barges and 8 steamboats. Six barges are usually combined in a single tow, three in length, two abreast, and the towboat aft. Thus the standard tow, including the steamer, is about 700 feet long, and at present the tow must be divided to permit it to pass through even the larger locks, those at Dams 1 to 6, inclusive (twin locks at 1 to 5, inclusive), which, as above stated, have 360 by 56 feet available areas.

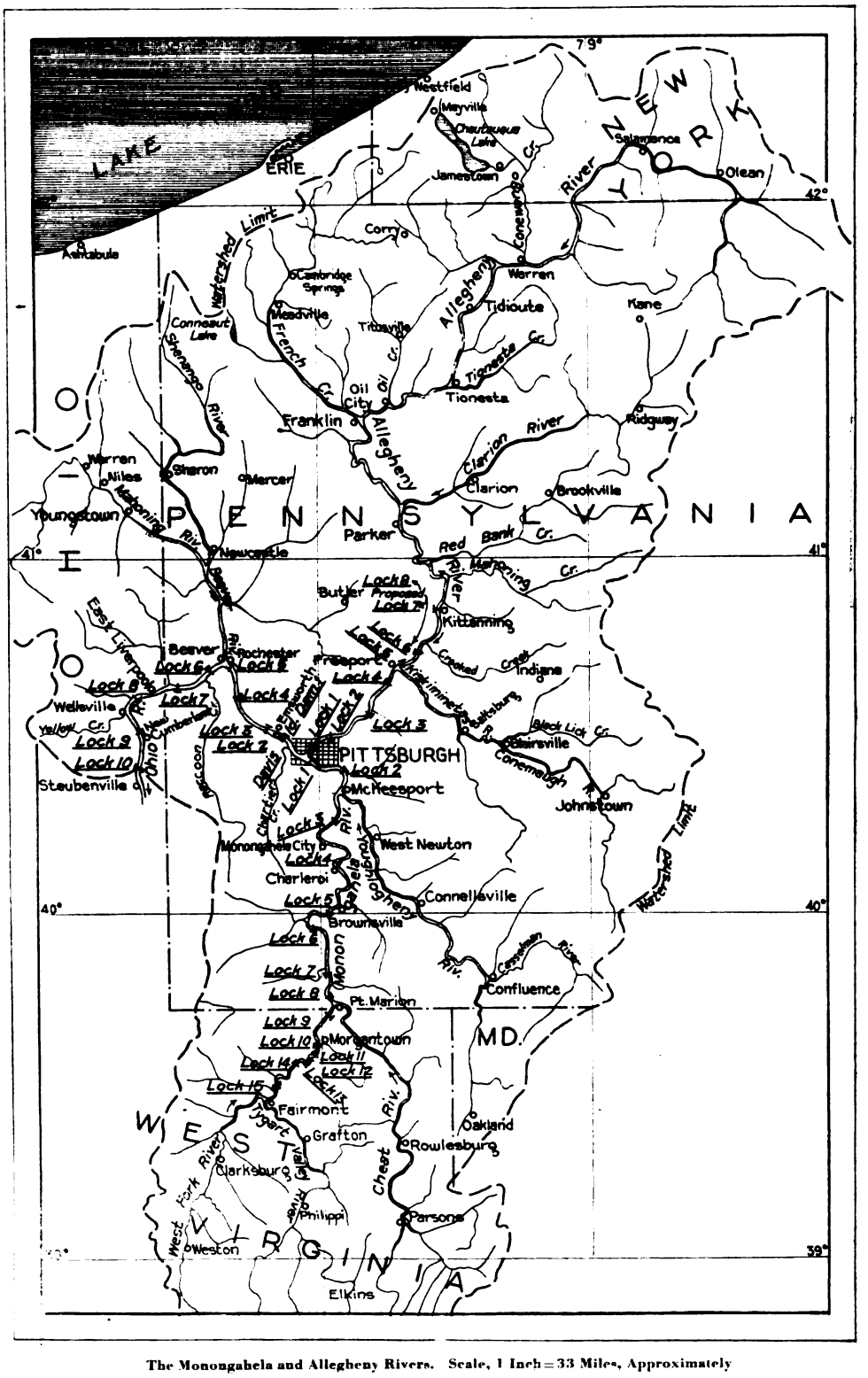
The rapid development of the traffic in coal, reaching in

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1920 at Locks 3 and 4 a maximum of from 90,000 to 100,000 tons per diem, with indications of further increase by extensions already planned by the larger industrial interests and the growing demand for coal by the general public, has led to serious consideration of greatly enlarged facilities to meet coming needs. Representatives of individual concerns and others interested laid this matter before Congress with the result that the survey above referred to was authorized. The recommendations of the report naturally are based upon the volume and character of the traffic, its past rate of growth, the rate of increase hereafter to be expected, and the manner that the ruling commodity—coal—is carried.

Contemplated Improvement

Accordingly, the plan under consideration contemplates minimizing delays, and the probability of accidents at locks and dams by providing adequate guard and guide walls both above and below the locks, the construction of new lock chambers of standard width of 56 feet, and 720 feet in length at the busier localities, Dams 3 and 4, and at others as needed, thereby obviating the dividing of tows to utilize both locks, or a single lock twice, and the reassembling of the tow above or below, an operation requiring time during which no other boats can use the lock. Also, there is contemplated the progressive replacement of the small locks above Dam 6, by new structures having the standard width and at least 360 feet available length. Evidently the completion of these new works should keep well in advance of the development of additional coal-shipping facilities and of the opening of new mines in the fields tributary to the pools above Dam 6. The correct program and time of doing the work are naturally dependent upon the demand for coal and its probable growth, all of which are susceptible of being more or less confidently predicted by those who are engaged in the management of the industries most concerned. Of course, a practical limit on the ultimate traffic of the waterway is imposed by the location and amount of coal deposits in the territory tributary to the river transportation, but for the immediate future, say for the next twenty to twenty-five years, it seems safe to assume that the traffic will continue to grow, and that the capacity of the locks at the busiest localities must therefore be carefully studied and increased to keep pace with demonstrated needs.



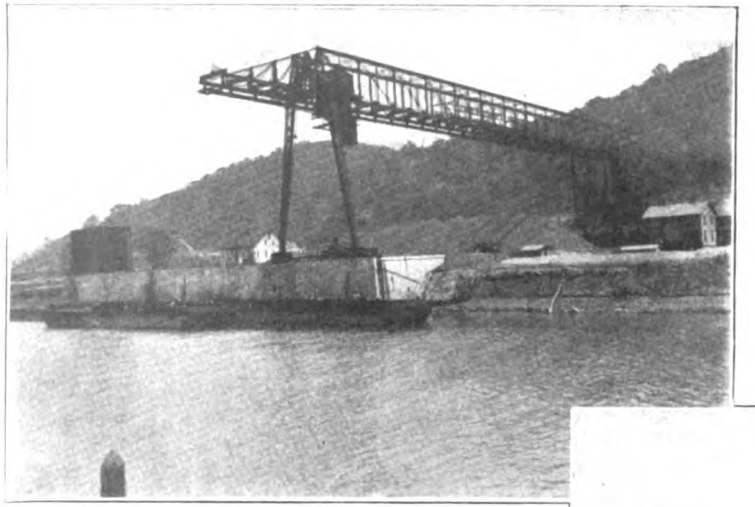
The Monongahela and Allegheny Rivers. Scale, 1 Inch = 33 Miles, Approximately

With respect to the actual traffic capacity of the Monongahela River locks there are given below figures derived from past experiences which may be accepted as a safe guide. The following are from the report of the District Engineer (1920):

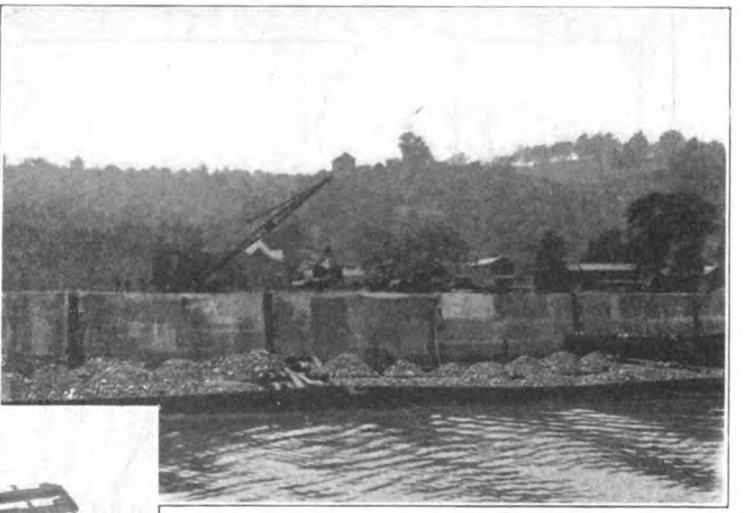
Capacity of Locks.

In January, February and March, 1919, at Lock No. 3, the entire

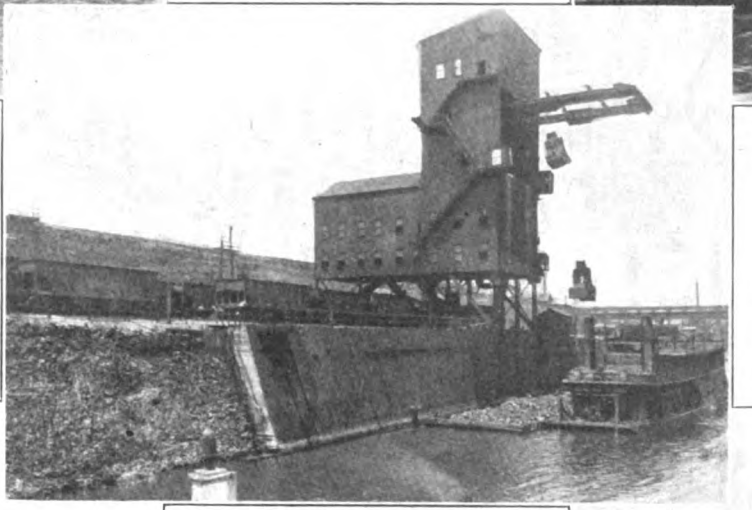
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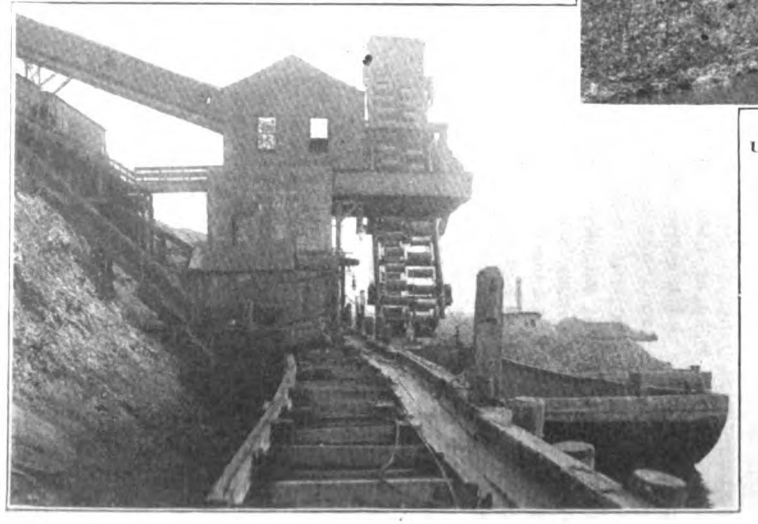
Unloading coal. Gantry crane and storage yard. The coal is hoisted from the barges and loaded on cars or stored in piles. Capacity, 1,000 tons daily



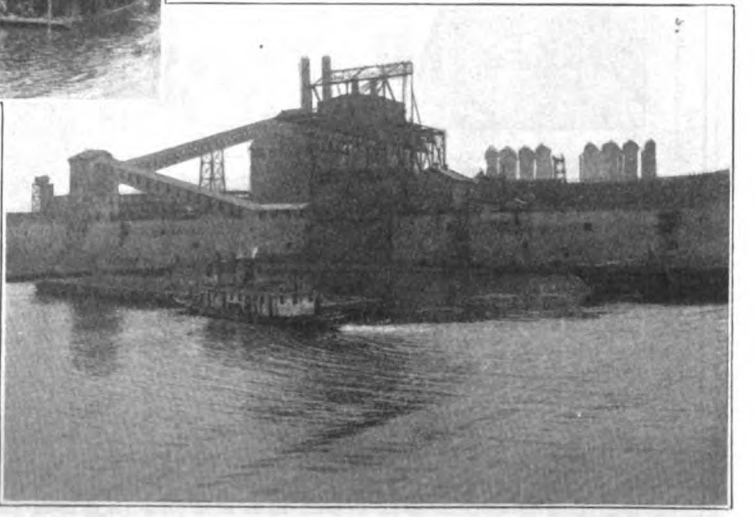
Unloading coal. Locomotive hoist and storage pile. Capacity, 1,000 tons daily



Unloading coal. Bucket hoist, crusher and car loader. Capacity, 5,000 tons daily

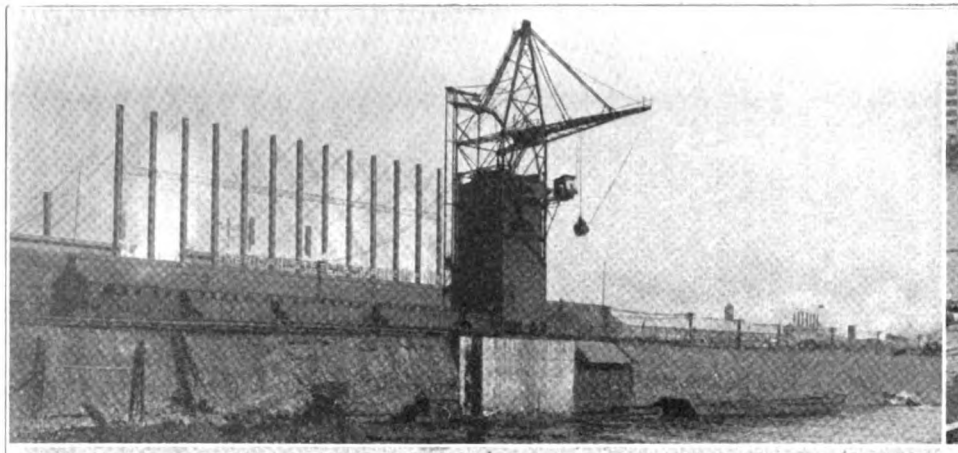


Unloading coal. Bucket ladder hoist and conveyor. Capacity, 10,000 tons daily



Unloading coal. Hoist and conveyor. Capacity 10,000 tons daily. Coke ovens in background. The coal is transferred to the ovens by belt conveyor

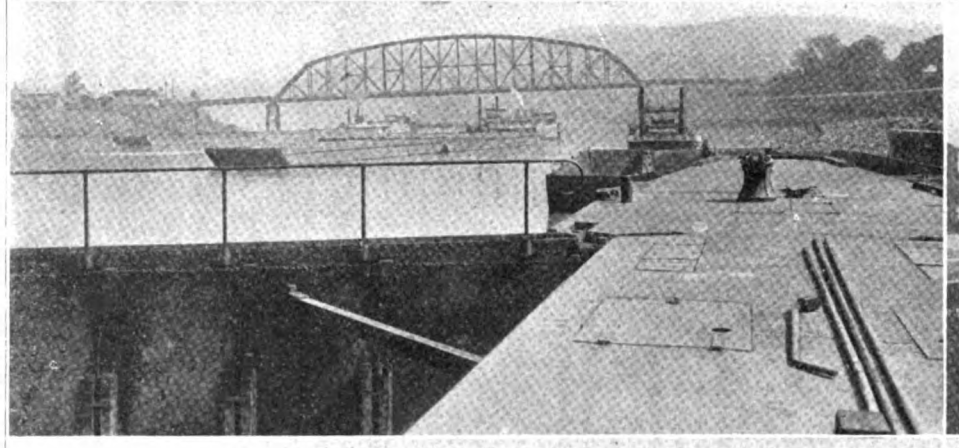
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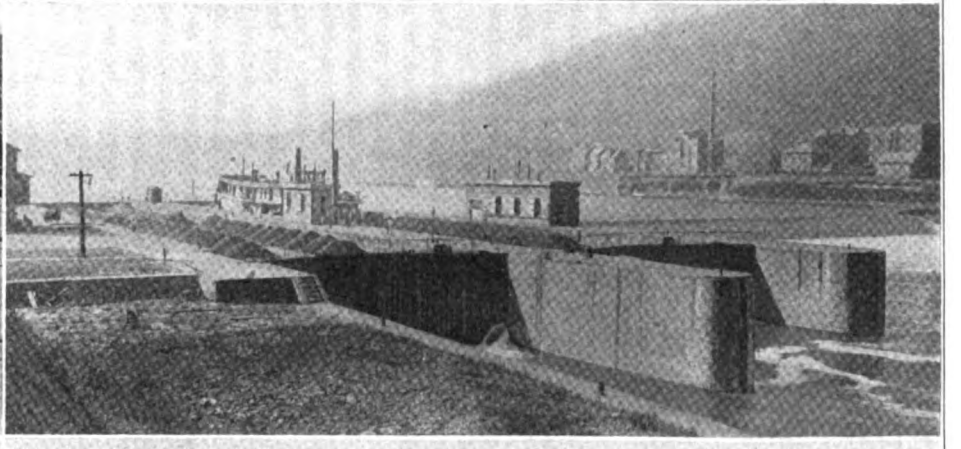
Unloading coal. Electric hoist. The coal is transferred to different parts of plant by rail. Capacity, 2,000 tons daily.



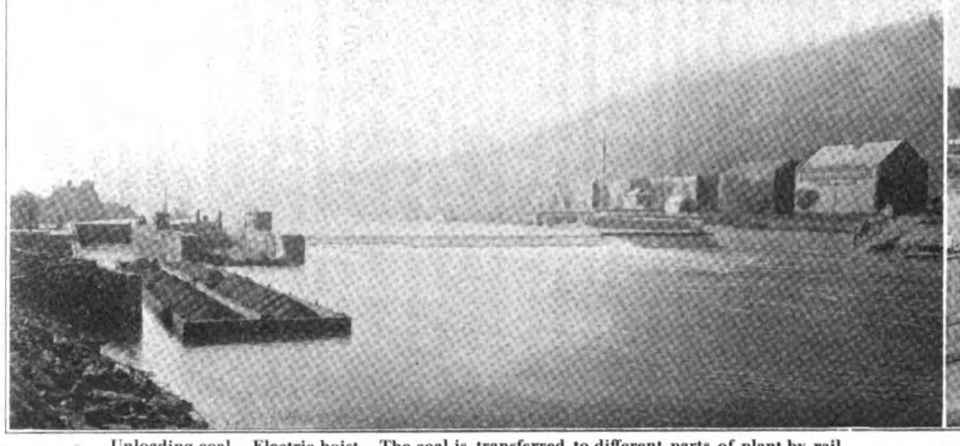
Barges loaded with steel products in Monongahela River, Pittsburgh harbor. The outer barge carries a cargo of 2,300 tons of pipe. Dimensions 42 x 269 feet, 7-foot draft.



Lock No. 5. Towboats and empty barges approaching the lower entrance.



A double lockage. Towboat and 6 barges, each carrying 1,000 tons of coal, in Lock No. 5.



Towboat and 6 barges leaving the double locks.



The tow made up and moving down the river after passing the lock.

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traffic of the river was confined to one chamber. The table below exhibits the traffic *first* for one lock in use, and *second* for the remaining nine months with both locks in use.

LOCK No. 3, MONONGAHELA RIVER TRAFFIC DURING 1919

One Lock in Use.

1919	Lockages		Total traffic, tons
	Up	Down	
January	454	497	1,107,118
February	451	471	1,017,278
March	524	498	1,136,788
3 months, average per month			1,087,061

	Lockages		
	Up	Down	Tons
Maximum for one day, single lock	21	25	51,600

Two Locks in Use.

1919	Lockages		Total traffic, tons
	Up	Down	
April	442	446	1,002,640
May	407	429	956,396
June	543	547	1,242,716
July	619	601	1,470,944
August	681	698	1,650,416
September	629	620	1,454,582
October	648	661	1,611,408
November	276	290	628,398
December	396	411	888,953
9 months, average per month			1,211,628

During the busiest of the 3 months' period with one lock in use, down lockages averaged about 17½ daily and up lockages 16 daily, with an average time between down lockages of 1 hour and 20 minutes. As a matter of fact, double this number of up and down lockages have been frequently made in said time. In March of the present year a record of the time was taken of approaching and clearing of the locks by 38 coal fleets in such manner that upward-bound fleets might have been passed without mutual interference through the locks. The time averaged about 37 minutes for a complete up and down turn of the lock.

* * * * * * *

With both lock chambers in operation there were in several days passed at Lock 3, Elizabeth, Pa., and Lock 4, West Monessen, Pa., from 95,000 to 100,000 tons of coal per day in addition to empty barges moving upstream. Number of up and down lockages, from 60 to 70. Total time locks were in operation was about 18 hours.

On June 30, 1920, there passed Lock No. 6, through a single lock, 47,825 tons. The actual time used in locking and boats clearing the lock was 11 hours and 5 minutes. The tows were made up as follows:

5 tows with single lockings down,
5 tows with double lockings down,
5 tows with single lockings up,
4 tows with double lockings up.

At the above rate there would pass this single lock in 24 hours, 101,485 tons, or for two locks 202,970 tons per day.

On the basis of the foregoing performances, assuming an average of 40 down lockages in 24 hours, passing 5,000 tons per lockage, and continuing at that rate for 300 days per year, a double lock with chambers 360 feet by 56 feet by 8½ feet would show a theoretical annual capacity of approximately 60,000,000 tons.

However, such results cannot be obtained in practice. Tows do not reach the locks in the order of maximum theoretical lock capacity; also they are likely the year round more nearly 3,000 than 5,000 tons each; again, a 300-day year allows for deductions of Sundays and holidays only, making no allowance for high water, fog, ice, accidents to vessels, etc. Moreover, such a maximum capacity is based upon the further assumption that the locks can be kept in continuous operation without machinery breakages or any time allowance for repairs, such as frequently become necessary on such structures. Taking all of these things into account, it is believed that approximately 30,000,000 tons per year for a double lock represents a more reasonable estimate.

Future Traffic Demands

In making provision for the future growth of traffic, it is necessary to assume that, due to floods, severe winter weather, and other similar causes, there will be considerable losses of time. A fair allowance for these losses might be two months, leaving the average working season as 10 months. This corresponds to the experience of the winter of 1917-1918.

The demand for coal from the Monongahela Valley, both by rail and by river, is now growing at an unprecedented rate and has almost reached the limit of the capacity of the facilities for its movement to the markets along the rivers and by the railways extending to the interior of several northwestern states. For years past several hundred manufacturing plants and hundreds of thousands of private homes have been served by natural gas for steam making and household heating. As, however, the supply of natural gas is failing rapidly, and must within a few years fail entirely, great financial losses and suffering will soon be experienced unless means to supply coal to take place of gas fuel can speedily be provided. The welfare of the great manufacturing districts of Pennsylvania, West Virginia, and Eastern Ohio is therefore concerned in a problem vital to their welfare and through them vital to the prosperity of our entire country.

The contingency here referred to has arisen so recently as to have left but little time to prepare to meet the demands sure to come within the next two or three years. So far as the possibilities of the Monongahela River are concerned, it has been shown that practically all of its coal movement, great as it is, is consumed in the Pittsburgh district, and without very considerable enlargement of its present lockage facilities it cannot be relied upon to come to the relief of the railways. That it can be made to serve a vastly greater traffic is merely a matter of the enlargement of certain of its locks and the extension of its navigable depth to mining fields as yet almost virgin territory, with heavier veins of excellent coal than ever existed in the Pennsylvania counties from which the coal now comes. Adjacent to the upper Monongahela River the state geologists of West Virginia, upon a conservative basis of calculation, report that there are 2,100 square miles of workable coal of high grade, which will yield 10,000 tons per acre, much of which is contiguous to the upper reaches of the improved river.

While the present system of locks has an apparent dependable capacity of 30,000,000 tons annually for the business as now conducted in large fleets of 4,000 to 6,000 tons, the opening up of new mining fields for individual, or small company developments, promises to greatly increase the number of lockages for smaller fleets and thus in a manner encroach upon the capacity of the present locks. For this reason, and others not necessary to recite, a greater capacity at the locks is important, for even where there are duplicate locks, as at Dams 1 to 5, inclusive, one chamber may be closed for repairs, so the other chamber for the time being should have capacity sufficient to do all the business which may be offered it. The topography of the Pittsburgh district is such that not many manufacturing establishments can store much coal to meet emergencies, and, in a sense,

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their coal yards are "afloat" in barges, hence the continuous service demanded of the Monongahela locks.

The increase in traffic is due almost exclusively to the growth in coal and coke tonnage. During the last four years this has grown at the rate of nearly 2,000,000 tons annually, and for the single year 1920, the rate appears to be about 4,000,000 tons. It is evident that, should the present rate of increase continue, the enlarged locks will soon be taxed to accommodate the business.

The problem involved is similar to that at the Soo, but the locality affords far less opportunity for the easy expansion of navigation facilities, and the question arises whether, in rebuilding such locks as 7 and 8, we ought not now to make them 720 feet long and count the excess cost as insurance against the certain growth of traffic in the near future. In any event, the second lock of any new pair should probably be made 720 feet long.

As showing the importance of the Monongahela River traffic, it may be interesting to note that it is exceeded in volume by only four of the great seaports—New York, Norfolk, Boston, and Philadelphia, and by the ore and coal movement on the Great Lakes.

It has already been stated that the coal traffic has increased from 5,700,000 tons in 1898 to an actual total of 14,700,000 tons in 1919, and that it will probably be about 19,000,000 tons during the present calendar year. The increase in 22 years has thus been about 200 per cent, while the present yearly increase in coal tonnage may perhaps be put at half to two-thirds of the traffic in 1898.

Why the Monongahela Improvements are a Success

The improvements made in aid of navigation on the Monongahela have been most successful. The reasons why are not difficult to find. In fact, to mention them is merely to draw attention to the obvious. In general, no *short* waterway can compete successfully with parallel railroads unless there exists, either immediately on its banks or so close to them as to eliminate relatively expensive rail hauls and transfers, an abundant supply of raw material, such as coal, iron ore or timber which can be handled in bulk, and, at the terminus of the water haul, cheaply transferred to industries also situated close to the banks of the waterway. As the water haul becomes longer, the economic possibility of absorbing the costs due to transfer from rail to water at the one end and from water to rail at the other increases, and eventually we arrive at the condition, illustrated by the familiar example of the ore, coal and grain traffic on the Great Lakes, in which a combined haul involving rail transportation for a considerable distance at both ends of the water portion of the route with the two accompanying transfers is very considerably cheaper than the through rail haul would be. In other words, water transportation is, in general, preferable to rail transportation only when the waterway is sufficiently capacious and well organized and of sufficient length to enable the cost of additional handling and transfers to be overcome by the greater economy of the water portion of the haul. The average haul on the Monongahela is only 50 miles, and even though the ton-mile cost of river transportation is considerably less than that of carriage by rail, it is clear the case is one in which extra terminal costs must be kept at a minimum, in order that this advantage of the waterway may be retained. This has actually been rendered possible through the fact that the Monongahela flows through the heart of a very rich coal region where there are many mines that can as conveniently ship by water as by rail, thereby virtually eliminating one extra transfer expense, and the coal is consigned to and used by industries so large that they can afford to install modern terminal facilities of the most economical kind. As a consequence, the economic advantage of the waterway is maintained and it has the further advantage that the traffic possesses greater certainty and ease of control, and, as already noted, the industrial plants can be constructed without the necessity of making provision for railroad yards of large area.

At present the total coal production of the seams near the Monongahela River is over 100,000,000 tons annually. The river is carrying from 15 to 20 per cent of this output, and in all likelihood gets all that can now be carried by water more advantageously than by rail. As the distance from the coal fields to Pittsburgh increases, the advantage of the waterway will also increase, and accordingly the width of coal areas tributary to the river will also increase.

Lo, the Poor Indian

They very much fear in the office of the Quartermaster General at Washington that some Western wag has been trying to have a little fun with the Army. If he is spoofing the War Department, Charley Stepinthemudd certainly has succeeded, for half a dozen veteran clerks of the Quartermaster Corps have been methodically searching files of the last hundred years in the hope of finding some record that Charley served as an Indian scout from 1812 almost to date.

Charley wants some compensation for his century of service, now that he is retired at the age of 130, and he plaintively asks if he must "waight another 100 years," which rather indicates that his financial difficulties are not very pressing.

And, poor Lo's story runs thus:

"Thorp, Wash.

"First, you will haf to excuse my Riting as I onley learned to Rite after I waz 100 years ago. I am now 130. I am a Onida and Senica Indian the Reason ov me riting to you iz this. I Have fol lowed the American Army near on too 85 years az an Indian Scout scouting and spying for the Army and I have never drawn any Pay for my services On account ov some ov them army officers not turning in my name for my services.

"My first service waz with General Jackson at New Orlens. Fiting the British Redcoats then scouting in Middle West after Bad Indians. I was with General Scott in the O'd Mexican War than scouting on the Plains. I was with A. J. Smith thru the sivil warr then Back West on the Plains and Rocky Mountains after Bad Indians. I went to Cuba with Colol Rosefent as a scout with them Ruff Riders and done my Part to help whip the spanyards.

"Rosefelt did not get me my transportation home soe I Had to goe and work in cane fields and suggar mill untill I could get enough to build me a good tight canue in whitch I cam back to the Missipia River and up to St. Louis and on up the Misurie River to great Falls Montana where I Procured too Horses and came on over to this Place to my old time white Firends House Where I stay most ov the time his great grandfather and I were boys together.

"Can not you Bring it to Pass soe I can gett just Recompence for my services to this out Belovid country for all the years ov toil and Hardships I have passed through in my countrys service? or must I waight another 100 years,

Respectively

CHARLEY STEPINTHEMUDD,
Thorp, Wash."

An ethnological expert with a side line of etymological training might gather from internal evidence that this letter was possibly written by a Caucasian of considerable education.—*Office of the Quartermaster General.*

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The Instruction of Engineer Troops in Ponton Bridge Construction

By

Mason J. Young

Major, Corps of Engineers

ALL engineer officers should realize the importance of thorough instruction of all combat engineer units in the construction of ponton bridges, but, perhaps, some officers have overlooked, or lightly considered, this particular engineer activity. Of all duties that engineer troops are expected to perform none is more completely an engineer function than the construction of ponton bridges. Infantry and artillery can dig in, in fact, they actually did a large part of the field fortification work during the World War. An engineer is supposed to build a little better trench or dug-out than an infantryman, and that is all. It is much the same with reference to road work. But when it comes to a river crossing, even if the river is little more than a creek, all branches of the service have from time immemorial down to the end of the World War, waited on the engineers, and if the engineers failed at the job, that water course was not crossed.



Bringing a heavy ponton into position

As the crossing of rivers, which usually means building ponton bridges, is so solely and completely a function of engineer troops, it then becomes a very great obligation upon all engineer officers to train their organizations very thoroughly in the use of the ponton equipment. Perhaps it will not be purposeless to mention a few important military operations in the Mexican and Civil Wars and the World War which were dependent upon ponton bridges for their success, or which failed to materialize because of the lack of a bridge train.

It is a historic fact that General Taylor's army was prevented from invading Mexico for a considerable time because it had no ponton equipment and could not cross the Rio Grande River. Napoleon himself records at least one similar failure.

Nearly every advance by the northern armies during the Civil War was across broad rivers that were bridged by the ponton equipage, practically the same equipage that we have to-day.

The engineer troops with the Army of the Potomac consisted of two regiments of New York Volunteers and a battalion of regulars. This battalion of regulars later became the First Battalion of Engineers, then the First Regiment of Engineers, and was in 1917 expanded into the First, Sixth and Seventh Engineers. These two volunteer regiments, and particularly the Battalion of Engineers, were continually building ponton bridges during the Peninsular Campaign, before the battle of Fredericksburg, for General Meade's army to cross over the Potomac, when it marched north to the battle of Gettysburg, and then again when it marched south, throughout all the maneuvers in Virginia and when Grant finally marched to Richmond.

When General Sherman marched north from Savannah he crossed the Savannah River about twenty miles north of the city on bridges of canvas boats. The river at that point was wide and swift.

Engineer officers should read Occasional Papers No. 44, entitled "The Engineer Battalion in the Civil War," and the introduction to the ponton manual. The authors of those papers speak of bridges, some 2,000 feet long and others built in currents so swift that the boats had to be held in place by ship anchors.

The rivers along the western front during the World War were narrow and had gentle currents. They offered comparatively few engineering difficulties when contrasted with American rivers. Many ponton bridges were constructed in the presence of the enemy, and a very considerable per cent of the American divisional engineer regiments used ponton equipment at one time or another. Of course, the most important river crossings effected by American troops were those of the Marne and the Meuse. The Seventh Engineers, for example, constructed improvised canvas ponton foot bridges, standard ponton bridges, and one heavy ponton bridge across the Meuse River.

In discussing the experience of the World War it must be remembered that the rivers in Europe were easy to cross, and from an engineer's point of view presented few real difficulties, whereas many of the rivers of the United States are broad and swift. Because of these conditions I believe the Civil War experience furnishes a much truer guide as to what should be the degree of proficiency of engineer troops in this specialty than does the experience of the recent war.

Another point that emphasizes the necessity of thorough ponton drill in peace times is that practically every ponton bridge built by American troops in Europe was built under the immediate direction and supervision of an officer or noncommissioned officer who had had long service as an enlisted man in the engineers before the war.

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Considering then the fact that the construction of ponton bridges can only be undertaken by engineer troops, and that rivers have had to be crossed as a result of nearly every military advance in the past, it is evident that ponton drill should occupy a very important place in every engineer training schedule. It is my belief that every engineer unit should each year have a ponton season set aside for this training alone, so that a high degree of proficiency can be obtained in this specialty. Furthermore, I believe that the importance of this training to an engineer soldier is analogous to the importance of the target season to all soldiers armed with the rifle, that it should proceed along much the same lines, and that it should occupy approximately the same proportion of the engineer soldier's time.

The ponton drill is practically the only engineer drill that has been standardized and for which there is a manual. Consequently it becomes an important disciplinary exercise and teaches officers and men alike the organization and co-ordination of engineer work.



Preparing a raft



First lessons in rowing and paddling

The following fundamentals should govern ponton training:

(a) The company is the bridge-building unit, and it builds bridges under the immediate direction of its captain. Consequently each company commander should have his entire company for ponton drill at one time, and he should personally supervise the drill.

(b) All noncommissioned officers should be trained in all details of ponton-bridge construction. The most difficult and most important thing for them to learn is the duties of chief of ponton.

(c) Every private should become a good oarsman.

(d) The ponton manual should be followed absolutely. This rule should not need statement, but it has not always been followed.

(e) Flotilla drill should be held if the current is moderate. I know of only two ways to develop proficient boatmen. One is to put them in the middle of a swift stream and the other is to give them flotilla drill.

(f) All knots and lashings should be made absolutely as prescribed in the manual.

(g) A trained company should build a bridge by successive pontons, under exhibition conditions, at a rate of ten feet per minute, or better.

In applying the above rules, the most important consideration is the development of good boatmen in every company. Under difficult conditions, and particularly in swift streams, only skilled boatmen can handle the boats, whereas the other operations of building a bridge present few difficulties. Speed in constructing bridges under exhibition conditions is a secondary consideration to the development of oarsmen. Under conditions which usually prevail when brides are built in war time, the engineer companies have not had ponton drill for months, and their personnel has often been largely changed by reason of replacements since having any such drill. Consequently there must be many trained boatmen at the end of the drill season, in order to have enough trained men available when an emergency arises months afterwards.

Under the conditions prevailing in the service to-day it is hard for a company commander to get enough men at one time to conduct ponton drill with his company as a properly organized unit. My only suggestion is that one company in a battalion at a time be relieved from all special duties and fatigue, and enough privates be attached to it as balk and chess carriers so that the company commander can construct a bridge by successive pontons with the prescribed details.

The training given the First Battalion of the 604th Engineers during July and August, 1918, just before the regiment went overseas, will serve to illustrate these ideas. Each company in the First Battalion of the 604th Engineers had nine (9) full days of ponton work. Half a company had ponton drill in the morning and the other half in the afternoon. It must be remembered that the companies were at war strength, and could turn out about two hundred (200) men for drill. Morning and afternoon drill periods were three and three-quarters (3¾) hours long. Thus a pontonier could have a maximum of thirty-three and three-fourths (33¾) hours' ponton drill, divided into nine drill periods.

The drill was conducted by the company commander or his lieutenants. Actually company commanders spent about half the morning and afternoon drill periods at ponton drill. The drill was discussed at officers' call in a general way. Each company commander used the drill period to instruct his men as he saw fit, and was alone responsible for the results attained.

The material available consisted of one ponton division of heavy equipage and four ponton wagons of light equipage. It was sufficient to drill half a company at a time. Drill was conducted on a broad shallow tidal stream flowing into Chesapeake Bay. There was only one experienced engineer soldier in the entire battalion. He was a sergeant, first class, and thoroughly understood ponton work. He was put on special duty at the ponton grounds, and used by the three company commanders as they saw fit. The company commanders were graduates of the engineer training camps, and all they knew about ponton work they had gathered at those camps. It was unfortunate that there was not more equipment and that the companies had to be divided for this drill. This condition necessarily distracted the attention of the company commanders and reduced the rate of progress of the men. On the other hand, the men

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were of a very high type, and they worked under the stimulus of preparation for movement overseas.

During the middle of the ponton drill season it was decided to terminate it by a competition drill and the memorandum quoted hereafter was published:

HEADQUARTERS, 604TH ENGINEERS

Camp Glenburnie, Maryland, *August 5, 1918.*

Memorandum No. 57.

* * * * * * *

II. 1. The ponton drill season will be completed Monday, August 12, 1918. August 9, 10 and 12 will be devoted to competitive work between A, B and C companies. The winning company will receive Saturday forenoon, August 17, as a half holiday.

2. The judges will be the regimental and battalion commanders and regimental adjutant.

3. The competition will consist of the following tests:

(a) Building bridge by successive pontons from present drill site to old landing—distance approximately 240 feet; weight, 60.

Materials will be piled at places habitually used, and oars, anchors and lashings in boats. Bridge will consist of one trestle, eight heavy and two light pontons. Six heavy pontons and two light pontons will be moored above bridge site and two heavy pontons below. The second, third, fourth, sixth, seventh, eighth, ninth and tenth boats will be moored upstream and the fourth and eighth boats downstream. The first ponton will be moored to bank. Building detail will be divided into sections and formed on bank in double rank. Sections will be as prescribed in Ponton Manual, except that there may be fifteen (15) lashers. Long balk will be used between trestle and first ponton. Time will be taken from time command "Construct the Bridge" is given until last man is off bridge on far side. The bridge must be dismant'ed and bridge equipage properly piled or secured in the same time it took for constructing, after a short rest is given competition details. In figuring time of construction in each case a penalty of one (1) minute will be given for each defective balk lashing, mooring knot, or improperly placed anchor, and a penalty of thirty (30) seconds for each defective side-rail lashing. Other defects will be penalized on a similar basis. After penalties have been awarded, the company which has the best record will be given a rating of sixty (60) and the other two companies will be rated on the basis of a deduction of four (4) points from the total of 60 for each minute they are behind the winner. Only the time of construction after penalties are awarded will be considered. However, if it takes longer to dismantle than it did to construct the bridge, the excess time will be added to the constructing time in figuring the final rating. The abutment section must not enter water when launching the trestle.

(b) Flotilla drill; weight, 15.

Competition will consist of a race over a previously laid-out course of approximately one-half (½) mile. Each company flotilla will consist of four (4) four-oared boats, and will perform specified movements in the School of the Flotilla at designated points on course to be covered. Penalties will be awarded if movements are not cleanly and properly executed and position in flotilla kept. After penalties are awarded, the company having the best total time will be awarded fifteen (15) points, the company having the poorest time nothing, and the intermediate company a prorated number of points.

(c) Six-oar boat race; weight, 15.

Race to be over a course approximately one-eighth of a mile, turn around a stake and back again, the total distance to be one-fourth of a mile. Rating to be computed as for flotilla competition.

(d) Assembling of light ponton; weight, 10.

Detail will consist of eight (8) men, who will be formed in line beside chest near water. Time will be taken from time signal to commence work is given until boat strikes water in launching. Penalties will be imposed and rating computed as for flotilla competition.

4. Final rating will be determined by adding ratings in each competition.

It is believed that these rules are fairly clear. The importance of rowing was emphasized by the flotilla drill and the boat races, which made up thirty (30) out of one hundred (100) points.

The manner in which the flotilla drill was conducted needs further explanation. Actually it was both a race and a maneuver by flotillas consisting of four (4) four-oared ponton boats. As has already been explained, the drill was held on a broad shallow tidal stream. Five light piles, painted white at the top and numbered consecutively, were set in the water so as to mark out a closed course slightly less than one-half mile in length. The flotilla rowed around this course, executing one of the following movements as it passed each pile or as it passed from one pile to the next: Left by ponton, left oblique and forward, pontons left (twice), right front into line, flotilla left and flotilla right. The flotilla was in line at the start and finish. A sketch showing the shore line, the positions of the piles and the movements to be executed at each pile, or between consecutive piles, was prepared several days before the competition, and blue-prints of it distributed. It would have been impracticable to hold the competition with a larger flotilla, or to have two flotillas maneuvering at once, because of the restricted water space.

The results of this competition were as follows:

	A Company			B Company			C Company		
	Time	Penalties	Rating	Time	Penalties	Rating	Time	Penalties	Rating
	′ ″	′ ″		′ ″	′		′ ″	′ ″	
		(1)			(2)			(3)	
Bridge	26 19	3	46.7	24	2	60	26 40	4	41.3
						(4)		(5)	
Flotilla	12 38	0	15	13 28	0	10	Disqualified		0
		(6)						(7)	
Light Ponton	3 25	10	0	2 40	0	10	2 51	10	6
Race	5 11	0	0	5 7	0	3	4 50	0	15
Total			61.7			83			62.3

(1) Poor mooring knot, 1 minute. Locker lids open and general untrimness, 2 minutes.

(2) Poor alignment, chess laid raggedly, locker lids open, 2 minutes.

(3) Poor mooring knot, 1 minute. Poor balk lashing, 1 minute. Poorly laid chess, trestle not vertical and balk in water, 2 minutes.

(4) Due to the disqualifications of "C" Co., "B" Co. was given an arbitrary rating of 10.

(5) Disqualified for not covering entire course.

(6) Five defective knots and loose canvas, 10 seconds.

(7) A defective knot and loose canvas, 10 seconds.

The bridge was dismantled by A Company in 16 minutes 5 seconds, by B Company in 13 minutes 13 seconds, and by C Company in 20 minutes.

Company B, the winning company, was commanded by Capt. Louis A. Barton, later promoted to the grade of major.

The results of the nine-day training period and the competition may be summarized as follows:

(a) Company spirit was developed and companies trained as bridge-building units. Furthermore, the regimental and battalion commanders had an opportunity to judge to a certain extent of the capabilities of the company commanders.

(b) All the noncommissioned officers got a good general idea of ponton-bridge construction, but only a few of them really became proficient in all its details.

(c) Sixteen (16) oarsmen and four (4) chiefs of ponton attained a considerable degree of proficiency in each company.

(d) The entire battalion was taught to build bridges as prescribed in the manual.

(e) Flotilla drill was held.

(f) Knots and lashings were usually well made.

(g) The fastest company built the bridge at the rate of ten (10) feet per minute. Faster work has, of course, been done. The bridge was a short one—one trestle had to be put in position without the detail entering the water, and two canvas boats, with short balks, had to be used. All of these conditions constituted slight handicaps.

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PLATOON ATTACKING FARM (Semi open Warfare)
Note the enveloping movement by one section on the extreme left, and the Lewis gun section giving covering fire on the right with scouts thrown out to the flank.

A Science of Infantry Tactics

By

Captain B. H. Liddell Hart, K. O. Y. L. I.

(Reprinted from *The Royal Engineers Journal.*)

"SIMPLICITY is the key to victory." This vital truth has scarcely been fully valued in the tactical teaching of the infantry leader. Too many text-books on tactics dealt with war in a series of water-tight compartments, explaining the points of difference rather than the points of similarity. The junior Infantry commander was taught many excellent precepts dealing with each phase of action, but his path was not smoothed for him by any framework of fundamental principles, upon which he could build as he acquired practical experience of ground and weapons. To simplify the task of the junior commander we require to establish the essential principles of tactics and their relation to the varying phases of battle. We must then fit them into their correct place, both in chronological and tactical sequence, in order to form a simple and truly scientific theory.

The family tree is an ancient institution and yet graphically clear as a chart of the various degrees of kinship. Let us endeavor to establish a simple and scientific tactical tree which will clearly convey to the military student the essential principles and their broad application to the phases of war. To understand these principles of tactics we must simplify and reduce it to the essential elements which are true of any fighting whether between two individual men, two platoons, or two armies. We will examine the simplest form of combat, that between two individuals. From their correct course of action we can deduce the essential principles, and can then apply them to the conduct of war.

But it may be argued that the conditions of war are entirely different from those of a straightforward fight between two men; that in war the enemy's movements and location are hidden from us until we are actually at grips with him.

Certainly, we agree, but the situation in war will resemble that of two men fighting under similar conditions, such as in the dark wherein a man can only locate and reconnoitre his enemy by actually touching and feeling him. Thus the man in the dark resembles the commander in modern war. Let us examine the correct principles of action which a man seeking to attack an enemy in the dark would naturally adopt.

"The Man Fighting in the Dark"

I. In the first place he must seek his enemy. Therefore the man stretches out one arm to grope for his enemy, keeping it supple and ready to guard himself from surprise.

This may be termed the principle of "protective formation."

II. When his outstretched arm touches his enemy, he would rapidly feel his way to a highly vulnerable spot, such as the latter's throat.

This is the principle of "reconnaissance."

III. The man will then seize his adversary firmly by the throat, holding him at arm's length so that the latter can neither strike back effectively, nor wriggle away to avoid or parry the decisive blow.

This is the principle of "fixing."

IV. Then while his enemy's whole attention is absorbed by the menacing hand at his throat, with his other fist the man strikes his opponent from an unexpected direction in an unguarded spot, delivering out of the dark a decisive knock-out blow.

This is the principle of "decisive manœuvre."

V. Before his enemy can recover the man instantly follows up his advantage by taking steps to render him finally powerless.

This is the principle of full and immediate "exploitation" of success.

To follow these principles is the only sure path to victory. We can only neglect the fixing phase, if our enemy commits some mistake, such as the neglect of his own security, by which he fixes himself without our intervention and so exposes himself to our decisive blow.

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Now the whole action of our man-in-the-dark can be simplified into two categories:

Guarding and Hitting

It will be noted that the man guards against two dangers: Firstly, that of personal injury from the enemy's blows; secondly, that the enemy may avoid his knock-out blow and thus cause him to overbalance. The man guards against these two dangers by extending one arm in front of him ready to parry and take the sting out of the blow aimed at his body; by using this arm to grope for and feel the enemy; and finally when he has located the enemy by seizing the enemy so firmly at a spot (the throat) so vital that he will be forced to concentrate all his energy on its defence.

All these objects have a common object, and therefore may be grouped under one principle termed "Security."

When the man has fixed his enemy, he delivers a decisive knock-out blow. It will be obvious that the harder this blow, the more likely it is to be decisive. Hence the man must put his maximum possible force into it, while he only uses the necessary minimum of strength to carry out the preparatory operations. This is the principle of "Economy of Force."

But the man can increase the effect of his available strength by surprising the enemy, by his speed, by the momentum or "follow through" behind his blows; by striking his opponent's most vulnerable spots; by full exploitation of every opening or advantage; by husbanding his energy; and by moving his limbs and muscles in harmony like the parts of a well oiled machine. All these are means to promote economy of force, and therefore can be grouped under that principle.

Thus we see that there are two, and only two, supreme governing principles—Security and Economy of Force. These two principles govern the execution of the five battle principles, and may be said to cut laterally across them.

A diagram may simplify the idea.

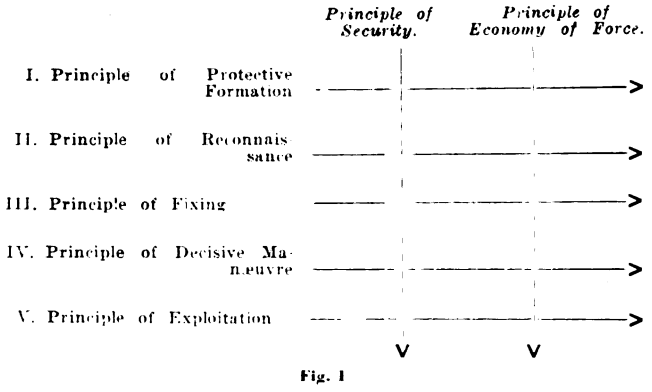


Fig. 1

Application to Infantry Tactics of the two Governing Principles Deduced from the "Man Fighting in the Dark"

A. Security. In war, as in individual combat, there are two kinds of security: Material and Tactical. The former is security against direct loss, such as casualties inflicted by the actual blows of the enemy; the latter is security against the indirect damage which we suffer if the enemy is able to avoid or parry our decisive blow, so that we weaken and expose ourselves to his counter-blow.

How does one obtain security? Exactly as did the man-in-the-dark. He pushed out one arm, which in war means adopting a *formation of security.* He used his outstretched arm to grope for and feel the enemy, which in war means *reconnaissance.* When the enemy is located, we *fix* him so firmly by an attack from one direction that he is unable to avoid or turn to meet our decisive attack delivered from another direction—usually a flank.

It will be seen that these three means to security correspond to the first three battle principles. Hence for convenience we will consider them in detail when we discuss the phase of preparation which comprises the three battle principles. The commander of any unit entrusted with the *role* of decisive manœuvre or exploitation must however remember that it is equally necessary for him to carry out these three "security" principles in the course of his own action.

B. Economy of Force. Now let us consider the principle of economy of force as applied to Infantry. One must use the minimum strength for the phase of preparation, essential though it is. One must devote the maximum possible force to the decisive blow and its exploitation. In strategy or grand tactics the distribution of our available forces is a complex problem, but in infantry tactics it is comparatively simple. Each infantry commander, platoon, company, battalion or brigade, has only four fighting sub-units under his command, apart from certain auxiliary fire weapons such as machine guns or mortars.

Hence he has only three possible ways in which he can distribute them, and these are:

i. *One sub-unit forward for reconnaissance and fixing and three for decisive manoeuvre.* This distribution will normally be best when advancing against an unlocated enemy as in the approach march or encounter attack. Thus he retains the bulk of his strength in hand until the position of the enemy has been discovered, so ensuring better results when the decisive manœuvre is carried out.

ii. *Two sub-units forward and two for manoeuvre.* This distribution will usually be advisable in a definite attack against an enemy whose positions have been located, in order to secure that the whole front of the enemy position in his sector is tested thoroughly so that a soft spot may be found. Moreover, it is imperative that the forward body shall not be held up before it has firmly fixed the main resistance of the enemy, otherwise the manœuvre body may have to be used before the decisive moment—which would be the antithesis of economy of force.

iii. *Three sub-units forward and one for manoeuvre.* This distribution may be advisable when following a creeping barrage—which reduces the need or possibility of manœuvre. This will ensure that the whole frontage is cleared directly the barrage lifts and so enable the forward sub-units to keep close behind the barrage. Further reasons for this distribution are that in such a case the strongest opposition will probably come early, and that a counter-barrage is likely, in which event the bulk of the unit will escape it.

It may also be advisable to adopt this distribution when allotted an unusually broad frontage, in order to cover it with fire. It entails the risk, however, of limiting the force of your manœuvre.

It must be remembered that while the decisive attack is made by the maximum force, its success depends upon the enemy being really fixed. *Manoeuvre is useless unless the enemy is first fixed in another direction.* Hence the manœuvre body is not necessarily the largest. The "last straw which breaks the camel's back" is a great truth in battle tactics.

It will be noticed that the author uses the words "forward body" and "manœuvre body," instead of the recognized terms "firing line" and "supports." This is because

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these terms are no longer applicable to modern infantry tactics. In order to instil a correct doctrine into the minds of the average officer and N.C.O. it is advisable to eschew misleading terms, and not to try to reconcile modern ideas with out-of-date phraseology.

The term "firing line" does not convey the idea of the outstretched arm or of distribution in depth. It suggests a broad frontal attack with no attempt to make use of covered ways of approach or to find the soft spots.

In the case of "supports" both the word and the idea are dangerous. It does not inculcate the essential idea of manœuvre, but rather the obsolete and unsound idea of reinforcing frontally troops who are held up, which means piling the dead in front of the enemy's strongest points.

Reinforcement of units which are held up causes confusion owing to the mixing of units, nor does it produce so great a moral effect as a diversion from a flank, either on the enemy or on the troops reinforced. As long as obsolete terms persist, there is a danger of a wrong idea lingering in the mind of the average leader. It is contended on the other hand that the terms "forward body" and "manœuvre body" instinctively suggest the true principles. *Even if we retain the old terms, however, the action of these respective bodies still holds good.*

When one speaks of weight or force in modern war it is essential to remember that it is weight of fire and not of mere numbers of men. An army composed of highly trained fire units capable of manœuvre can defeat far larger armies who rely on mere masses of men. Thus highly fortified enemy defences must be countered by an increase of mechanical fire power, and not by reducing the intervals, and so increasing the casualties, of the infantry.

The infantry commander must not, however, delude himself with the idea that he has fulfilled the principle of economy of force when he has correctly distributed his sub-units.

He must use every means to increase the effect of his available numbers. How? By following the same sub-principles as did the man in the dark, which were:

i. *Surprise.* Striking the enemy from an unexpected direction, at an unexpected moment, in an unguarded spot. It is the duty of every commander before and during the attack to use instinctively this, and the following, means to economy of force. He should ask himself subconsciously at every stage of the fight: *How can I surprise the enemy? Is there a covered approach by which I can get closer to the enemy or round his flank? Is the smoke or fire of other units or arms affording me a momentary chance to get forward or to assault the enemy?*

ii. *Speed* of movement, fire, and eye. Opportunities in battle are fleeting and must be constantly noticed and seized.

iii. *Momentum. How can I keep up the pace of the advance? Is this a suitable moment to use the expanding torrent system?* We will discuss this matter later.

iv. *Soft Spot,* seeking and striking the enemy's weakest spots, instead of dashing out the lives of one's men in front of his strongest points.

Where does there appear to be a weak spot or where is the enemy beginning to give way?

v. *Husbanding* one's men by the aid of correct tactics and covered approaches instead of massed frontal attacks in line.

How can I get my men over that exposed stretch with the least loss?

vi. *Mutual support,* whether of brigades or sections, all working together like the muscles of the body or the members of a football team.

Can I help the units on my flanks to get forward by bringing cross-fire to bear on the enemy opposing them?

vii. *Exploitation* to the full of every advantage gained.

How can I best exploit the soft spot which I have found or the fire position which I have gained?

Before going on to deal with the execution of the five battle principles, let us consider certain

New Characteristics of the Infantry Fight

Infantry tactics have been thrown into the melting pot by the realization, which has been forced upon us, that our former methods are inapplicable and wasteful of force under modern conditions. The outstanding change has been the realization that the weight, or force, of an attack does not increase in proportion to the numbers of men thrown in; that progress can only be made by intelligent manœuvre of fire power.

Increasing numbers beyond a certain density adds nothing to the effectiveness of the attack or defence, but only results in greater casualties. Instead of dense lines of bayonet men in attack, or crowded position, in defence, one must use widely dispersed combat groups containing comparatively few men, but well equipped with fire and smoke weapons. These must be allowed ample frontage to manœuvre and find the enemy's soft spots. Thus the exact intervals will depend on whether the ground is open or close.

It is necessary at this point to remember that, in any large action, each of the infantry units will be restricted to a definite sector of the front. At first sight, therefore, it will be confined to a purely frontal attack. But modern destructive weapons have enforced a wide dispersion of the combatants on the battlefield. This dispersion has rendered possible penetration by the fire units—the sections—between the enemy defence posts. It is the *role* of the section, platoon, and company commander in turn by exploiting this penetration to change their sector of the battle from a mere bludgeon fight into a manœuvre combat, thus fulfilling the principle of economy of force by striking "from an unexpected direction against an unguarded spot."

Infantry in Attack

We now turn to consider the application of our man-in-the-dark theory to practical tactics. The ideal infantry battalion, company, or platoon, should resemble a human tank, comprising both offensive power and protective armour. Its offensive power rests in its arms and legs, or in other words its weapons and manœuvring power. The protective armour is represented by an open formation, such as a diamond or square, which prevents more than one of the sub-units being surprised by the enemy, and so affords time for the remainder to manœuvre to take the enemy in flank.

A. Preparation (Security).

"The man extends one arm to grope for, feel, and seize his enemy by the throat."

1. Protective Formation.

We deduce from our study of the man-in-the-dark that each unit should move with an advanced guard or forward

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body—the outstretched arm—pushed out in the probable direction of the enemy, whilst the main, or manœuvre body, follows in rear. The latter will thus be ready to manœuvre against any enemy which the forward body encounters, and by its mere presence will protect the flanks of the forward body. In modern war the defenders can only be definitely located bit by bit by actual attack. Hence the danger of a surprise counter-attack is ever present.

An open formation of security is therefore just as vital during the attack as during the approach.

a. The Advance or Attack against an unlocated enemy.

Maxim i. The best formation for any body advancing against an unlocated enemy will usually be that of the diamond (see Figs. 2 and 3). Whichever point of the diamond encounters the enemy first has the duty of fixing him whilst the other three manœuvre to take the enemy in flank.

Maxim ii. Until a unit is committed to attack on a definite point its commander should move with his forward body in order best to direct the movements of his unit and keep in touch with the situation in front. The diamond, with its solitary leading point, facilitates this direction by the commander, and enables him to make the best use of any covered approaches.

Maxim iii. Hence it should also be used for all manœuvre bodies and units in rear until they are committed to a definite *role.*

Maxim iv. Security is the first essential. Hence each unit should move *by bounds.* In this method each body advances alternately, while the other is halted in a position from which it can cover with fire the moving body. The manœuvre body, in an advance, will only bound as far as a position in rear of the forward body, from which it can cover the next advance of the latter.

When not in the neighborhood of the enemy speed is more important than security. Therefore, units should move in column of route along roads, with only the actual head of the forward body deployed. Thus in the case of a company serving as advanced guard or forward body to a battalion, only the forward platoon would be deployed in

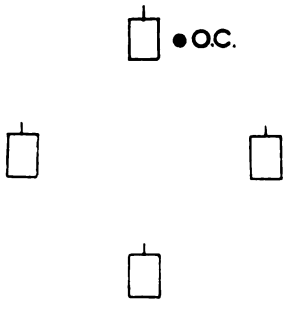


Fig. 2. Diamond Formation

diamond formation, whilst the three manœuvre platoons move in fours along the road, until in the neighborhood of the enemy.

b. The attack against a located enemy.

Maxim i. You will normally have two sub-units forward and two for manœuvre. The formation will usually be a modified square (see Fig. 4). The two forward sub-units should be well apart in order to cover the whole extent of your frontage with fire and to thoroughly explore it for soft spots. The two manœuvre sub-units should move as close together as the enemy's fire allows, in order to be under quicker control for manœuvre.

Maxim ii. Speed is the first essential, and therefore continuous progress must be aimed at, instead of movement by bounds.

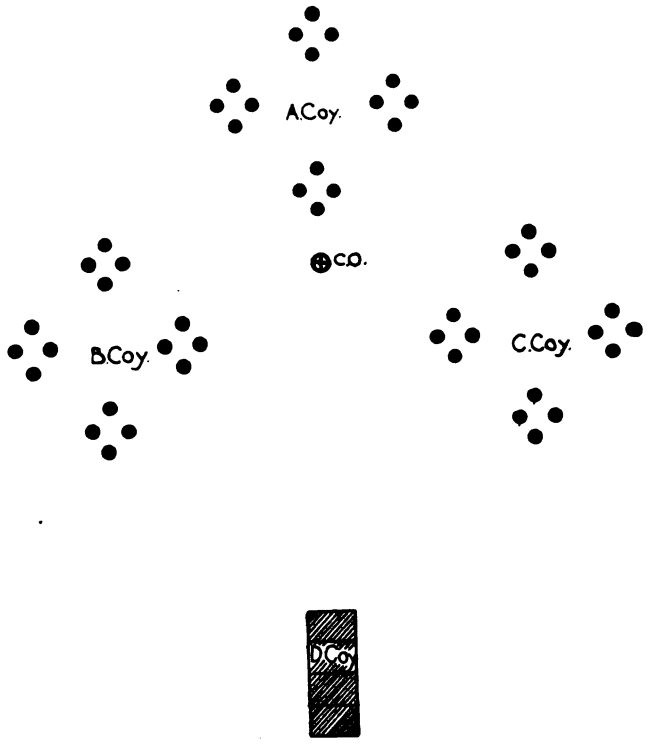


Fig. 3. A Battalion in the Approach March Against Unlocated Enemy



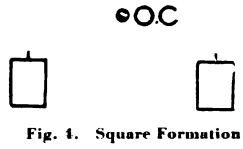


Fig. 4. Square Formation

SECTION FORMATIONS.

We now turn to consider the formation of the actual fire, or fighting, units which are the sections. The extended line is not a formation of security; it is not under the instant control and direction of the section commander and thus it prevents full advantage being taken of covered approaches and reduces the power of manœuvre.

The very idea of a line presupposes a wasteful frontal attack instead of a manœuvre combat. Hence it should be abandoned in favor of a formation such as arrowhead (see Fig. 5), with the section commander as the point of the arrow. Arrowhead is no more vulnerable to frontal fire than an extended line, whilst against enfilade fire it is even less vulnerable. It gives the section commander far greater powers of control and manœuvre, and is capable of firing in any direction. Thus it forms our ideal of a human tank or moving strong point.

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When advancing through defiles or through woods and thick bush, the arrowhead can be closed into worm formation, in file or single file.

Maxim i. Arrowhead will therefore be the usual formation for both fire and movement.

Maxim ii. Worm will be the alternative formation for movement.

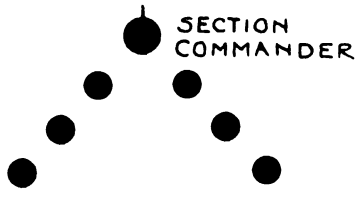


Fig. 5. Arrowhead Formation

Maxim iii. During the advance the section commander must use his intelligence and change from one formation to the other as the ground dictates.

II. RECONNAISSANCE.

Reconnaissance may be divided into two classes, "previous to battle" and "during battle."

a. Previous Reconnaissance.

This is carried out by three methods:

i. The commander of each infantry unit studies all information regarding the enemy and the ground, which his superiors or the other arms, such as cavalry and aircraft, have been able to obtain.

ii. He carries out a personal survey of the ground ahead before committing his unit to an attack on a definite objective or to the defence of a definite position. In this survey he should be accompanied by his sub-unit commanders and any *liaison* officers.

iii. Sending forward specially trained company scouts to carry out long-distance reconnaissance to obtain information on definite points.

b. Battle Reconnaissance.

This is carried out by observation and fighting:

i. Observation is achieved mainly by section scouts or patrols moving ahead of, but in touch with, the sections or higher units, respectively, which they are covering.

Maxim i. Each section when it has shaken out from the platoon should send a pair of scouts ahead to insure protection. Section scouts should move ahead of, but within view of their sections. It is their *role* to discover the most covered ways of approach and to give warning of defence posts or parties of the enemy, and thus prevent the section coming under heavy surprise fire. They should move by bounds, and at the end of each bound one scout should signal back for the section to come on or the reverse, whilst the other remains observing. When held up by the enemy's fire the section scouts should take up a position from which they can cover the section, as it moves up. The section should always move to rejoin its scouts in order that it may become an intact fighting organization once more.

Maxim ii. Patrols, which should consist of a complete section, or platoon, will be used to afford close protection to large units. They should move in touch with the unit which they are covering, but considerably beyond the radius of action of the section scouts. Like larger units also they should move in a formation of security, such as the diamond.

ii. Reconnaissance by fighting will be carried out by the advance of the forward bodies which by actually attacking the enemy's position will feel and test it at all points, and so endeavor to discover or make a breach at some weak spot. Hence it may be best considered as part of the phase of fixing.

III. FIXING.

Each forward body should advance direct on the enemy in order to reconnoiter him by fighting, discover and penetrate his weak spots and so continue its advance until it has gained the objective. If no soft spots can be found in the frontage allotted to it, it should fix him firmly, so that the manœuvre body can work round his flank and deliver a decisive surprise blow.

Maxim i. Thus when the fire of the enemy holds up a forward body, its duty will be to keep the enemy immediately opposing it *fixed* to his ground and to absorb his attention by maintaining a vigorous fire and working its way closer at every opportunity provided by the fire or smoke of neighboring units or of the auxiliary arms.

Any slackening of pressure by the forward body will only result in the defence being able to turn and meet the flanking attack. There is a danger that during this flanking movement, the manœuvre body may be exposed to cross-fire or counter-attack from other enemy posts. This can only be averted by the neighboring forward bodies really fixing their own immediate enemy. To insure this mutual support every forward body must be determined to close with, and fix the whole attention of, the enemy opposed to them.

Maxim ii. The leading sections must not delay the advance by halting to fire until no further progress can be made without beating down the hostile fire.

Maxim iii. The action of the forward infantry in attack must consist of a constant pressing forward to close with the enemy in order to find the weak spots in his defences.

Maxim iv. To this end they must seize every available cover afforded by the ground, fire, or smoke.

Maxim v. The speed of advance will be vastly quickened if tanks working with the infantry are used to carry the equipment and extra ammunition of the infantry.

Maxim vi. The forward sections can often fix the enemy defence posts opposed to them far more effectively by firing smoke to windward of them than by rifle or Lewis gun fire. The smoke drifting down over the enemy blinds them and so enables the manœuvre sections to work round their flank unseen to assault them. Moreover this method economizes ammunition.

Maxim vii. To enable him to take instant advantage of any soft spots which are found by the forward companies or platoons, every battalion and company commander should detail an officer or specially selected N. C. O. with runners to move with each of the forward companies or platoons, and to send back word to him the instant a gap is found or made.

Maxim viii. Commanders should keep touch with the units on their flanks by observation or by sending out a patrol or special scout when the necessity for information or communication arises.

B. DECISIVE MANŒUVRE.

iv. "The man delivers a decisive blow from an unexpected direction against an unguarded spot."

Each manoeuvre body will move close behind. Its normal purpose will be to assist, by means of manœuvre, the

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forward body to advance and gain the objective. If the fire of the enemy holds up the former body it will be the *role* of the manœuvre body to turn the flank of and enfilade the enemy resistance which is opposing the forward body.

Maxim i. To achieve this a manœuvre body may have to quit its own sector and follow in the wake of a neighboring unit which is still advancing. It will pass through the gap thus made, and come in on the flank of the enemy, against which it will deliver an immediate blow.

As soon as this manœuvre has achieved its aim the forward and manœuvre bodies will mop up, reorganize and continue the advance until the objective has been gained. They will then consolidate the ground won in the most suitable tactical positions in the vicinity.

Maxim ii. If the enemy counter-attack during the advance the manœuvre body will be at hand and ready to counter-manœuvre against them.

Maxim iii. The commander of the unit must not, however, hold back or hesitate to throw in his manœuvre body to turn the enemy's flank directly it is clear that the forward body has fixed him.

Maxim iv. To guard against the danger of counter-attack during its flanking movement, the manœuvre body must itself be distributed in depth.

Maxim v. Company and platoon commanders should always move with their manœuvre platoons, or sections, directly they have committed their forward body to a definite attack.

Maxim vi. Battalion and brigade commanders should also move with their manœuvre companies, or battalions, but only until they commit them to a definite *role*. They should subsequently move with their reserve. Thus every infantry commander will be able to keep control of the course of the attack and influence it without delay at the decisive moments.

Maxim vii. It must be clearly understood that the assault is not necessarily carried out by the manœuvre body. If the enemy turn to meet the latter, it will be the duty of the forward body to seize the opportunity to rush in and assault the enemy.

Maxim viii. In the case of the platoon the Lewis gun sections may often be used for manœuvre. They are less mobile and present a larger target than the rifle sections, but if covered approaches are available, they are more valuable for manœuvre, because of the greater surprise and enfilade effect of Lewis gun fire.

It is highly desirable that infantry should be systematically trained in deployment and changing direction *by signal*. These will not only be of great advantage during the approach march, but could be used on many occasions during the actual attack to quicken manœuvre and direct subunits to take advantage of covered ways of approach. If thoroughly ingrained in the troops, signals can be used *at suitable moments* instead of the slower methods of messages.

C. Exploitation.

v. "The man instantly follows up his advantage and renders his enemy finally powerless."

a. The limited or unlimited objective in attack?

In battle *the only true objective is the enemy*. But his actual strength and dispositions can only be ascertained by fighting. Hence certain topographical objectives must be allotted beforehand in order to serve as stepping stones by means of which the artillery can co-operate with and support the infantry advance. On the other hand it is a direct violation of economy of force to limit the advance of unexhausted units which find soft spots and can press on with little opposition. One should only replace those units whose momentum is checked by fatigue and severe opposition. Therefore these stepping stones—termed objectives—should be restricted to the battalion or higher formations. The companies, platoons, and sections of each battalion should press on to gain the battalion objective, their objective being the only true one—*the enemy*, wherever they find him in their path.

Hence the battalion will be the smallest unit which needs to carry out pursuit beyond the objective.

b. The pursuit.

Companies and platoons need only be distributed into two bodies, forward and manœuvre, but battalions when

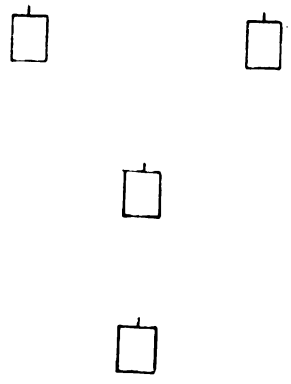


Fig. 6. Battalion in a Definite Attack

carrying out a definite attack should be divided into three bodies: forward, manœuvre, and reserve. (See Fig. 6.)

The reserve body is the means whereby the battalion or higher commander exploits success or retrieves failure. At the moment the battalion objective is taken, the enemy will be disorganized and probably demoralized, but if the attacking unit halts on the objective and is content to send out a few patrols only, the golden opportunity of exploiting the enemy's local reverse will be lost. If the troops which carried out the assault have to be reorganized for pursuit precious minutes will be lost. If a separate unit under a different commander is used for pursuit, delay is bound to occur, and the pressure on the enemy be relaxed, thus affording him a chance to recover.

Hence a fresh body, but one which is under the control of the commander who has taken the objective, should be used for pursuit.

Maxim i. The normal purpose of the battalion reserve therefore will be to exploit the success and continue pursuit until such time as fast-moving tanks or other mobile troops have caught up and passed through them. In this way a relentless pressure on the yielding enemy will be maintained, so that his retreat may rapidly spread and gain momentum, thus resembling a snowball rolling downhill.

Maxim ii. If the forward and manœuvre companies fail to gain the objective, the battalion commander may use his reserve to relieve them or to meet counter-attacks.

(To be continued)

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Conversion of Hachures to Contours

The preparation of the Chateau-Thierry battle map

By

L. B. Roberts

Major, Engineer Reserve Corps; Assoc. M. Am. Soc. C. E.

[NOTE.—Before the invention of that useful device known as the *contour*, the usual method of representing ground forms was by means of *hachures*, or hill and valley shading, as shown on Fig. 1 of this article. As many American officers know, the majority of European maps which pretend to represent ground forms, do so by means of hachures.

Hachures are unsatisfactory for several reasons. First, they give only a very general impression of the contour of the terrain and are not sufficiently accurate or rather definite to allow the solution of problems in map reading, such as the grade of a road, or the visibility of one point from another, etc. Second, hachures clutter the map and confuse the other necessary features. Third, the making of hachures is a slow and painful operation, requiring great skill on the part of the draftsman to produce even tolerable results.

Major Roberts well expresses the attitude of the American towards the hachured map, and entertainingly describes the novel and interesting experiment of converting a hachured into a contoured map.—ED.]

AT the beginning of the World War there was in existence a complete topographical map of France on a published scale of 1:80,000, or about 4/5 inch = 1 mile. This map is called the *carte de l'etat major* or general staff map. Its preparation was undertaken at the beginning of the nineteenth century, and its completion required about sixty years. Starting about the year 1810, maps of each commune (the smallest French political division) were made, to accompany the registers of property used by the authorities as a basis for taxation. These property or cadastral plans were drawn on different scales (usually 1:2,500) with varying degrees of accuracy. The general staff map was compiled from the cadastral plans; in this compilation they were superimposed upon the accurate control skeleton of triangulation started by Cassini in 1750, so that the proper positions of the important features, such as churches, cross-roads, etc., were well established.

In addition to the general staff map, scale 1:80,000, various engineering units of the French Army, as a part of their field training, had mapped disconnected areas around certain fortresses, on a scale of 1:20,000, or about 3 inches =1 mile.

During the war, due largely to the demands of the artillery, the production of large scale maps was carried on by British and French engineers, so that there was available, when American troops arrived in France, a narrow band covering the battle zone of that period on the western front.

Generally, these large scale maps were also compiled from the cadastral plans, were produced rapidly under great pressure, and were not as accurate as those of the fortress areas published to the same scale. The fact that a system of 1:20,000 scale maps did not cover the entire area of France was not generally known or appreciated by the A. E. F.

In the American forces the preparation and reproduction of nearly all maps in the army zone was one of the functions of G-2-c, or the topographical division, intelligence section, General Staff. Until the American base printing plant was completed (June 15, 1918), American troops were supplied with available French and British maps.

During offensive operations there were times when the opposing forces broke through the limits of the band of large scale maps along the battle zone, and maps on a smaller scale would necessarily be distributed. This was the case during the third German offensive of 1918, when the drive starting May 27, between the Oise Canal and Berry-au-Bac, broke the allied front. The French reserves were successful in limiting the exploitation of the initial German success; American troops definitely stopped the advance in the vicinity of Chateau-Thierry.

The German drive completely overran the limits of the existing large scale maps, and all that was available for distribution was the general staff map, scale 1:80,000.

The American divisions at Chateau-Thierry, under the 3d French Corps, looked to the French for their supply of maps; the general staff map, which was the only map the French were able to supply, was never satisfactory to our troops. The relief, or contour of the terrain, on this system is shown by means of hachures instead of contours. This method of hill shading is generalized and misleading, and was particularly confusing to the Americans, whose entire training in map reading had been gained through a study of the ground forms as shown by contours. While the map situation during the early part of the war was such that it was necessary to plan and conduct the first battle of the Marne on the 1:80,000 scale map, and we know that the French were able to use it and use it well at that time, the Americans had not been trained in the use of such a map and would have none of it. Complaints in regard to it were emphatic and vividly expressed; it seemed to be as difficult to issue proper orders for troops to take certain positions as it was to obtain proper reports of troop locations.

To meet this situation it was necessary to furnish a better map for operations at once; the quickest thing to do was to enlarge the 1:80,000 scale map to a scale of 1:20,000 by photography. This, of course, introduced errors; any errors in position on the original were amplified four times, and the enlargement of the hachure lines made them still more difficult to read. This enlargement to 1:20,000 was issued to the troops and was not satisfactory; it was, in fact, the first step in a military engineering expedient, and should have been valued as such, and nothing more (see Fig. 1).

The second step in the preparation of the Chateau-Thierry map was to eliminate the hachures and substitute contours. Accordingly, by direction of Col. R. G. Alexander, Chief, G-2-c (Topography), G. H. Q., the writer undertook to make this change.

It is difficult for those whose work has never brought them in contact with the actual making of a map to realize, when using a good one, either the time required for the various necessary operations or the difficulties that existed in each case. The most important question in the production of a map is usually one of relative accuracy. For instance, the time necessary to produce a sheet of either the 1:50,000 or the 1:80,000 scale maps at the *Service Geographique* is given as from sixteen to eighteen months. In this country, an average fifteen-minute quadrangle on

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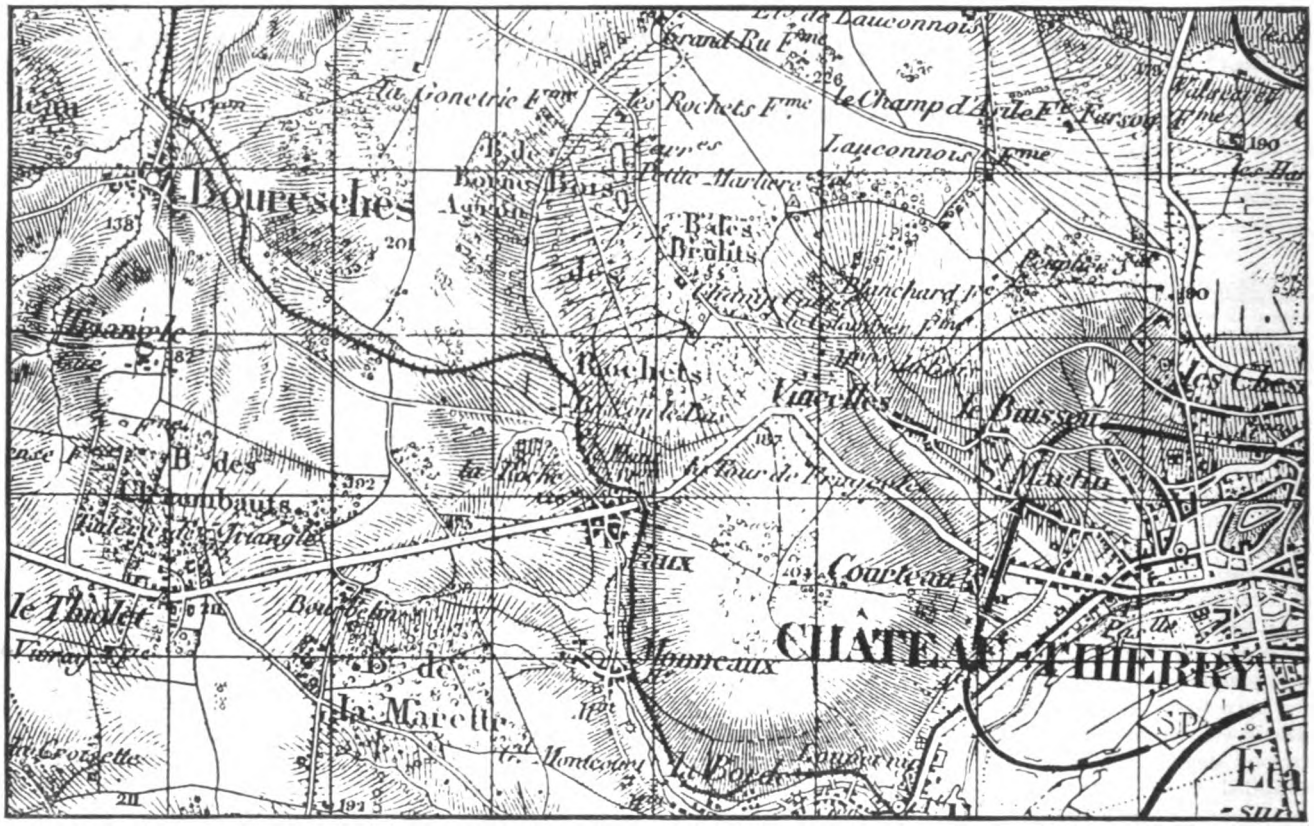


Fig. 1. Portion of French hachured map. The squares are one kilometer

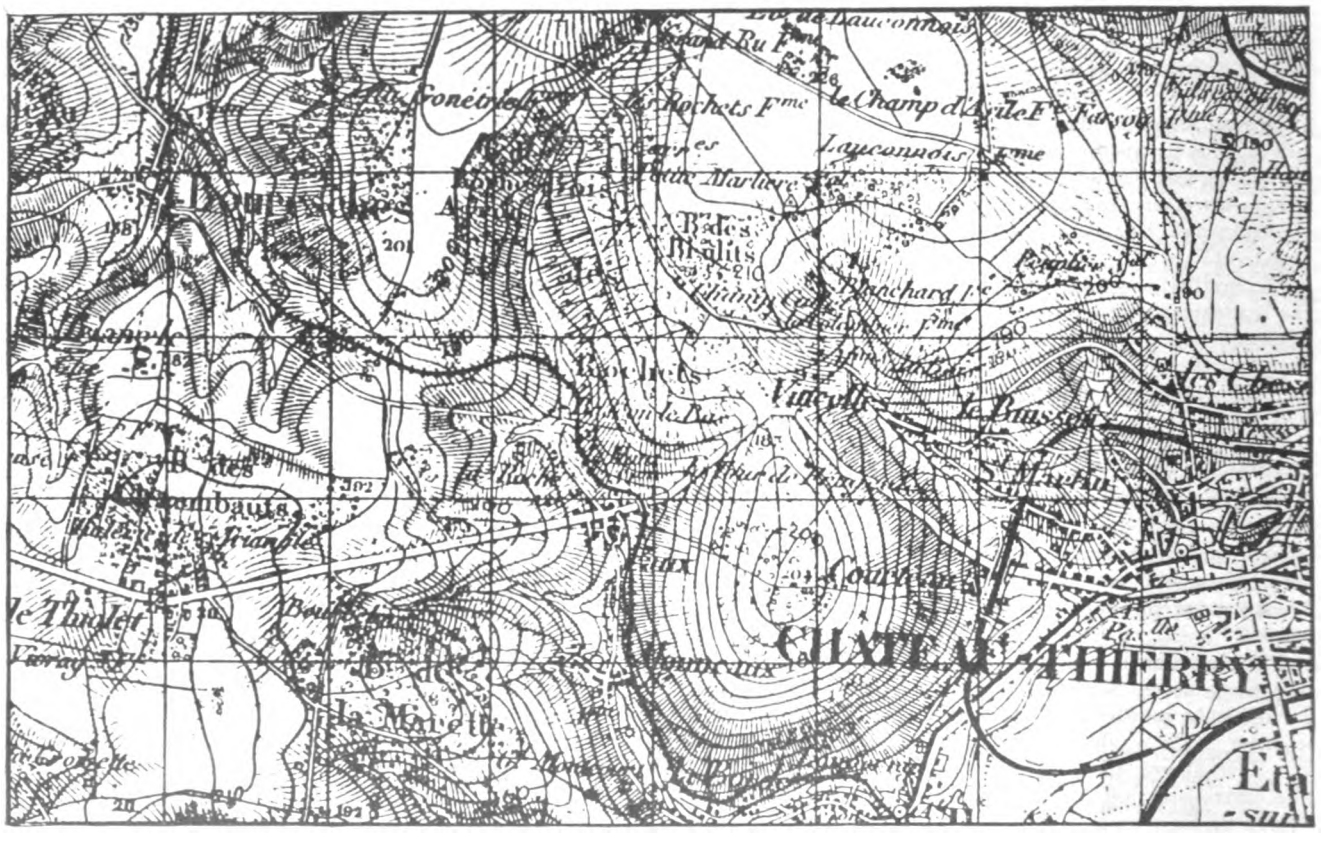


Fig. 2. 10-meter contours sketched from hachures and elevations

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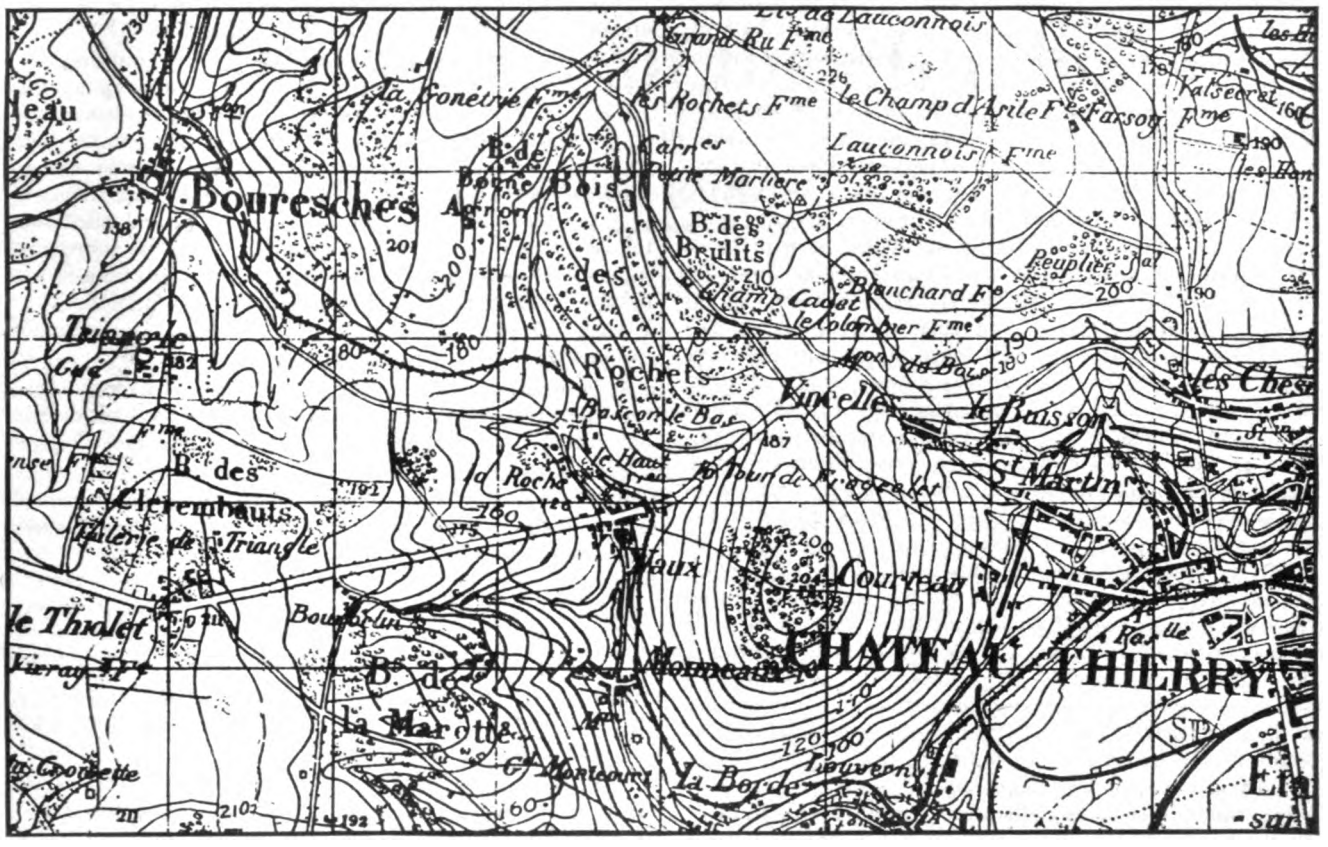


Fig. 3. Contour map based upon hachures

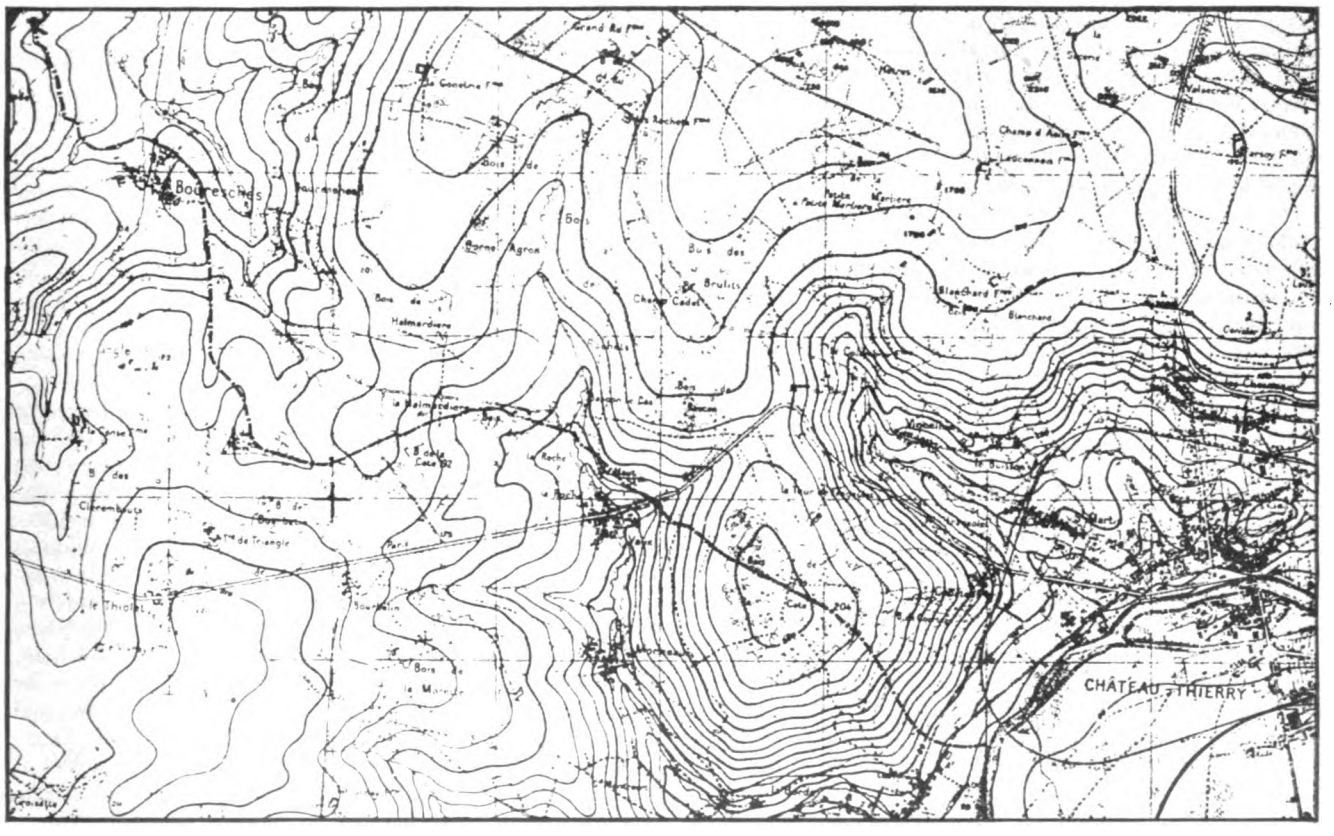


Fig. 4. Contour map by French survey. Compare with Fig. 3

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a scale of 1:62,500, or about 1 inch=1 mile, is produced in about a year by the U. S. Geological Survey. In both of the services mentioned the work is extremely accurate, and is carefully checked in every detail. On the other hand, the writer has seen an Indian produce a perfectly clear and readable map in a very few minutes by drawing in the sand with his fingers, and between these two extremes every gradation in accuracy can and does exist.

The problem in this case was to produce a large scale map the size of which was 32 by 42 inches, as rapidly as was possible. The work was started at 10 a. m. June 21. Two engineer sergeants immediately started a tracing on linen of the roads, timber and cultured features on the 1:20,000 scale map, which had been photographically enlarged from the 1:80,000. It was evident that one difficulty would be caused by the fact that very few men could work on the tracing at the same time. Another draftsman, however, who had been trained to letter backwards and upside down (a useful accomplishment where zinc plates need correction) was able to speed up the work by working from the top of the tracing.

G-2 had been collecting picture post cards of France, and the writer first had a look at the collection around Chateau-Thierry to see if an idea of the shapes of the hills could be obtained. The cards were not of much assistance. The next step was to draw form lines, without any regard to actual elevations, directly upon the photographically enlarged 1:20,000 map. These form lines showed, as closely as the hachure edges indicated, the outlines of the drainage net and of the ridges and plateaus.

An examination of any sheet of the staff map will show a number of elevations scattered over the area; these elevations were fixed trigonometrically before any modern system of leveling had been adopted, and were known to be considerably in error. From the elevations shown as the crests of ridges or high points on hills and plateaus, it was possible to change the form lines of the ridges into contours of the tops; in a similar manner from the elevations given near water courses the bottom contours were crossed on the drainage net. There now existed the main elements of a contour system, and by interpolation all the contours were drawn between the upper and lower limits of elevation. The work of drawing and tracing the contours was completed in six hours.

The tracing of the woods and planimetry was not yet complete. However, it was possible to make immediate use of the tracing of the contours by taking off prints direct from the enlarged hachure map as a base. One hundred copies of this map were made in four hours by the Dorel process (in which all the work of reproduction, including registration, is done by hand), and were immediately sent forward by courier. (See Fig 2.)

After the arrival of these maps at the front the following telegram was received at G.H.Q. "Hq. 2nd Div, June 22, 1918, Col. Alexander, G-2, G. H. Q. Contoured maps Chateau-Thierry one to twenty thousand very valuable to us. If possible send additional copies."

The entire force available continued the work on the tracing of the planimetry and woods. This tracing was completed at 1:10 a. m., June 23rd. Together with the tracing of the sketched contours, it was sent to the base printing plant at Langres-Marne, by motorcycle.

The base printing plant, operated by the 29th Engineers, had been in operation only five days. It was known that this job was coming down and everyone was set to turn it out quickly. In spite of many difficulties, 1,000 copies of the map in its final form were sent to the 2nd Division at 6:30 a. m., June 23rd. (See Fig. 3.)

The French battle map of the same area made its first appearance in Paris on June 29th. (See Fig. 4.)

Ever since the break through, the French mapping services had been working on a 1:20,000 scale map of this region; it was made according to the excellent methods adopted by the French Army, and conformed to high standards of accuracy and draftsmanship. It was a compilation from such cadastral surveys and original information as existed at the *Service Geographique*, and also from the restitution of aerial photographs. Since the sources of information were more accurate and especially on account of the aerial photographic restitution, the issue of the French edition, with necessary over-prints, to combatant troops was continued.

It is interesting to note that on this first French issue, the Bois de Belleau, as shown on the staff map, had already officially become the Bois de la Brigade Marine.

It is believed that a comparison of Figs. 3 and 4, with regard to the accuracy obtained by the rather novel method of production will be of interest to military map makers and users.

Decline in Cost of Footwear

The high cost of footwear is bound to fall sharply, if figures given out recently by the Quartermaster Corps are any indication of readjustment in prices.

When bids for 500,000 pairs of shoes for the army were opened in April, 1920, the average price was found to be $6.73 a pair. Today, with bids calling for 250.000 pairs, the contracts have just been awarded at an average price of $3.43 per pair, a cut of practically fifty per cent within twelve months.

Such prices will save the taxpayers millions of dollars in shoes for the troops.—*Office of the Q. M. Gen.*

Better Care of Disabled Veterans

First fruits of Congressional action to provide better and more ample facilities for the care of disabled veterans of the great war were announced recently. By authority of Congress, the Treasury Department was recently directed to transfer to the War Department $750,000 for the enlargement of the Fitzsimons General Hospital, Denver, Colorado, to enable it to take care of tubercular cases among veterans of the late war.

These funds were turned over to the War Department on April 20 last, and an immediate start was made by the Construction Service of the Quartermaster Corps, in the preparation of plans and specifications for enlarging this hospital by approximately 600 beds. This work includes the remodeling and completion of six large ward buildings of about 100 beds each, the construction of a new storehouse, some additions to existing storehouses, the erection of quarters for eight officers and six non-commissioned officers, an administration building, additions to the laundry, refrigerating plant, and bakery. It also involves the extension of water, sewer and electric lighting systems and roads, and the enlargement of the heating plant.

Major General H. L. Rogers, the Quartermaster General, has sent an officer of the Construction Service from Washington to Denver with the complete plans and specifications, and work will be started shortly.—*Office of the Q. M. Gen.*

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The Voyage of the "Gwalia"

By

Francis Rotch, Jr.

Formerly Lieutenant, 57th Engineers

[NOTE.—Engineers have made good on so many different kinds of work on land that a new one occasions little surprise. But here is a story of how an officer and a bunch of men from the 57th Engineers tackled a job on the briny deep, heretofore the exclusive domain of our rollicking rivals, and got away with it.—ED.]

THIS is the story of how twenty-nine soldiers of the American Expeditionary Forces navigated a 400-ton tug from St. Nazaire, France, to New York, and were lost only once during the entire trip.

To start at the beginning, as all stories should, we will have to go back to the "good old days." The 57th Engineers was organized to take over the transportation on the inland waterways of France. As this service would take the men, more or less—it happened to be mostly less—near the lines, it appealed to a lot of seamen, both of salt and fresh water, who thought this branch offered more excitement than the Navy.

After the Armistice, many of these men were sent to the base ports, attached to the transportation corps, and assigned on tugs and barges about the harbor, the writer being assigned as Assistant Marine Superintendent at St. Nazaire, under Capt. Bertrand Fay.

Along in July, 1919, the closing of the port of St. Nazaire left the Army Transport Service with several large ocean tugs on their hands, tugs that had been commandeered by the Army from their owners in the States, and it was the wish of the Government to return them to their original owners. Two of these tugs were the *Cadmus* and the *Gwalia*, belonging to the New England Fuel and Transportation Company of Boston.

Captain Fay assigned to me the task of picking the crews to take the tugs back. As one of the other tugs, the *Penguin*, was manned by a civilian crew, her enlisted personnel having returned to the States, her crew was transferred to the *Cadmus* under Capt. Fred Kornick, but to man the *Gwalia* was a different matter. No civilian crews were obtainable, and it was impracticable to send her home with a French crew, so Captain Fay decided to send the *Gwalia* back with a crew of officers and enlisted men from the personnel at St. Nazaire. I was told off as her skipper, with a crew of soldiers of the American Expeditionary Forces, all of them members, prior to the Armistice, of the 57th Engineers.

There was no trouble to pick a crew, as my office was besieged with men only too glad to get a chance to work their way back to "God's Country" (even a "Y" secretary offered his services!). The 57th was full of good men, and it was only a matter of a few minutes to pick my crew and have the list sent in to headquarters.

Lieut. C. S. Appleby, Q. M. C., an old-time salt-water chief engineer, was assigned as chief, and he immediately put on a pair of overalls, grabbed a chunk of waste, and went to work; what he did to the old girl's engines is history. In a week they were running like a watch, and a happy man was the chief.

The crew was soon aboard, and we were hard at work cleaning ship and putting her in shape for the long trip ahead of us. A turtle-deck was built over forward, and as far aft as the fireroom door, extra guys were put on the stack, and everything put in shape for sea.

There is enough trouble and confusion in getting a merchant vessel ready for sea, but to sail from a French port with a soldier crew is another story. One has all the forms and procedure incident to a merchant ship, added to that of the passenger list of an army transport. There were a thousand and one little things to do, from making out a passenger list down to a field return, and with the added job of getting stores and supplies, I surely had my hands full. The hardest part was to convince the supply officer that as many navigation instruments were necessary to navigate the *Gwalia* as for the *Leviathan*. According to that gentleman, all that I had to do was to steer due west, and I would strike the coast of the U. S. A. some place between Florida and Maine.

At last the red tape was all unwound, all papers made out to suit the gentlemen at the embarkation camp, and we were ready for our final inspection. Then came another rub. According to instructions for returning troops, they were to take back with them only a limited amount of clothing. As our trip would take at least a month, and the men —particularly the fireroom gang—would be working all of the time, I made request for additional clothing. Long and loud was the wail put up by the embarkation people, but through the good offices of a captain inspector, who had a very good idea of the sea and its peculiarities, we were given all we asked for. He was a fine little man, that captain, and I only wish I could remember his name.

Then for the final inspection and physical examination, and again army and sea customs clashed. We marched to the camp for our final examination, and, of course, some of the men were left aboard, as steam was up. When the roll was called, naturally, some of the gang were missing, and long and lengthy explanations were the order of the day. Luckily, the inspecting officer and our surgeon (some title we handed Nick!) patched things up, we were "decootied" and passed as pure and shining examples of the American Army.

While on duty with the Army Transport Service at St. Nazaire, a captain of the Medical Corps had the nerve to tack a sign on the office of the Marine Superintendent, and to get even with him I invited him to act as ship's doctor for the trip, and so the name of Capt. J. C. Nicholson, M. C., was added to our crew, and we all can say that through the entire trip Nick never lost his smile.

On the afternoon of the 10th of July we pulled out of the inner basin and tied up at the outer dock. The next day a French compass adjuster from Nantes came down and made a few passes over the compass, mumbled a few secret words and informed me in all good faith that the compasses were adjusted. We afterwards found out that he was right, within at least 20 degrees, most of the time.

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The next day some son-of-a-sea-cook wished about ten tons of lachrymatory gas on us with instructions to dump it overboard not less than 200 miles from shore. That afternoon a gentle breeze was blowing from aft and soon the engine and firerooms were chock-a-block with gas. While the gas is harmless, still it brings tears to the eyes by the bucketful, and in no time at all the engine-room crew was on deck and loud in their lamentations. It rested with one tearful soldier "black squadder" to solve the proposition. "Soldiers are issued gas masks to use, so why not make use of them?" And in a jiffy the entire crew donned their masks, and the good people of St. Nazaire were treated to a sight that we think was the first in history—a ship putting to sea with her entire crew wearing gas masks. The *Cadmus*, ahead with the pilot, pulled out from the dock and headed out through the breakwater and we followed, leaving behind a various collection of *petites mam'selles* belonging to various members of the crew, and also the famous wheelbarrow belonging to Kirkland.

We had no more than dropped the pilot than, looking astern, one saw a long line of boxes bobbing in our wake—the boys had lost no time in ridding the ship of her tear-bringing cargo! While we were supposed to dump the stuff 200 miles out to sea, one could not blame the boys for doing the "Jonah and the whale" act with our unwelcome cargo, as by this time the fire-room must have been uninhabitable.

Once clear of the last buoy, our course was set for Ponta del Gada, Azores, and the usual ship's routine set in.

Toward evening it started to blow up from the northeast, and before dark a nasty, typical Bay of Biscay chop started up, and the old girl began to tumble about. Around eight that evening the chief came into the wheel-house with the cheerful information that the ash-gun was leaking and the water was then above the plates in the fire-room, and the only way the leak could be stopped was to plug the ash-gun from the outboard side. The tug was brought up into the wind, and we lowered the old chief over the side; then the fun began; between rolls the old boy would ram a wad of oakum in the discharge pipe, and the next moment he would be 6 feet under water. The pipe was at last plugged, and a weary, dripping chief stumbled to his room, knowing that a dangerous leak had been stopped. The fire-room by this time was in bad shape, as we had jammed the bunkers full of coal, and there was more or less coal on the plates; the bilges being full of water, every time she rolled the force of the water in the bilges forced the fire-room plates up, causing the loose coal to go in the bilges; this in time had clogged the pumps. It did not take the boys long to clear the pumps, and soon we were on our way once more.

The next day showed no let-up in the gale, and both tugs were shipping lots of water. The turtle-decks built over forward kept most of it off the decks, though it was impossible to go aft.

The morning of the 14th there was considerable sea running, though the wind had gone down a little; the *Cadmus*, just off our starboard bow, was making very heavy weather of it; she appeared sluggish and was rolling very badly. About 8 a. m. she signaled that she was unable to proceed, and would have to heave to to make repairs to her engine and steering gear. Running close to her, we asked if they wanted a tow, but on receiving a reply that she would be all right in an hour or so, we stood by. In a couple of hours she signalled that she was going to put into Vigo Bay. As the wind and sea was on our starboard quarter, the two tugs were making fairly good weather; the moment the *Cadmus* headed into them, she began to dive like a duck. It did not take Captain Kornick long to decide that the lesser of the two evils was to continue on his way—so we squared away on our original course.

Our ship's surgeon, to give him his official title, had his bunk in the chart-house; that evening while getting his forty winks, the ship gave a particularly deep dive—doctor, bunk, trunk, charts and everything that was not fastened down, all piled in one corner of the chart-room. It took the united efforts of the mate and two men to sort the Doc out from the rest of the junk. At last he arose triumphant, still wearing his famous grin.

Meals were a serious proposition, and our soldier cooks were having a merry game of tag with the pots and pans on the galley stove. Grover, chief cook and steward, was nearly drowned when the crew's slum got the better of the galley gang and capsized all over him. It was a case of washing down both Grover and the galley.

It takes more than a blow to dampen the spirits of the average Yank engineer, and by night things were running like clockwork. Our crew being old hands at the game, soon adjusted themselves to their conditions, and the usual sea routine was the order of the day.

Sergt. Lawrence Kirkland, Company B, 9th U. S. Infantry, who went through the entire war with that historic outfit and was wounded, acted as chief mate. Kirk, in civil life, is a New York tow-boat captain, and after I had made several attempts to handle the tug in a crowded harbor, I turned the job of harbor pilot over to Kirk, and he sure was a dandy. He, like the rest of the mates, was shy in navigation, but for all that he was an A No. 1 man.

Master Engineer Jorgen J. Jorgensen, Company B, 57th Engineers, held down the second mate's billet. Jorg was an old deep-water man and was at home with his job. No better man could be found than this quiet Dane.

Master Engineer Roger W. Cook, Company B, 57th Engineers, was the third mate, and got away with the job in a splendid manner, and, with the exception of striking eight bells while I was still shooting the sun at noon, covered himself with glory.

In the engine room Chief Appleby had three good men in Greene, Blackwell and Anderson. And, like the deck officers, they gave all they had in them.

By the morning of the 16th the gale had broken, and as we were well out of the Bay, the short choppy sea that has made that place famous, or rather infamous, with seamen since the days when the Phœnicians sailed across on their way to Britain for tin, had gone down, the sun came out, and soon the rigging was full of clothing, drying. From then on, until we reached Ponta Del Gada, the trip was no different from a thousand others before and since.

On the morning of the 18th high land was sighted ahead, and at 3 that afternoon the ship was safely moored at the coaling station in the beautiful little harbor of Ponta Del Gada. The *Cadmus* was in bad shape from the buffeting she had received in the Bay, and her decks had opened up and needed to be caulked. Boiler and engine trouble had developed, so we reported to the admiral commanding the American forces that we were in need of repairs. He immediately had mechanics from the station ship. *Buffalo*, come aboard and set to work.

The *Gwalia* was in good shape, so we started to coal, and soon the ship was covered with the well-known dust of Cardiff coal. Coaling at Ponta Del Gada is carried on in the manner usual to tropical coaling stations; that is, with baskets. Gangways are rigged and the coal carried aboard by the natives in baskets, averaging 50 pounds to the basket. Coaling started at seven and finished at noon, by which time we had 80 tons aboard. We cleaned ship and pulled on the outside of the *Cadmus*.

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We were ready for sea, but the *Cadmus* still had extensive repairs before she would be in shape to continue the voyage. Shore leave was given the men, and they soon made themselves at home in that pretty little semi-tropical town. Several trips were taken by the boys about the island, the most popular being to Furnas Lake, the boiling springs situated on top of one of the mountains.

Just before leaving Ponta Del Gada a colored soldier, who had been left behind from a transport and sent to the hospital, was assigned to us for transportation home. John was put to work in the galley, and held his own with the best of the bunch.

On the afternoon of the 26th we pulled out on our second leg of the trip to Bermuda, and soon had the hospitable island of St. Michael only a blue haze on the horizon. I think the crew will be a long time forgetting the week we spent at Ponta Del Gada, especially the wonderful strawberries and green corn, two things that are not on the army ration. The first four days out were uneventful, fine weather, calm sea, and a warm sun.

The glass began to drop the evening of the fourth day out, and by midnight it was blowing pretty hard from the southwest. By morning a fairly heavy sea was runni and both tugs were making heavy weather of it. This kept up for two days more. On the afternoon of the seventh day out, every indication pointed to a big blow, and it looked like the tail-end of a West India hurricane, though the wind held steady from one quarter. About 3 that afternoon we ran into a queer red haze, as though we had entered into a huge red inverted bowl. The visibility was about one-half mile, and the whole sky, from horizon to zenith, was one reddish haze. It looked bad to me, and being only an amateur navigator at the best, I got sort o' worried, but we kept plugging along as the wind still held from the same direction. About 8 that evening the wind began to box the compass, and the glass was taken down with St. Vitus' dance. Then I was worried! Soon the wind held steady in the northwest, and I knew we were out of the path of the storm, so held our course. Then the rain came, and how it did rain—it came in solid sheets, nearly horizontal, and driven ahead of that wind it was impossible to get out of the wheel-house.

The morning of August 3 the wind and sea had gone down, but it was still very thick and there were frequent rain squalls. I had reckoned that we would raise the Island of Bermuda at noon, and knew that we were not far off, so I slowed down. At noon no land could be seen—in fact, one could not see over half a mile, and then only between squalls, so I stopped the tug, as I did not want to pile up on a nice hard coral reef at that stage of the game. About 3 that afternoon it began to clear, and I got a good sight, and discovered that we were 12 miles to the north'ard and a little to the westward of the island. We soon had the tug on her course, and in a couple of hours sighted the island, but too late to enter the harbor that night, so cruised up and down all night, and at daylight headed for the entrance and picked up the pilot. Soon we were winding our way among the coral reefs that fringe the Island of Bermuda.

After passing quarantine we were ordered by Captain Menner, the American Naval Commander, to Ireland Island, where we tied up alongside of the coal dock, receiving in the meanwhile the jeers and chaff of the crew of the *Cadmus*, which had arrived the night before.

As our next run was to be only a short one, only enough coal was taken aboard to carry us to New York, but we stocked up with a large supply of green stuff and fruit There had been more or less friction between the negro and white population of the islands before we arrived, especially with the Americans, and shore liberty was denied the crew, except about the dock-yard.

At the request of Captain Menner of the U. S. S. *Tallahassee*, three time-expired men were sent home on the *Gwalia* and four on the *Cadmus*. On the morning of the 8th we pulled out from Ireland Island on our last leg to Hoboken. It was a fine bright day as we slipped by the last harlequin-striped buoy off St. George and shaped our course for the last run. Quite a ground swell was running and our three sailor passengers began to lose interest in the world at large and the *Gwalia* in particular. After a year's voyage, tied up to the dock at Ireland Island, on the old "Flat Iron," as the *Tallahassee* was called by her disrespectful crew, the lively jumping about of the *Gwalia* was too much for the representatives of the Navy. And for once the Army had the best of the Navy on the Navy's home ground.

The day before arriving at Hoboken we lost the *Cadmus*. Not liking the ground swell on her beam, she had hauled to the south'ard early in the morning, just before daylight. When day broke she was nowhere in sight, and fearing an accident we turned and went back to look for her. After cruising about until noon, we decided that she had given us the slip, so we came back on our original course. A heavy fog shut down that evening and held all night; by noon the next day it was still thick, so we decided we had better get a sounding. As we had no sounding machine aboard, Jorgensen bent a couple of extra log lines together and with an extra grate-bar for a lead, got bottom in 30 fathoms, which showed that we were near the entrance to New York Harbor. Soon after we heard a fog-horn dead ahead. According to the light list it should have been *Ambrose Light Vessel*, so we proceeded ahead dead slow, and shortly she appeared through the fog, as welcome a sight as one could wish for. Soon the *New Yorker*, with the pilot aboard, came alongside and we were mighty glad to see him. He reported the *Cadmus* one hour ahead of us. And from that we decided that she gave us the slip that night so she could be the first in. After passing quarantine we proceeded up the bay, the crew giving a hearty cheer when passing the Statue of Liberty, and shortly afterward we tied up to the dock at Hoboken.

Next day the crew were taken to Camp Merritt, and from there sent to the various army camps to be discharged. The sight of the boys whom I had been with for over a year, and who were willing to trust to my navigation to bring them home, hiking up the dock, led me to think that if every ship master was blessed with as willing and loyal a crew as I had, his lot would be a happy one.

And so ended the "Voyage of the *Gwalia*," the first vessel in history to cross the Atlantic Ocean manned by a crew of officers and enlisted men of the American Army.

Motor Vehicles in U. S. A.

At least 8,500,000 automobiles, passenger cars, and motor trucks are in use in the United States. There are, in addition, nearly 400,000 farm tractors, more than 1,000,000 stationary engines of the internal-combustion type, and probably over 200,000 motor boats. These machines consume a large percentage of the 100,000,000 barrels of gasoline, more or less, produced annually, and a large quantity of kerosene. In 1923 there will be in use probably more than 9,000,000 passenger cars, close to 2,000,000 motor trucks, more than 1,000,000 farm tractors, and 1,500,000 stationary internal-combustion engines. This means, without counting aircraft, over 13,000,000 machines of the various types mentioned.—*Proc. Am. Soc. C. E.*

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Principles Governing the Use of Combat Engineers

With Illustrative Examples

By

W. A. Mitchell

Major, Corps of Engineers

IN this article it is desired to show the application in the field of a few of the principles which have been brought out in studies of combat engineers. Naturally, the application of these principles is somewhat modified in many cases by the requirements of the particular situation. For example: the division may need the engineers for work in the advance, and at the same time may need them for keeping up the roads in rear of the division because the corps and army engineers have been unable to do this work: in such case, the engineers may not be used exactly as required by the principles.

The examples available of division engineer work are somewhat limited. The records and official reports are not at all complete. As a result of a special visit to the War Department, it became evident that the reports were made in a hurry and did not bring out essential points. Therefore, the examples given are limited principally to the operations of the regiments which made complete reports.

A combat engineer regiment should not be composed entirely of laborers nor should it be composed entirely of technical men. No cases are known where a combat regiment did not possess enough technical men to do its work properly. On the other extreme, cases are known where the personnel of a regiment was composed almost entirely of technical men, with the result that they were unable to do real and effective work and a further result that much inherent good officer material was not available for development.

Principle. *A Combat Engineer Regiment should be trained in combat work as infantry, in bridge work of all kinds, in quickly laying out lines of trenches and constructing observation posts, wire entanglements and all kinds of obstacles.* If there is a great deal of road work to be done around the camp or if there are a great many barracks to be constructed around the camp, the division commander must calmly decide whether he wants to have untrained a proportionate number of his infantry, artillery and engineers, or whether he wants his engineers to be more untrained than his infantry and artillery. It is thought that road work or barrack construction does a combat engineer regiment about as much good for its work with a combat division as feeding horses does an artillery regiment, or as greasing a rifle does an infantry regiment. This comparison appears to be unfair because in actual combat operations a combat engineer regiment spends more time in fixing roads than an artillery regiment spends in feeding horses or an infantry regiment spends in greasing guns. But the comparison is actually correct: for training purposes, the combat regiment gets no real profit from road work and should preferably be made to do none at all. If there is a lot of road work to be done in a division camp, the construction troops should do it; and if there are not enough construction troops for this work, the division commander has to decide, as stated above, what troops shall acquire least training or whether all shall be proportionally untrained because of the fact that a lot of road work must be done.

The training of combat regiments is a matter which has received very little attention. Invariably, it has been found that when the matter has been carefully considered by those in charge, the training has been excellent. At General Headquarters, A. E. F., the circulars issued on engineer training were all that could be desired; but in the various divisions, especially in the United States, the training was often not very effective. Cases have been known where the division commanders believed that building of wooden barracks and roads and little culverts around the division camp were excellent training for engineers; others made their engineers devote all of their time solely to digging fortifications; and one case was reported where the engineers spent a month in sodding the ground around division headquarters. In this last case, it is known that the engineer regiment did not make a good showing in field operations.

There was one occasion where an engineer regiment was sent to an old French camp which possessed a target range, or rather it possessed a field which had three or four old trenches and target butts which were to be used for a target range. Unfortunately the range did not fit any of the American systems of target practice and consequently it was necessary to build a real range. Possibly, it was intended that the engineers dig the ditch in accordance with the mistaken impression that this is good engineer training for a combat regiment; but there were about 4,000 infantry and machine gun men in the same camp and the camp commander proportioned the work out among all the troops in camp. By using three reliefs and working from before day-break to after dark, a 40-target range was completed in two days and an 80 target range was completed in 5 days. In the 17 days that this camp was occupied practically all of the division came to the camp and went through a short course of target practice. It is believed that this is the only case on record where a whole division went through a course of target practice during active operations. No such results could have been attained if the engineer regiment had worked alone.

Even during active service, opportunities arose for training in quick marking of a fortification line. While the 2d Engineers (2d Division) was at Camp Bois L'Eveque,

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rumors became prevalent that the St. Mihiel operation would soon take place. As nearly all thought that it was either St. Mihiel or Verdun, and it was evident in either case the engineers might have to rush to a front and lay out a fortification line, two whole days were spent in training the regiment for this work. The regiment was given limiting points in its firing line and was required to stretch a line connecting these two lines or points. At first the line was short, and later it was much longer, so that each man of the line represented a squad or 2 squads or a platoon. The officer then went along the line and settled arguments between the men, as few would agree to take poor positions in order to help out the men on their right and left. This is the same argument that is seen today in practical problems in field fortification in which the one concerned insists on terminating his line at some point other than the one assigned to him, because it is better for him, regardless of his neighbor.

Principle. *Construction work does not train a Combat Engineer Regiment for its proper work.* The official report of the 2d Engineers (2d Division) concerning the battle of Chateau Thierry, states: "The prevalent opinion that sapper engineer regiments acquire adequate training from construction and road work is erroneous. A sapper regiment has certain duties to do in war time, and it is very little more trained in its war duties by construction and road work than an infantry regiment would be trained in its war duties by construction and road work. The 2d Engineers was not a trained engineer regiment when it went into battle at Chateau Thierry; far from it; though many of its men had been trained in camp before the World War. In later operations, the regiment spent a day here and a few days there in training, while the other regiments of the 2d Division were resting during the pauses in the operations. The regiment could never rest; it had not been given a fair chance to train because military necessity required that it spend its time in construction work, so it had to seize every opportunity to improve. It was supposed to know certain things, and yet it had never been taught these things. Before its first battle, it had never laid out a quick fortification line, never built a standard trestle bridge, foot bridge, or ponton bridge, yet during active operations of the next six months it had to do and did things after previous drill in every case except that of the ponton bridge.

Principle. *In movements by rail or water, engineers should be sent to entraining and detraining points to facilitate the loading and unloading.* In the movement of the 4th and 89th Divisions from the Rhine to the coast, enroute to the United States, one company of engineers was sent to each of the three entraining points to facilitate the movement, with the result that the movements were made with a speed and ease almost unequalled.

Principle. *Engineer detachments should accompany the advance guard in any sustained march through new country. This is necessary in order to make certain hasty repairs, and to get the necessary information to other engineers for more difficult repairs.*

In the advance to the Rhine, nearly every division marched in two columns; and one company of engineers was sent with the advance guard of each column. These engineers repaired the roads for the advance. The remainder of the regiment followed in the reserve of one column. This organization was maintained practically throughout the entire march to the Rhine.

In the march to the Rhine, the map platoon of the 314th and 315th Engineers (89th and 90th Division) reconnoitered the roads at least one day in advance, and issued before each day's march a map showing the day's march, the turning point of each unit, and the stopping places of each unit for the night.

Principle. *In any operation involving engineer work, the engineers should be consulted and given every opportunity to make preparations.*

In the plans for crossing the Aisne River the 2d Engineers (with 36th Division) were given every opportunity to make preparations for the crossing; in fact, the engineers concluded that they were given too much opportunity to do the crossing, the general plan made by headquarters higher than 36th Division, being that the engineers were to build the bridge before the infantry got across, this being contrary to the books. The engineers were to build two foot-bridges in the face of the enemy, one bridge across canal, then one across the river. The first would have been easy, provided the enemy was surprised; but the engineers were very much afraid that they could not build two foot-bridges in immediate succession because the enemy could not be surprised two times in the same place at the same time.

However, every assistance was given the engineers, and all possible preparations were made. Six double sets of foot-bridges were prepared and laid out in the fields and the engineers were drilled in special work with these foot-bridges.

While waiting for orders to cross, the engineers also built a heavy bridge to carry trucks and tanks and this was also set up in the field, awaiting the orders to cross. However, the order to cross was not given until after the Americans had left that area. Consequently there were left in the fields, near the River Aisne, one extra heavy type highway bridge and 12 hasty foot-bridges.

In the St. Mihiel attack, one division engineer made special preparations to cross "No-Man's Land," loaded bridges on trucks and wagons and placed the greater part of his engineers on one particular road while a smaller number was placed on another road. The particular road was completed across "No-Man's Land" in about one hour, being almost 24 hours before some other divisions got across; but the adjacent division took over the road and used it at once, without having worked on it at all and the division engineer learned upon going to his division headquarters that G-4 and G-1 the night before had kindly given this road to the adjacent division, but had not thought it necessary to notify the division engineer.

The best known instance showing the advantages of preparation by engineers for work ahead, is the case of the 110th Engineers (35th Division) at Consenvoye. The division chief of staff notified the engineers about two weeks ahead of time that the Meuse River must be crossed sooner or later and arranged so that the engineers could bring up the necessary bridge material. The result was that, when the order was received to cross the river, the engineers made a foot-bridge in a very short time and are reported to have made the heavy wagon bridge in the incredibly short time of five hours for a length of about 185 feet. In the St. Mihiel the 1st Division engineers built and carried forward three bridges for crossing the Ruft de Mad, well behind the German lines. The size of the bridges was figured from airplane photographs and actually fitted the requirements quite well. In spite of their weight they were carried at least a mile by hand, this being necessary because of the road conditions.

Principle. *Engineers should thoroughly reconnoiter the roads and railroads; in an advance, engineer reconnoitering parties should accompany the infantry advance elements or at least the support.* This principle seems to have

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been thoroughly understood by nearly every engineer regiment. These reconnoitering parties secured information as to the necessary work for putting into shape the roads, bridges, water points, etc. The only difficulty with the reconnoitering parties lay in their inability to determine just how much work was necessary, this being a matter requiring such a varied experience that few of the inexperienced reconnoitering engineers could perform this work in an entirely satisfactory manner.

Principle. *In a retreat the engineers should destroy the railroads and railroad bridges.* It is well known how the Belgians failed to destroy the railroad bridge at Liege. This failure on the part of the engineer officer or of the one general who controlled this engineer officer was worth the lives of some 50,000 or may be 200,000 men. If this bridge had been destroyed, the Germans would not have brought forward their supplies and especially their ammunition in such large quantities; consequently the advance against Calais and the first fighting around Ypres would have been much more unfavorable to the Germans. It would have taken at least three months to rebuild that bridge. Meanwhile, all supplies must have been transferred from one train across the river to another train, which would have very materially reduced the quantities of the supplies which were received by the German army on the front.

It is not a settled theory as to just who should order the destruction of bridges. The general rule before the war was that only a general officer should order the destruction of a bridge. This rule sounds reasonable if the enemy will adopt the same rule. For example, at St. Mihiel, the 2d Division rushed into Thiaucourt and captured the town. They found a German engineer company calmly and peacefully awaiting orders from some general officer, but the orders never came and the Germans never blew up the bridge. "We had been considerably worried over that bridge because it was a large one, and it was with great pleasure that we unloaded in 'No-Man's Land' the trucks which were carrying out our own bridges to put across in place of this bridge at Thiaucourt, which we thought would surely be blown up." The arguments as to who should give the orders regarding the blowing up of a bridge, are like the arguments as to whether we should blow up the Panama Canal locks in case the enemy is going to capture Panama. The argument against blowing them up is that we can use the canal after we recapture it; meanwhile let the enemy use it. The argument for blowing up the locks is that the enemy might not see it our way; they might not decide that they would ever need the canal again and after they had used it and saw we were going to recapture it, they would blow it up to prevent our using it when we recaptured it. In the French army in most cases, the bridges were prepared for destruction, and standing orders were given, probably by a general, that they would be blown up when it was certain that the enemy would capture it. The man on the spot was the man to decide whether the enemy would surely capture the bridge or not. This seems a proper solution if we can anticipate the enemy operations, as is generally possible. Otherwise, it appears that division engineers should be able to decide for themselves the steps suitable to the operations, in accordance with an approved policy of the general.

It is known that two companies of the 6th Engineers and parts of the 11th, 12th and 14th Railway Engineers, greatly assisted in covering the retreat of the British after the German offensive of March 21, 1918. No other U. S. troops were concerned in any retreat, consequently the lessons drawn from engineers in retreat are obtained mostly from text-books or from the work of the Germans in retreat.

In their retreat from Blanc Mont, the Germans seemed to have had two different division engineers in the American front. The engineers in front of our right destroyed their bridges effectively, broke all the steel rails on the 60-centimeter railway and on the broad-gauge track. The engineers in front of our left burned the supply depots, but did not destroy the broad-gauge tracks to any great extent. They broke only every tenth rail and a few frogs on the 60-centimeter; consequently, in two days two engineer companies rebuilt 12 miles of 60-centimeter track and were ready to connect up to the front and to the rear.

Principle. *In a retreat, the engineers should surely destroy the roads and bridges.* The Germans attempted to destroy the roads, but as a rule they showed poor judgment in the places selected, and the results were not effective. At Varennes we found a large crater. This crater was in a very convenient place for us. The Germans could have put it in a more convenient place, but they could have easily found a place more inconvenient for us. For example, they might have put it where the road ran between a ridge and low marshy ground, as at Juvigny, or in a cut, or in a high ground between marshy places.

At Blanc Mont they had two large craters in the road. These two large craters were very conveniently located for us; we built dirt roads around the craters and went on our way. Later we surfaced these dirt roads with lumber or stone.

At Landree-et-St. George there were two bridges over a small creek. We considered these bridges so important that the engineers were ordered to follow the infantry support line into the town and get to work on those bridges immediately. They did so, and lost 24 men in that operation, but they found that the bridges had not been destroyed, for which we were duly grateful.

At Beaumont and Pouilly the Germans had various ponton equipment. They sank some of it, but did not sink all of it. As a result, some of the boats were used to help build a ponton bridge near Beaumont, and an infantry colonel established a ferry with the other German ponton equipment east of Pouilly.

It is not known just what was the matter with the German engineers in some of these divisions, but it is probable that some of their commanding officers made them waste so much time on absurd traps that they were diverted from their proper work. It is a very simple matter to destroy a road and render it impassable for days by trucks. It is a still simpler matter to destroy a railroad. Consequently, it is surprising that the Germans failed so greatly in this respect.

The French at Pont-a-Mousson blew out one bay of the stone bridge. The Germans in 24 hours built up this bay and used the bridge without any further trouble during the short time they were in Pont-a-Mousson.

At Jaulgonne the 103d Engineers (28th Division) built a ponton bridge with boats which the Germans had allowed to float down the river. They put a sign on this bridge reading: "Made in Germany, but reconstructed by the 103d Engineers."

Principle. *There is not much use in sending engineers to consolidate an infantry line. They should not, generally, dig infantry trenches. They cannot possibly be expected to erect wire entanglements in front of a firing line which is in active operation; consequently, sending engineers to consolidate a trench is generally another way of sending engineers to reinforce the infantry.*

In the battle of Soissons the 2d Engineers (2d Division)

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and the Division Machine-Gun Battalion formed the division reserve. At the end of the first day they were very close to the front line, and when dark came the regimental commander ordered the engineers into front lines to consolidate the trenches of the infantry. They stayed there as part of the front lines, and were there until the division was moved from the front lines. Actually, they did not do much consolidating of trenches, but dug the trenches of one of the regiments in the front line. This was a very rare case, and even in this case it really amounted to reinforcing the infantry.

In the Meuse-Argonne the 6th Engineers (3d Division) were sent forward to consolidate a position. Most of their work consisted of fighting.

In their attacks against Verdun the Germans sent engineers just behind the infantry to consolidate the positions taken. This was really trench warfare; and the consolidation consisted principally in reversing captured trenches. The engineers carried sandbags, wire, etc. Such consolidation is possible, but not very practicable; and even in such cases the engineers spend most of their time as infantry.

Principle. *When a position becomes stabilized, the engineers should lay out the second and third positions and these positions should be dug by the engineers, assisted by the troops not in the front line.* At Chateau Thierry the second position was made quite strong and was dug by engineers and infantry. No attempt was made to build up or to strengthen the front lines except where they were changed as a result of heavy enemy fire. In the Argonne, two engineer regiments did some work on second lines, but none on real second positions.

Principle. *The building of wire entanglements in front of the front lines can be efficiently carried on only at night.* This is not exactly a lesson of the war, because it was never tried in the day time. We used to reconnoiter each day and make preparations for the night work, but no one presumed or expected that we were going to do any wire entanglement work in front of the fire trenches in the day time.

In only one case was there any real staking out of position, viz, by 1st Engineers in the Meuse-Argonne, and this position was not attacked. (To be continued.)

Tidal Phenomena and their Reduction

Tidal phenomena directly affect the work of most engineers practicing their profession on the seaboard. They are of particular concern to officers of the Corps of Engineers engaged in river and harbor work. All such engineers are more or less constantly in need of authoritative reference works on the subject, and Junior Engineer Floyd C. Bedell, Engineer Department at Large, has made a study of the bibliography bearing on this manifestation of natural laws.

From the large number of references relating to the theory of the tides and reduction of tidal observations, it becomes necessary for one who is not fully informed on the subject to choose a few volumes and turn to the larger lists only for information bearing on special problems as these may occur from time to time. Such a restricted list Mr. Bedell calls "A Working Library Pertaining to Tidal Phenomena and their Reduction," and is here presented for the guidance and information of all concerned. This list is not intended to be exhaustive, and it can be improved, without doubt. It is intended to represent merely a list of books that may be used by anyone who desires to gain a good working knowledge of the subject.

"Tides and Kindred Phenomena in the Solar System," by Geo. H. Darwin; an excellent popular, though scientific, treatment of the whole field.

"Practical Manual of Tides and Waves," by W. H. Wheeler; a non-mathematical discussion containing also a bibliography in the appendix.

"The Tides"—in Encyclopedia Brittanica, 11th Edition.

"Manual of Tides," by Dr. Rollin A. Harris; a description and theory of tides.

"Hydrodynamics," by Horace Lamb; an exceedingly difficult subject, and, although scholarly, the mathematics is difficult for the ordinary practicing engineer.

"The ABC of Hydrodynamics," by R. de Villamili; recommended as an introduction to Lamb's text.

"Theorie des Marees," by Maurice Levy; a text on the solution of the differential equations involved in the passage of a tidal wave up a canal with a certain slope to its bed.

"Recherches Experimentales sur la Propagation des Ondes," by Bazin; experimental results on the propagation of waves similar to the tidal wave.

"Tidal Rivers," by W. H. Wheeler.

"Canal and River Engineering," by David Stevenson; information on practical results obtained by engineers in "training" tidal rivers and estuaries.

In the related subjects of Astronomy, Hydraulics and Mathematics the following will be found of great interest and value:

"General Astronomy," by Young.

"Hydraulics," by Ballasis (Rivington-London).

"Graphical Mechanical Computation," by Lipka.

"Fournier's Series and Spherical Harmonics," by Byerly.

"Hydrology," by Mead.

For those who may be assigned on work requiring a general knowledge and who can give only a limited amount of time to the subject the following volumes and articles are recommended as a short reading course:

"Tides," by Darwin; in Encyclopedia Brittanica.

"Tides and Kindred Phenomena," by Darwin.

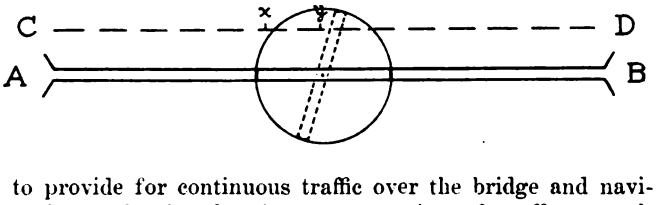
"Manual of Tides," by Harris; Part I, Chapter I.

"Tidal Rivers," by Wheeler.

"Canal and River Engineering," by Stevenson.

A Little Puzzle in Bridge Erection

A problem was presented of replacing an old bridge with a center-swing draw by a new bridge with a single-lift draw span, parallel to the old bridge. The new bridge was so close that when completed it would prevent the opening of the draw of the old bridge (see figure). It was necessary



to provide for continuous traffic over the bridge and navigation under it—that is, no suspension of traffic was allowed. The fixed span of the new bridge (C-x) was first erected. The draw span (x-y) was then erected in its closed position, the old draw opening meanwhile into the space y-D. Upon completion of the new draw span it was raised to the open position and the old draw opened into the new draw opening while the span y-D was placed. Traffic was then shifted to the new bridge. The cantilever ends of the old swing span were then cut off until it could be opened without touching the new bridge.

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A New Mobile Water Purification Unit

From data supplied by the Design and Development Branch, Engineer Section, Schenectady General Reserve Depot

IN the A. E. F., special engineer troops (water supply) were responsible for the supply of adequate quantities of water at water points located as conveniently for the troops as service conditions would permit. About 40 water purification trucks of two types were used in this work. Since the war, development work has been carried out, along lines indicated by the A. E. F. experience, by the

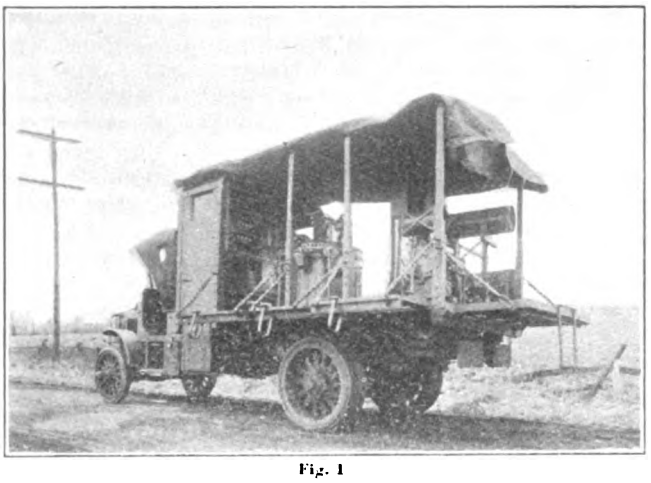


Fig. 1

Office, Chief of Engineers, in conjunction with the Wallace Tiernan Company, Inc., of New York, manufacturers of this type of equipment, who constructed much equipment of this kind for the A. E. F. A water purification unit has been developed that can be mounted on a 3½-ton, class B, army truck, which has considerable more mobility than the 5-ton truck. This will enable it to reach difficult places near water sources where the heavier truck would not be able to go. The body of the truck is the standard type, with bows and canvas cover, except that a small laboratory is built in at the front behind the seat and the sides are cut so that they can be dropped and held by chains at the level of the floor, thus increasing the available floor space. Figs. 1 and 2 show the general features of the equipment. By disconnecting the filter, the body and equipment can readily be removed from the chassis.

The equipment consists essentially of a single centrifugal pump delivering 100 gallons per minute against a 75-foot head at 1,150 revolutions per minute; a direct-connected 4-cylinder gasoline engine, delivering about 25 horsepower at 1,150 r. p. m.; a 42-inch pressure mechanical filter with a hand agitator; a five-way control valve; a combination direct dry feed and solution feed chlorinator, with a capacity of 1/10 to 12 pounds of chlorine per 24 hours; an alum pot and a soda ash tank, with appropriate feeds; a venturi meter and a water meter; and a simple laboratory for making acidity, alkalinity, color, turbidity and free chlorine tests.

The diagrammatic sketch, Fig. 3, with its accompanying key, shows the general operation of the plant. It may be operated as a simple pumping unit, as a pumping and chlorinating unit, or as a pumping and filter unit with or without chlorination. In selecting the source of supply it is desirable to secure running water, up stream from any source of pollution and with the maximum accessibility for the pumping unit and the tank trucks. Normally, the first operation is to wash the filter until the discharge is clear. The cleaning water should be chlorinated to prevent bacterial contamination of the filter sand; then the 5-way valve is turned to filter to waste and operated for a few minutes until a clear effluent is obtained. Alum must be added during this process. When alum is added to alkaline water it forms a flocculent precipitate which coagulates in a layer or blanket on top of the filter sand, permitting the passage of the water but removing most of the sediment. An alum pot containing crystal alum is connected around the pump so that a small stream of water is pumped through the pot, thereby dissolving the alum and feeding it into the suction line. The supply line has a calibrated needle valve to control the flow.

Water of low alkalinity, neutral or acid waters will not precipitate the alum, and it will pass through the filter and render the water unpalatable. To secure proper coagulation it is therefore necessary to raise the alkalinity of the water to the proper point. To accomplish this a 3 per cent solution of soda ash and water is placed in the soda ash tank, from which it flows to an automatically controlled constant level tank and then through a special graduated hard rubber orifice into the suction line. The advantage of feeding the chlorine, alum and soda ash into the suction line lies in the thorough mixing in the pump, allowing the maximum time for the chemical reactions to take place before the water reaches the filter.

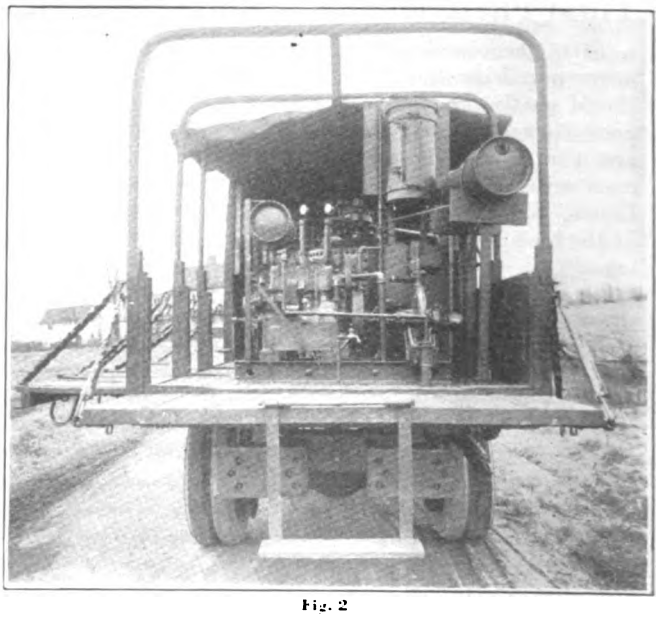


Fig. 2

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Gauges are provided at the pump and on each side of the filter. In normal operations the pump gauge registers from 32 to 36 pounds per square inch, and the filter gauges register a pressure difference depending upon the cleanness of the filter. A calibrated venturi meter is placed in the discharge line. From readings of the different gauges an idea may be obtained of the condition and efficiency of the operation of the filter.

A road test of the truck over 200 miles of mountain roads showed 3.6 miles per gallon of gasoline and 28.6 miles per quart of oil.

As a result of laboratory tests of the purification unit it was found necessary to increase the size of some of the piping, change the situation of the alum pot and eliminate one of the meters. After these changes a capacity of 80 to 85 gallons per minute of filtered water of low or negligible turbidity was obtained against a head of 75 feet above the pump. In order to test the ability of the filter to handle very muddy water, a 350-gallon tank of water was made as muddy as possible by constant agitation with an excess of mud and sand, and this was pumped through the filter; the effluent was clear and palatable, but the capacity of the filter rapidly diminished, so that in about 25 minutes the flow practically stopped. Three to five minutes' washing with clear water restored the filter to perfect operation. Certain field tests are planned for the summer months. It is believed that the piping can be simplified, and it may prove desirable to use a pump of the same capacity as the present one, but capable of operating against a head of 100 to 150 feet.

The equipment, which is still in the development stage, is a marked improvement over that used in the A. E. F., being lighter and simpler, with increased capacity. Definite figures for capacity can not be given, owing to the wide range of conditions under which the plant will have to operate. The maximum capacity would be obtained when pumping clear water, requiring chlorinating but not filtering, and the minimum when handling very muddy water, necessitating frequent cleaning of the filter. Limitations imposed by weight obviously preclude the installation of a filter capable of handling the full capacity of the pump.

Under the proposed new organization of the engineer service, water supply will be handled by a special engineer organization called the Engineer Water Tank Train. The following quotation from the new staff manual shows the organization and capacity of this unit:

(a) One engineer water tank train is normally assigned to each army, and one to G. H. Q. reserve for each army in the expedition. This assignment may vary considerably with the character of the theater of operations, especially as regards the available sources of water.

(b) Each water tank train consists of three companies and one headquarters and service platoon. Each company is equipped with 50 water tank trucks with the necessary auxiliary trucks, such as gasoline tank trucks, repair trucks, etc., so as to provide two independent units of 25 tank trucks each. Each tank truck has a capacity of 500 gallons, giving a capacity of 12,500 gallons for each unit, 25,000 gallons per company, and 75,000 gallons for the water tank train. The headquarters and service platoon includes 12 purification trucks, each containing the necessary apparatus for purifying water at the rate of about 6,000 gallons per hour for chlorination only, and about 3,000 gallons per hour for chlorination and filtration. The train will also be supplied with a small quantity of canvas water tanks, water troughs, pumps, and other water-supply equipment.

(c) The engineer tank train is intended to provide the special equipment necessary for installing and carrying out water-supply activities in forward areas. It will always operate under the appropriate unit engineer, and personnel necessary for water-supply installation work will be drawn from general engineer troops.

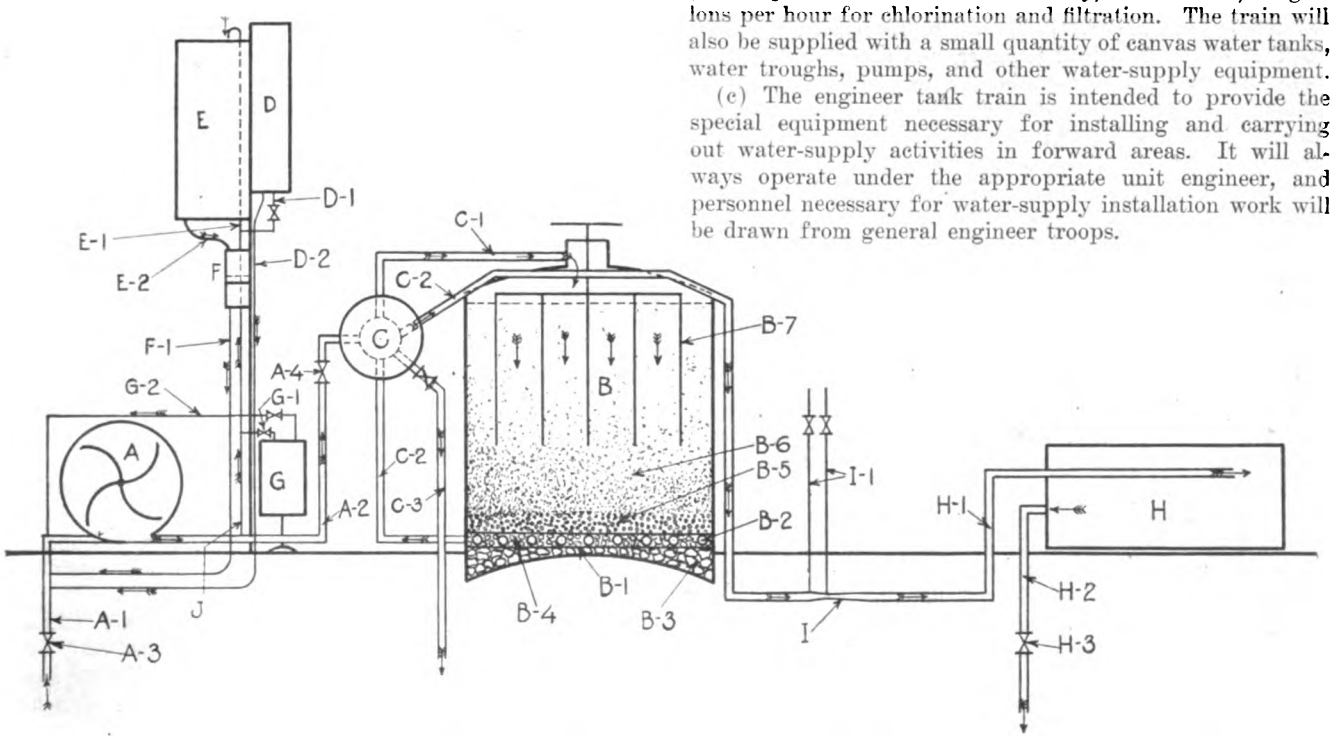


Fig. 3. Key. Diagrammatic Sketch: Water Purification Unit

A. Pump—
- A-1 Suction line.
- A-2 Discharge line.
- A-3 Suction valve.
- A-4 Discharge valve.

B. Filter—
- B-1 Strainer manifold.
- B-2 Strainer pipe grid.
- B-3 Coarse gravel.
- B-4 Intermediate gravel.
- B-5 Fine gravel.
- B-6 Sand, round quartz.
- B-7 Agitator.

C. Five-way valve control—
- C-1 Filter influent.
- C-2 Filter effluent.
- C-3 Wash water waste.

D. Chlorinator—
- D-1 Water supply to chlorinator.
- D-2 Chorine solution hose feed to suction line.

E. Soda Ash Tank—
- E-1 Water-supply line.
- E-2 Soda ash solution line to constant level tank.

F. Soda Ash Orifice Feed Tank—
- F-1 Soda ash solution to suction line.

G. Alum pot—
- G-1 Water-supply line.
- G-2 Alum solution feed to suction line.

H. Contact Tank—
- H-1 Influent.
- H-2 Effluent.
- H-3 Discharge valve.

I. Venturi Meter—
- I-1 Leads to manometer.

J. Water Supply to Chemical Controls.

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Map Reading

Some Instances Showing the Necessity for Proficiency

By

L. M. Adams

Major, Corps of Engineers

TO point out, at this late date, mistakes that were made in training officers for the World War may seem a useless expenditure of paper and ink, but since we are now engaged, in the Officers' Reserve Corps and in the R. O. T. C., in training officers for the next emergency, advantage should be taken of the opportunity for correcting such deficiencies as the test of actual field service developed.

The observation of the writer in France in 1918 led him to the conclusion that there was a serious lack of ability to read maps among all ranks and branches in the A. E. F. A few instances will be cited to illustrate this point.

In July, 1918, I was at the Reg. P. C. ——— Inf. at *Nicholas Inferieur, Anould Sector* (Vosges), to consult with the Reg. C. O. in regard to camping an engineer battalion in his sub-sector for work on the French "Blue Line" Resistance Position. Three infantry lieutenants at the R. P. C. were about to join their platoons in the front line, and one was directed to guide me as far as the Resistance Position. The four of us started off together, and after we had gone about 500 yards via circuitous paths along the heavily wooded mountain slopes which characterize this sector, we came upon a group of French engineers putting in high wire entanglement. I asked the "guide" if this was not part of the Resistance Position I was looking for; he replied "No, it is still a long way to G. C. 5" (Group de combat No. 5). I replied, "But I am not going to G. C. 5, I wish to locate the Resistance Position—the 'Blue Line.'" I then produced the official French military map of the sector—scale 1:20,000—and asked the three officers to indicate on it where their G. C.'s were and where their Company Command Post "P. A." was. None could point out on the map, even approximately, these locations, each stating that he knew the route only to his own G. C. I then asked them to point out on the map where we then were—none could do this, although we were only some 500 yards from the starting point, which was clearly shown on the map.

On returning to the Reg. P. C. I asked by what route the companies should march from the Brigade P. C. The Reg. C. O. and his intelligence officer stated that French guides would be furnished and the men should march by a certain short cut over the mountain and that the transportation should come by the main road. I asked them to indicate the routes on the map, so that there would be some check on the French guides. Neither officer could indicate the routes on the map, and, later, at Brigade Headquarters, neither the Brigade Commander nor his adjutant could indicate the routes that would have to be followed. We later found that one of the engineer companies had marched several extra miles to reach its camp, this extra distance being very evident from the map.

In this same sector, and in the St. Die sector also, I found many miles of main roads near the front which had to be camouflaged with a screen to hide the day-time traffic from direct view of German observation posts or "sausage" balloons. Along these roads, which were considerably winding, there were several instances where the screen was erected on the wrong side of the road, due to a failure to use a compass and map correctly.

In the St. Die sector, August 16, 1918, twenty trucks of the 5th Division Supply Train were to report to the engineer division dump at Le Bihay at 6:30 p. m. to haul barbed wire by night to an advanced dump for use in an operation. These trucks started empty on this journey of about twelve miles from Raon-L'Etape at 530 p. m., but nothing was heard of them at the divisional dump until after 9 p. m., when I found them halted in the main street of St. Die. The officer in charge, a captain, had a good map with him, which showed both his starting point and his destination, but he had led his truck train over practically all roads in the sector, except the right one, and had even driven his trucks over one road so near the front that the noise of the trucks must have been clearly heard in the German lines. Why his train did not draw artillery fire will never be known except to the Germans.

A certain major of engineers, an electrical engineer by profession, could not point out on the map, even approximately, where two French batteries were which he had just visited and which I desired to visit. They proved to be only a mile away from where we were at the time and close to a main road clearly shown on the map.

On September 13, in the St. Mihiel attack, I found a lieutenant of engineers with his platoon at work on a wood road at least a kilometer away from the main route he was supposed to be at work on. He could not show me on my map where he was or what road he and his company were supposed to be improving. This same date, I found an engineer reserve captain with his labor company on road work, who did not know which way it was towards the German lines, although the place he was working at was under direct observation of German balloons and was frequently shelled.

Before the St. Mihiel attack, excellent military maps, scales 1:50,000 and 1:20,000, were issued to practically all officers, and yet I frequently found officers, even company commanders, who carried no map with them at all, attaching so little importance to them. These officers would accept detailed verbal instructions given from the exceptionally clear and accurate French military maps, of which they possessed a copy, and never offer to open and mark their own until told the importance of doing so.

For forty-eight hours after the infantry attack of the 5th Division at St. Mihiel had been launched, it was unknown whether the most advanced companies had reached

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the "exploitation line" or not and whether the 5th Division's right and the 9th Division's left connected, left a gap, or were in echelon. The most conflicting reports were received as to map location of adjoining companies of the same battalion. Each company officer, prior to the battle, had a sheaf of report blanks with an excellent map printed on the back of each blank. It would seem easy under this system to get accurate and early information as to exact map location of all units. This did not prove to be the case, as few of the company officers had any exact idea of where they were on the map, or how to go about locating themselves, if the stress of battle had, for a time, caused them to lose their bearings.

As another and more serious instance; on September 16, work on the main resistance position across the 5th Divisional front (St. Mihiel Salient) was well under way. A new brigade had just moved up to hold the front, and the question arose as to where the friendly artillery barrage should be laid down in case of an enemy attack. The new brigade commander's aide was acting as brigade adjutant and was formulating a demand on the artillery as to laying down this friendly barrage. His map showed the approximate extreme front line of G. C.'s (outguards), P. A.'s (supports) and C. R.'s (reserves) of the Resistance Position. The "main line of resistance" was shown on the map as a single curved line connecting the C. R.'s. This young officer had planned to call for a friendly barrage to be laid down in case of attack just in front of this curved line marked on the map by the corps headquarters before the attack began, and in no way agreeing with the actual disposition of various elements on the ground. The barrage he was going to ask for would have fallen entirely on the area occupied by our own troops.

Many similar instances of the general inability of our officers to read maps could be cited. The existence of excellent maps of the entire American front made it possible for staff officers to formulate orders from these maps, often to the entire exclusion of personal reconnaissance. The carrying out of such orders naturally required a fair degree of ability to read maps on the part of all ranks and branches.

The development during and since the war of facilities for the making of maps will result in their being used in future campaigns to even a greater extent than during the late war, and the importance of map reading, in connection with the training of reserve officers and of the R. O. T. C., cannot be emphasized too highly.

(Continued on page 369)

Reserve Officers and Citizens' Military Training Camps

It is the earnest desire of the War Department to establish a cordial relation and mutual understanding between all elements of the United States Army and to further their training and instruction. Due to lack of appropriations and personnel the Department is now, and may continue to be for some time, unable to cause the citizen officers of the Officers' Reserve Corps, and to some extent of the National Guard, to be placed on active duty enabling them to be instructed and to foster the desired mutual cordiality between the personnel of the Regular Army and of the other components. However, there will be many opportunities of bringing about the desired relationship other than by placing reserve officers on active duty. Department and Corps Areas Commanders are charged with the duty of making full use of any existing opportunities within their jurisdiction which will enable officers of the citizen army to become acquainted with the regular establishment and to receive any benefit or instruction that facilities available permit. Accordingly, such officers, especially those of the Officers' Reserve Corps, will be informed of events of interest taking place in the regular establishment and will be invited and encouraged to attend, when practicable. When practicable, reserve officers will, if they desire instruction at their own expense, be attached to organizations or establishments of the Regular Army for instruction, target practice, field exercise, etc. In such cases the legal inability to exercise command will be observed. All proper steps will be taken to reduce to the minimum the expense of officers who seek instruction at their own expense and to give them the maximum of instruction in a minimum of time.

Inquiries have been received at the War Department indicating that, in some instances, officers of the Officers' Reserve Corps are making applications to attend, for the purpose of securing some training, the Citizens' Military Training Camps. In some instances it is indicated that the officers desire to attend at their own expense.

The mission of the Citizens' Military Training Camps is to train civilians to become privates, non-commissioned officers and second lieutenants of the Reserve Corps. The training courses have been designed accordingly. In view of the limited funds appropriated by Congress for this purpose, the number of persons who may be accommodated at the training camps is limited. In view of the fact that the courses of instruction are not suited to the further training of persons who are already reserve officers, and in view of the further fact that the attendance of such officers would prevent the attendance of an equal number of civilians who have had no training, applications of reserve officers to attend Citizens' Miitary Training Camps can not be approved, even though the officers desire to attend at their own expense.

The facilities and personnel are not available to establish separate camps or course this year for reserve officers who might be willing or desire to attend a training camp at their own expense without being ordered to active duty. The funds appropriated for pay of reserve officers set the limits within which the War Department may order officers to active duty. There are certain purposes for which, under the National Defense Act, reserve officers must be placed on active duty and paid. There are certain other duties for which reserve officers should be placed on active duty to insure the organization and development of the citizen soldiery. An allotment of the limited amount of funds for the following purposes is contemplated:

(a) For pay of reserve officers on duty with the War Department General Staff;

(b) For pay of reserve officers as instructors at the Citizens' Military Training Camps;

(c) For pay of reserve officers receiving instruction at the Special Service Schools of their arm. These will then be qualified to act as instructors within their units;

(d) For pay of a limited number of reserve officers of each division of the Organized Reserves to be called for a 15-day period of information and instruction in the missions of the three components of the Army of the United States and the plan and procedure of organization and administration of the units of the Organized Reserves.

Unless the amount of funds appropriated exceeds what it now appears may be expected, there will be little, if any, remaining after the above allotments are made. The War Department will not, therefore, in general, be able to provide a short training period for other reserve officers, either in camps or otherwise.—*Office of the Adjutant General.*

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Taming the Yellow River

By

Charles K. Edmunds

[NOTE.—Chas. K. Edmunds is President of Canton Christian College, China. Dr. Edmunds, an engineer and scientist, has been much concerned during many years' residence in China with problems of irrigation and flood control.—ED.]

(Courtesy of *Asia*, the American Magazine on the Orient)

"I WANT to be Emperor of China."

He was an American of middle age, compactly and powerfully built, with friendly eyes and quiet voice. He was conversing in a Washington club and his hearers perceptibly leaned forward. It was evident that he had a real idea.

"Emperor of China for five years," he continued. "And I want the job in order to do just one thing—to tame the Yellow River."

He smiled. But there was little doubt in the minds of his hearers that he knew what he was talking about in the matter of taming rivers. This sentence or two in the gossip of a club opened a vision of a great service America could render China. "To tame the Yellow River," would mean, as this American outlined the main scheme and accessory plans, to convert the Yellow River from "China's Sorrow" to a beneficient stream watering a very "Upper Valley of the Nile." It would reclaim a strip of waste land 5 miles wide by 250 miles long, sufficient for more than a hundred thousand fertile Chinese farms, and would forever prevent such outbreaks of the river through its dikes as that which in 1887 is said to have killed by flood and famine more than a million people.

John R. Freeman, of Providence, is the man who would control the Yellow River. He is probably America's foremost water engineer, final consultant on many of the country's greatest projects, including the water supply systems of New York City, Los Angeles, and San Francisco, some of the chief problems of the Panama Canal and some of America's largest water-power developments. The foundation of his interest in the control of the Yellow River is his regard for the Chinese people and his respect for their civilization and culture. As consulting engineer for the American International Corporation and the Chinese government, he went to China to improve the Grand Canal. The Yellow River crosses the Grand Canal. It was therefore necessary for him to study the Yellow River. While he was thus engaged, Chang Chien, the Chinese industrial and philanthropic leader who has gained fame through his model city, invited him to criticize the report of the Kiang-Hwai body of Chinese engineers. Since 1911, when Chang Chien organized this body and undertook its support at his own expense, these young Chinese engineers have been studying the flood and famine regions of Shantung and Kiangsu, with an eye to permanent measures of relief. The invitation to Mr. Freeman resulted in the preliminary report he has recently completed on flood control for Kiangsu.

His study of the problem of flood relief in China may lead to a work larger than the Panama Canal and greater in immediate humanitarian results. For it may point the way to saving hundreds of thousands of people from death by famine and insure them prosperity in fertile lands. The total cost will be small for a work of such magnitude. It now seems probable that all of the construction costs can be recovered in the increased value of the lands reclaimed. The total necessary expenditure is less than the amount necessary for the adequate relief of one great famine. But how can any man tame a stream that has many times broken out of its bed, devastated hundreds of square miles and found its way to the sea 250 miles from its former mouth?

Mr. Freeman's answer is so simple that it seems almost obvious after the discoveries on the relation of swiftness of current to erosion and silt transportation made by the engineers working under his supervision during the past two years. He would make the river dig its own channel, from which it could not escape—a work which, if done by dredging machines would cost over $100,000,000. He has found that, in flood times of the river, the greater its volume and the faster its flow, the deeper it digs its channel. Therefore, he says, increase its velocity to the rate which his researches show will dig up the silt and transport it to the sea, by confining it to the requisite narrowness of channel for from 250 to 300 miles. Furthermore, shorten its course by confining it to a series of straight-line channels from 10 to 20 miles in length between necessary bends. The new banks would be protected against undermining by spur dikes of stone riprap built much as the Chinese have built them for a thousand years, or by a modern device of concrete sheet piling reinforced with bamboo, instead of steel. Then the river will dig its own deep channel to the sea, and in this it will securely confine itself.

This dangerous part of the Yellow River flows through a vast delta plain of sediment hundreds of feet deep, easily cut into by a swift current. Geologists say that for fifty million years, since the second geological period, fine dust from the dry regions to the north has been blowing down on the lands that are now Shensi, Shansi, Chihli and western Shantung and forming yellow, powdery loess, which, during heavy rains, is easily washed away into the rivers by rushing torrents from denuded hills. The Yellow River has been carrying this fine silt to the Yellow Sea. But, as Mr. Freeman's figures show, despite the fact that the river carries more than 99 per cent of its mud to the ocean, the small fraction it drops along its course has raised the river bed about 10 or 15 feet above the surrounding plain, and in floods the water surface inside the dike is 25 or 30 feet above the plain outside. At the peak of floods more than 5 per cent in weight of the total flow is silt, carried by a velocity of 8 or 10 feet per second, but, when the mean velocity falls to less than 5 feet per second, the silt burden decreases rapidly. At velocities of more than 5 feet the river digs its bed deeper. After the flood, as the velocity

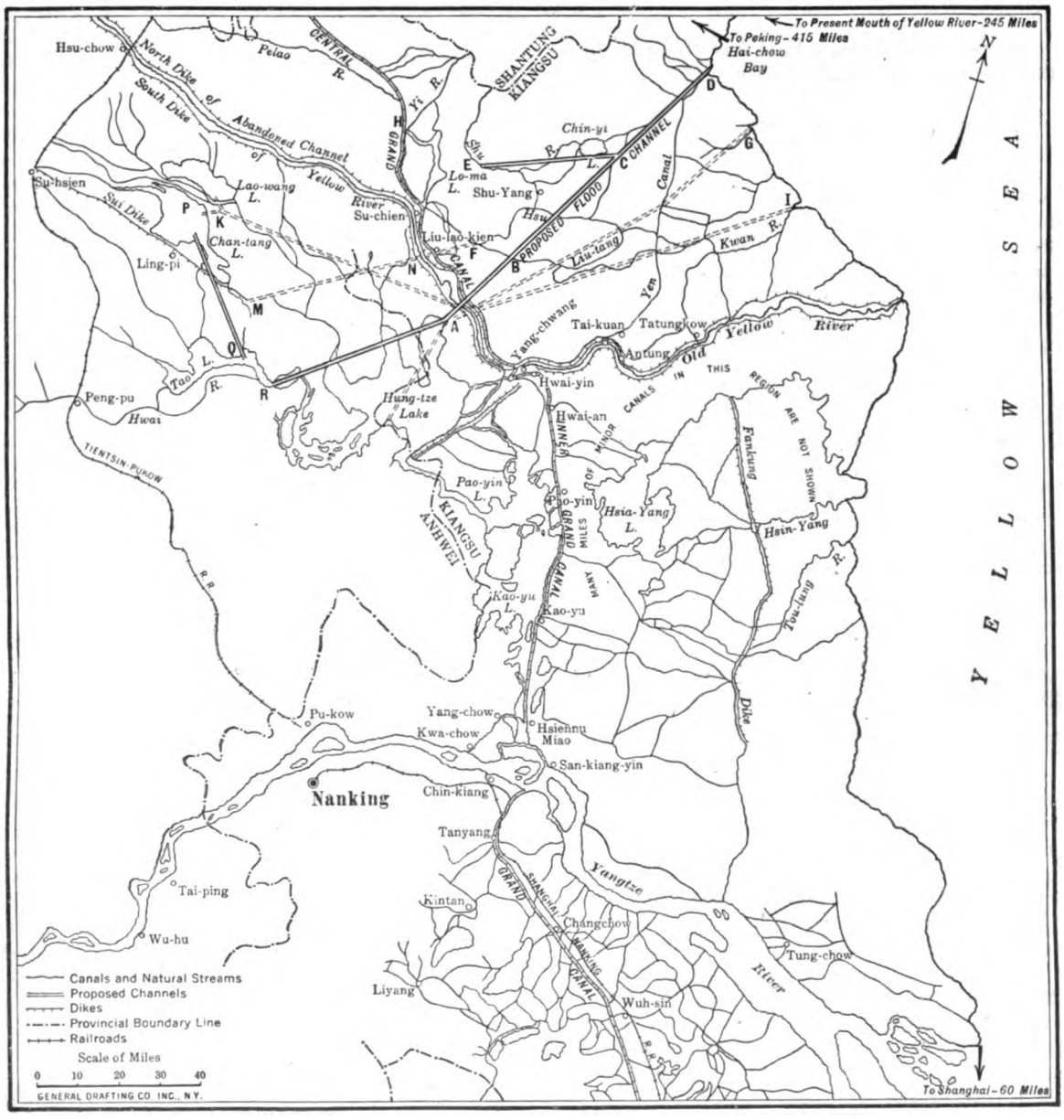
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slackens, it refills the bed to the former depth. It is this ability of the river to carry off so much silt to the sea, also to leave part of it along its course, that Mr. Freeman proposes to utilize in turning the cause of hundreds of thousands of deaths into a source of new life.

The river now curves and wanders at will out of its main channel, whenever swollen by floods, over a territory 5 to 6 miles wide between its inner dikes for 250 to 300 miles of its final course to the sea. Along this course and within these present inner dikes, Mr. Freeman would dig two very deep parallel ditches, each about 70 feet wide, leaving between them a strip of land about a quarter of a mile wide and 250 to 300 miles long. The earth thus excavated would form new dikes about 25 feet high. The outer sides of the two ditches he would reinforce with concrete piles and stone rip-rap, for these would be the ultimate sides of the river. The material excavated by shovels and by hand he would pile at the edges of the ditches, to make new dikes, about 2,000 feet apart. The sloping sides of the dikes, above normal stream-level, he would plant with willows to give resistance against floods. These new dikes would mark the edges of the new course of the river, running in straight lines 10 to 20 miles.

Into the new straight channels he would turn the river. Its own scour would eat away the 1,800 feet of land lying between and make the main channel. (See Fig. 1.) Mr. Freeman would then proceed to train the river to fill with silt the area 2 to 3 miles wide on each bank between the new and the old dike. Huge concrete pipes, 12 feet in diameter, built through the new dikes from the river, below flood-level, would permit the silt-laden river water to be drawn off in flood seasons to overflow the country between the new dikes and the old. (See Fig. 2.) Silt thus deposited would in time fill up this space, making the new walls of the river eventually 2 to 3 miles thick, and imprisoning it for all time. Furthermore, China would have along the Yellow River an area of new, fertile, river-bottom lands, 5 miles wide and 200 to 300 miles long, fully protected from flood.

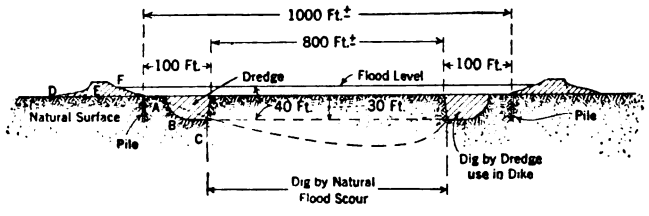
One of the unique elements of the plan is the conversion of the Yellow River from a flood menace, by reason of its height above the plain, to an irrigating stream, by virtue of that fact. Mr. Freeman would build irrigation canals across from the new dikes to the area beyond the old dikes, at favorable places across the plains on each side of the



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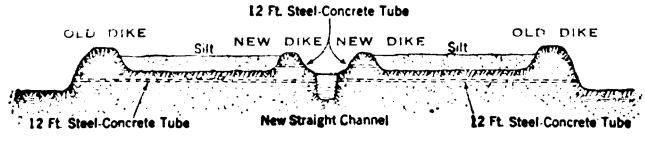
river, in such a way as to pierce the present inner dikes. If the river were tapped below low water-level, these tubes could irrigate the country outside the present dikes. The tubes would be fitted with dependable sluices at the river. Such work would have to be done with the utmost engineering skill, for the danger from botching would be great.

Such is one part of the plan. But this whole low, flat, delta region of Shantung and Kiangsu is a network of rivers, lakes, and streams. Frequently floods spread over hundreds of square miles, spoiling the crops, drowning the farm animals and starving the people. At present, most of the streams drain into the Grand Canal and thence an undue portion flows into the Yangtze. Freeman would apply



his Yellow River method to drain these directly to sea to the east, rather than to the Yangtze. He would dig a new channel—a straight line 85 miles long from the Hungtze Lake to Haichow on the Yellow Sea—100 miles south of Tsingtao. He would use the same scheme of digging parallel deep ditches, barely large enough to give material for the new dikes. in straight lines. He would turn the waters of the lakes and the Hwai, the Yi and the Shu rivers into these ditches and make their flood waters do four-fifths of the required excavation. He would spend only $6,000,000 in man and machine labor and as the result make the waters do $24,000,000 worth of dredging and scouring. He would dam up the lakes at different levels as successive reservoirs to hold flood waters and from these reservoirs he would build irrigation ditches carrying water to the surrounding country during drought.

The combined projects in Kiangsu Province could be completed in ten years. They would create 1,700,000 acres of new land, some of it reclaimed swamp lands of the lake and river region. The Yellow River and the new channel would be made navigable streams. China would be given a new port, Haichow, the sea terminus of a system of water



transportation into the interior.

Surveys for this Hwai River conservation work in Kiangsu Province were originally undertaken by C. D. Jameson, engineer, under the auspices of the American Red Cross ten years ago. Another survey by Gen. W. L. Sibert, of the United States Army, under the auspices of the Red Cross, followed four years later. The Kiang-Hwai body of Chinese engineers, organized and supported by Chang Chien, have added their work since 1911. The plan now presented by Freeman is the result of two tours of inspection and study during the past four years and much more surveying and test boring is required to perfect its details, and make precise estimates of cost.

The American International Corporation has temporarily withdrawn its engineers from the work of reconstructing the Grand Canal, and the opportunity for further surveys necessary to complete the Freeman plan of conservation is, for the time, cut off. For these surveys, only a few tens of thousands of dollars are necessary.

Here is a constructive piece of work to prevent recurring famines, an opportunity for Americans to initiate and back financially—with the possible co-operation of a public increasingly interested in China and its government—a great humanitarian plan, which could be undertaken either by a corporation that could guarantee sound construction and a reasonably good investment return, or by a semi-official public body such as the Red Cross, or by the Chinese government itself, under suitable engineering counsel and management, with the financial aid of the new consortium.

Shoot!

A rifle competition among teams representing all cavalry and engineer regiments and separate battalions will be held at Fort Bliss, Texas, beginning on July 1.

The teams from the different organizations have been selected by means of regimental competitions held at the headquarters of the different organizations.

Practically all cavalry and engineer officers of the regular establishment have generously subscribed the money necessary to obtain the trophies which will be awarded the winners.

These trophies are to be given to the team making the highest score in open competition between engineer and cavalry teams; to the engineer team making the highest score in a competition limited to engineer organizations, and to the cavalry team winning the highest score in a competition limited to cavalry organizations. Trophies will likewise be given to individuals of both services competing in individual matches under similar conditions.

The trophies will remain in the custody of the winners for one year, when they will be competed for again.

In order that individuals may retain some memento of their victories, medals will be provided for 1st, 2d and 3d places in the individual contests and for members of winning teams.

The next issue of the journal will contain an account of the shoot and the names of the winners, with scores.

From the results of this competition between the cavalry and the engineers, a squad of twenty-four of the best shots in both services will be sent to Camp Perry to prepare for the National Rifle Matches. A team of ten men and two alternates will be selected to represent the combined cavalry and engineers in these matches.

Concrete Truss Span Erected Without Falsework

In erecting the six 66-foot truss spans of a reinforced concrete highway bridge at Wichita Falls, Texas, the contractor used a scheme of construction that eliminated the necessity for falsework. In place of the usual falsework a pair of steel trusses, supported by the piers for the permanent structure, carried the weight of the concrete during erection. The concrete trusses were cast in a horizontal position on a temporary floor carried by the steel trusses, and after hardening were raised to their final vertical position by tackle slung from the top of the steel trusses.

When the work on one span was finished, the steel trusses were moved forward to the next span, first on rollers resting on the top chords of the concrete trusses, and later, after the trusses were half way across the new span, on another set of rollers underneath the bottom chord of the concrete trusses, the steel span acting as a cantilever during the process.—*Engrg. News-Record.*

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Reorganization of the Engineer Service in the French Army

From data furnished by the French Embassy

A MORE or less thorough reorganization of the army is the usual aftermath of every great war. Such reorganization takes place not only in the armies that have participated in the struggle, but often in those of other nations endeavoring to profit by its lessons. Such a process is now going on in all the Allied armies.

The reorganization of the French army is not yet completed, but the lessons of the war have been carefully studied by the staff, and the principles which should govern the organization of the engineers, from the French point of view, have been enunciated. The following is a brief outline of these principles. They are of special interest at this time, inasmuch as we also are passing through a similar period of reorganization.

In the French army the engineers perform the functions which in our own army are performed by the engineers and the signal corps. The following remarks are limited to the engineer service proper, as understood in our own and most other armies.

Duties of Engineers in the Field

These include:

1. Transportation of troops and materiel.
2. Organization of the ground. (a) Communications; (b) Fortifications; (c) Demolitions.
3. Shelter for troops.
4. Supply of engineer tools and materials for troops of all arms.

The engineers are both a combat arm and a supply service. Their chief duties are transportation, construction and supply.

Engineer Troops of a Large Unit

These will include a chief engineer, an engineer staff, the engineer troops belonging to or temporarily assigned to the unit, and military and civilian labor units.

The chief engineer is a member of the staff of the commander of a large unit. He commands the engineer troops, both permanently and temporarily with that unit, and acts as technical supervisor of engineer troops of the smaller component units.

Classes of Engineer Troops

These include:

1. Army, corps, or divisional engineer units.
(a) Standard engineer units of the corps and division.
(b) Cyclist engineer units with cavalry divisions.
(c) Army engineer companies (regular or territorial), similar to the companies of the standard division or corps troops.
(d) Mining companies. These will perform the following duties: Use of explosives on a large scale, mine warfare, important shelters, use of mechanical digging plant, locating mines and traps laid by the enemy.
(e) Bridging companies, for the construction of position bridges under difficult conditions (swift currents, heavy loads, etc.).
2. Communications or transport units.
(a) Standard gauge railroad regiments.
(b) Narrow gauge (cableway or mono-rail) railroad regiments.
(c) Heavy bridge units.
(d) Motor transport battalions.
(e) Animal transport battalions.
(f) Inland waterway operating units.
Note. The last three (d, e and f) are classed as "engineer trains."
3. Special units. These include several classes of specially skilled troops and non-combatant units.
(a) Electrical companies.
(b) Water-supply companies.
(c) Forestry and hut construction companies.
(d) Road companies.
(e) Labor units of various classes, etc., etc.
4. Engineer trains and depots.
(a) Army engineer trains (tools).
(b) Army ponton trains.
(c) Motor and animal transport trains, with repair units.
(d) Depots—gasoline, engineer tools and devices, materiel, explosives, etc. (Depots include what are commonly known as dumps.)

Remarks

These troops will be in general either permanently assigned to the larger units, including, of course, their component units, or to the general engineer reserve, at the disposal of the commander in chief of the armies. A very large general reserve is regarded as essential because of the great variety and vast amount of engineer work to be done, and the objections to detaching from the larger units the troops properly belonging to them.

As a general rule, engineer works in wartime require only a few skilled specialists, but a very large number of common laborers. Accordingly, the end to be sought in engineer organization is:

1. A few engineer units with a large proportion of officers and non-commissioned officers and plenty of skilled artisans.
2. A large number of labor units.

Man Power is the only kind that can be relied upon under all conditions, especially in the forward part of the combat zone. During the late war many classes of mechanical devices, designed to save man power, were employed. Such

(Continued on Page 373)

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The Military Engineer

Dedicated to the National Defense

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CITIZENS' MILITARY TRAINING CAMPS

I. Crab-apples or Pippins

UNIVERSAL training to a common and a high standard of citizenship is what our country most needs today. A democracy, or government by the people, can be completely successful only when the people are intelligent. Freemen must be intelligent; ignorant people are never free in the highest sense of the word. If we want good citizens in this country we must make them, we cannot let them grow up by chance. All the best fruits of earth are *cultivated* and this is as true of man as of the fruits of the soil. An educated cultivated gentleman is as much superior to an uncultivated clod as the splendid pippins we see on our tables at breakfast (if we are lucky) are superior to the crab apples which were their progenitors. Yet crab apples become pippins under cultivation, and in like manner the clod with proper training becomes a gentleman and the highest type of citizen. We would nearly all be clods if we had no opportunities for training, and we would nearly all be good citizens if properly trained.

This is, of course, the greatest reason for universal education—to raise our standard of citizenship. There is another aspect, the military. National security in such a world as we live in, demands readiness to defend ourselves, and one of the elements of such preparedness is that our citizens generally must be: first, patriotic, loyal and dependable, that is to say, *disciplined* in the highest sense; second, physically fit; and third, trained to bear arms. No arguments as to the correctness of these contentions will be necessary with most of our readers; they are already convinced.

Shall we ever have in this country a universal education which will at once improve our standard of citizenship and insure the national defense? Perhaps, if our citizens as a whole ever become convinced that universal education will produce these results without producing militarism such as we have seen in Prussia. One would have supposed that the beneficial effects of the training given to our men who went to war would have convinced everybody. They certainly did convince the great majority of those who received the training. But these are only a small proportion of our citizens, and daily growing smaller.

We need further demonstrations to convince America of the benefits to be derived from education under the supervision of the Federal government. Such demonstrations will be given this year, and on an increasing scale in coming years, by the Citizens' Military (Volunteer) Training Camps.

A summary of the regulations governing these camps was published in our last number, under the title, "The Plattsburg Camp Idea Revived."

On page 335 of this issue we publish a memorandum from the office of the Adjutant General on "Reserve Offi-

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cers and Citizens' Military Training Camps." It is to be regretted that limitation of funds does not permit establishment this year of camps for the further training of Reserve officers, but it is hoped that all Reserve officers will exert their influence to the end that the best possible class of citizens may be secured for the Citizens' Military Training Camps.

II. The Acid Test

MUCH depends upon the outcome of these camps. The World War was fought under the policy of universal military service, which was adopted by all participants. For over one hundred and forty years we had managed our various wars under the volunteer system, wherein a few men of higher ideals or nobler spirit sacrificed themselves for the many, and yet, when we entered the World War, we recognized the inherent weaknesses of the system. Without a tremor we adopted a compulsory service law founded on the truly democratic principle that citizenship has its obligations no less than its privileges. Under this law we produced an army whose determination, whose ability, and whose general efficiency had never been equaled in our own history, nor, everything considered, was it surpassed even by those gallant allied hosts who held the front at the Marne, at Ypres, and at Verdun.

At the close of the war that army, approximating 4,000,000 men, was demobilized and absorbed in the civilian body-politic without a thought of a military coup d'etat—without the slightest jar to the orderly processes of government.

Notwithstanding the success of this experiment in raising armies, notwithstanding the demonstrated value of military training and right living, we have elected to discard the principle of universal obligation to defend the state and have reverted to the volunteer principle, which has proven so costly in men and in money. But, no longer a nation of squirrel hunters, we have made reluctant concession to the notion of preparedness; we admit that it is both a costly and a dangerous folly to seek to extemporize an adequate war force after the incidence of the emergency. Though we have abandoned the policy of universal military training, we have yet gone so far as to countenance a brief training in military fundamentals for those inclined to avail themselves of the opportunity. The new defense law contemplates a national force—the Army of the United States—to consist of a small professional army, a national guard and an organized reserve, all to be raised by the volunteer system.

A year has elapsed since the law received the approval of the President and it is now about to undergo its first real test. The progressive series of military training camps announced by the War Department furnish the young manhood of the country the opportunity to fit itself for that stern duty which it must perform when peaceful measures fail to secure the national safety. Corps area commanders are now engaged in arousing the interest of those who in the discharge of their citizenship should attend these camps and the President has recently issued a statement to encourage those to whom, under an enlightened practical idea of patriotism, no such appeal should be necessary.

By playing his part in this movement a young man will increase his value to his state and to the nation and reap a direct personal benefit as well, but failing to present himself for training, he not only rejects an opportunity of great value to himself but his indifference endangers the national defense. By his inactivity he denies the soundness of the military policy enacted by his representatives in Congress and leaves the nation virtually without recourse. While he continues to enjoy the protection of the state he takes no personal part in assuring its continued existence.

The success of our new military policy depends directly upon the organization of a reserve composed in the main of young men voluntarily subjecting themselves to military training and sacrificing time and pleasure to a sense of patriotic duty.

Are we wise to deny the greatest lesson of the World War? Are we right in discarding the idea of compulsory universal military training? Can we rely on the volunteer spirit to maintain the nation in an adequate state of preparedness?

The citizens' military training camps will put our national military policy to the acid test. Will it reveal a manhood conscious of the high obligations of democratic citizenship? Will it give us the assurance of a future—peaceful and secure?

The Local Post and Its Mission

THE best indication of the fact that our Society has grown in the course of a year and a half from infancy to healthy, vigorous youth is to be found in the splendid development of active interest on the part of our numerous local posts. This development is our best assurance of success in the future.

Something more than the reading of THE MILITARY ENGINEER is required to bring about the accomplishment of the aims for which the Society was founded. No institution devised by man can succeed if it ignores the human equation. The human equation, in order to affect an institution, requires human contact on a considerable scale. The only feasible means of securing this contact is by means of local posts. There the contact of minds reduces abstract problems to concrete forms and facilitates their solution, taking the human equation into consideration.

The number of posts and the number of members affiliated with them are steadily increasing. Many of the posts have fully emerged from the formative stage and have entered upon programs that are not only interesting and instructive to their members, but that will eventually contribute something well worth while to the War Department's plans for the national defense. The detailed report in this issue of the program evolved by the Montgomery Post is an excellent example of real progress. Many others are working along similar lines.

The Officers' Reserve Corps is still rather a nebulous organization, but there is no doubt that progress is being made toward the attainment of the end that the War Deparment has in view, which is, that Captain Z of the Engineer Officers' Reserve Corps will be Captain Z, Commanding Company B, Nth Engineers; his lieutenants will be assigned, and he will know them and their capabilities; he will even have a "top kick" and a mess sergeant; he will be conversant with the idiosyncrasies of his battalion and regimental commanders. Mobilization for active duty in an emergency will merely mean that he will change his clothes, and repair to a locality that he already knows, to take up work with which he is familiar, among fellow engineers whom he knows and can rely upon. Compare the mental attitude of Captain Z under such conditions with his attitude were he merely an unassigned officer, whose organization and duties would be determined, in haste and confusion, only after the emergency was upon us, with the result that the electrical engineer might find himself in a railroad unit, and even those whose assignments accorded with their train-

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ing and ability would certainly find themselves amongst strangers.

The possibilities for interesting and valuable programs in the posts will be enormously increased when the War Department plans are carried to the point where the bulk of the members of each post have definite assignments to organizations. Each officer will then have a known objective. and problems can be studied in the posts that will afford each member an opportunity to develop himself along the lines that he will follow if called to active duty.

The War Department has taken steps to institute summer camps for the military instruction of young citizens who voluntarily enroll themselves for this purpose. Local posts should support the movement. They can and should do much toward bringing out the right material for these camps.

In many places close relations have been established between local posts and nearby engineer units of the Reserve Officers' Training Corps. The contact of R. O. T. C. students with the activities of local posts will have far-reaching effects; it will enhance the value of military training in the eyes of the student who sees practising engineers giving serious thought to it and to other phases of national defense; it will make it natural for the engineering graduate to affiliate with the Society and its posts; and it will bring the student into contact with engineers among whom he will pass the rest of his life.

The Reserve Officers' Training Corps and the Citizens' Military Training Camps are the chief sources for reserve officer material in the future. They are fundamental elements in our policy of national defense. Their growth and efficiency should be fostered by all possible means. In their cultivation the local posts will find a productive field of usefulness.

It Is for the People to Decide

ON the basis of the National Defense Act the War Department has worked out an organization for the Army of the United States, the first echelon of which will consist of six field armies, each army composed of contingents from the regular establishment, the National Guard and the Organized Reserves in the ratios of one to two to three. In other words, in the first echelon the regular army will constitute one-sixth of the whole, the National Guard one-third, and the Organized Reserves one-half. Should the emergency necessitate a greater force, the regular army will be practically submerged in the great mass of citizen soldiery.

The United States has been divided into nine corps areas, with a corps headquarters and a division of the regular army in each. Directed by the corps area headquarters, the National Guard and the Organized Reserves will form around the regular division as a nucleus, and by this means it is hoped to build up the military force directed by Congress in the National Defense Act.

Needless to say, the organization now set up can not be maintained without adequate funds. It might be possible to preserve the framework of the regular army with 170,000 or 175,000 men, but the result of recent Congressional action is to reduce the number to not more than 150,000 men by October 1, 1921. The House, in fact, was disposed to force an ultimate cut to 125,000 enlisted, with the idea of maintaining an average strength for the year of 150,000 as against the present strength of 220,000 enlisted. In brief, the regular army is a diminishing force.

What is the answer to the problem? Manifestly the plans for the regular army must be revised and the reduced personnel redistributed in such manner as best to fulfill its mission in the general scheme. The citizen-soldiery will have to assume a greater share of the burden. The various states will have to do more toward developing and training the National Guard. The officers and men enrolled in the Reserve Corps will have to depend more largely on their own efforts and less on the War Department for the acquisition of military knowledge and experience.

In the broader aspects of national defense the citizen-soldier rather than the regular army man is the leader. The individual citizen must bear the burden of making effective the military policy of the country. Congress is but the servant of the citizen-soldier, while it is the master of the regular.

Acting for the people, Congress has framed a plan for the national defense, but the realization of that plan is squarely up to the people. Preparedness will become either a living vital element in our daily life or it will become but an idle dream.

It is for the people to decide.

Death of Col. Thomas C. Clarke, E. O. R. C.

By the death, on May 25, of Col. Thomas C. Clarke, the Engineer Officers' Reserve Corps lost an officer of the highest type, the country lost a citizen who had given abundantly of his services as an engineer both in peace and in war, and the Society of American Military Engineers lost a staunch and unselfish worker in the cause of national defense.

Thomas Curtis Clarke was born in Philadelphia on December 11, 1873. He specialized in metallurgy and finished his education at the Massachusetts Institute of Technology. Years of experience with large steel and coke enterprises qualified him as one of the foremost consulting engineers of the country on the subject of by-product coke ovens. Frequent trips to Europe kept him in close touch with developments in this line and gave him a fluent command of French and German.

As early as 1895 Colonel Clarke served in the National Guard of New York. Upon the establishment of the Engineer Officers' Reserve Corps he was one of the first to give definite expression, by action, of his sense of responsibility for the defense of his country, and was commissioned captain in January, 1917. Called to active duty in May of that year, after a few months' training at Oglethorpe and Belvoir, he was promoted to lieutenant colonel and assigned to the 110th Engineers, 35th Division. He went overseas in March, 1918, succeeded to the command of the regiment in July, and in September was promoted to the rank of colonel. His part in the excellent work done by his regiment in the Meuse-Argonne offensive is described by his adjutant, Capt. E. P. Rankin, Jr., in this issue.

For participation in a trench raid by the French 69th Division that penetrated half a mile into the German lines, he was decorated with the Croix de Guerre.

Upon returning to the United States he re-entered the reserve as a colonel, and affiliated with the New York Post of the Society, of which he was one of the most enthusiastic members and one whose friends were legion. He was also a member of the American Society of Civil Engineers and of the Society of Chemical Industry.

His death was due to pneumonia, following a brief illness and operation. He leaves a widow, Mrs. Elizabeth I. Knox Clarke, of 101 East 74th Street, New York.

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Activities of Our Local Posts

Montgomery Post

DWIGHT C. TREVARTHEN, P. O. Box 763, Montgomery, Ala.

At a meeting on May 14 the following plan of activities, submitted by the board of directors, was adopted without amendment, and steps were taken to put it into execution:

Purpose of the Society.

The Society of American Military Engineers was formed with the specific purpose, among others, to develop and foster, in the interests of the national defense, relations of helpful interest between the engineering profession in civil life and that in the military service. Modern military practice may be properly considered a branch of engineering science, embracing not only the operations of armies in the field, but the means and methods employed in housing, equipping, transporting and supplying these armies, requiring in some cases, as in the World War, a utilization of the entire resources of the nations involved. National defense includes not only the subject of military practice and operations, but also the questions of development and conservation of national resources, the development and utilization of transportation facilities, and other questions thereto related. This subject is therefore of vital interest to and forms the common meeting ground for the civil and the military engineer.

Proposed Special Activity.

It is therefore proposed that the Montgomery Post adopt as a subject for investigation, study and discussion the important question of national defense, limiting its consideration for the time being to the State of Alabama and that portion of Florida lying immediately south. The field of this investigation will include studies of the seaports, transportation facilities, topography, agricultural and mineral resources and development, water-power development and related subjects, having in mind the relation of such subjects to the question of national defense. These studies will be made preliminary to a subsequent adoption and solution of a more or less definite military problem involving the determination of defensive measures and military operations that should be undertaken to oppose the assumed advance northward through the State of an enemy force with an established base on the Gulf within the limits of the sector being studied.

Method.

In pursuing this special study, it is proposed to adopt a method which is here described in a general way. The time to be devoted to this problem will be approximately one year, including twelve monthly meetings of the Post. At each meeting some particular phase or element of the problem will constitute a subject for discussion at that meeting. Papers and discussions will be prepared in advance by a committee specially selected for that purpose. These papers will be read at the meeting and will be submitted for general discussion. All papers and all written discussions, including maps, will be turned over to the secretary for compilation and future reference. Efforts will be made to obtain lectures or talks on subjects of particular importance or interest, by persons having special knowledge or experience in those subjects. It is contemplated that the period of preliminary study will require about six months, and the military problem an equal period. The details of the military problem must in many respects be based upon information disclosed in the preliminary studies, so that in the beginning it will not be precisely stated. In order, however, that the preliminary studies may be properly shaped and adequate to the immediate end in view, the problem will be outlined in general, and the program of study will be initiated by a paper on this particular subject, which will be a general discussion of the possibilities in this respect, and the various problems involved. In working out the military problem effort will be made to secure the occasional assistance of military experts. It can thus be seen that all preliminary studies must be twofold in their nature; they must be made from the broad general standpoint of national defense, and they must have specific reference to and be adjusted in scope and content to the military problem to be solved.

Objects in view.

These preliminary studies and the subsequent discussion and solution of the military problem will provide a definite objective for the energies of the Post; will add interest to the meetings; will be instructive and helpful to the individual members; will lead to the crystallization of ideas, now, perhaps, more or less vague, on the questions of proper measures for national defense; will clarify and define, in our minds at least, the relation that exists or should exist between national development and national defense; will lead to the delineation and adoption of definite policies, and may be the means of bringing to the attention of the public, of officials, bureaus, and departments of the State government and of the United States Government, important features of these vital questions.

The Military Problem.

A hostile force of adequate size, to be hereafter determined, will be assumed to have effected landings and established a base or bases at one or more points on the Gulf coast, probably at Mobile or Pensacola, or at both. Information of this intention was obtained only a few days before its accomplishment, though actual hostilities had been considered a practical certainty for some time prior to that. The purpose of the enemy is to advance northward through the State of Alabama, seizing points of importance, crippling industry, capturing or destroying supplies, demoralizing inhabitants, and ultimately seizing and diverting to his own use mining and manufacturing industries in the northern part of the State. A defending force will be mobilized at a predetermined point, and will operate against the hostile army, protecting important points and resisting the advance. Final and precise details of this problem will be worked out following the completion of the preliminary studies, and thereupon will be undertaken a study and solution of the various phases and problems, particularly the engineering problems, incident to the offensive and defensive operations involved.

Preliminary Studies.

Preliminary studies must include such discussion pertinent to the subject as will form the basis for the determination and solution of the details of the military problem. The following subjects will constitute the course of preliminary study:

1. A general discussion of the military problem

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2. Topographical and geographical features of the sector
3. Railways
4. Highways
5. Agricultural development and production
6. Mineral resources, mining development and production
7. Industrial development
8. Population and manpower
9. Seaports and waterways
10. Power development.

These subjects will be assigned to committees, one or more subjects to a committee, whose duty will be the collection of information on its subject or subjects, the preparation of papers and discussions and the collection of necessary maps. The chairman of the committee will be responsible that his subjects are adequately treated, assigning, as he may see fit to the different members, particular phases of the question; or the principal paper on the subject may be prepared by the chairman or some member, and submitted in advance to the other members of the committee for preparation of written discussions. The chairman will direct the discussions of his particular subject at the Post meeting, and he may also arrange for an address on that subject by an outside authority. When such an address is contemplated, advance notice should be given the secretary. The papers should be comprehensive in scope and adequate in content, having in mind the dual nature of the treatment desired; they should contain a discussion of the relation of the information contained in them to the proposed military problem, with a brief summary of conclusions. In preparation of papers, it should be borne in mind that the time available for presentation and discussion will be somewhat limited. All papers and discussions will prove more interesting and instructive if presented in connection with a map of the territory, prepared in such a way as to afford a pictorial summary of the information presented.

Grouping of Subjects.

The subjects for preliminary study are grouped for assignment as follows, each group including the subjects for consideration at a single meeting of the Post:

Group No. 1, Subject No. 1—A general discussion of the military problem.
Group No. 2, Subject No. 2—Topographical and geographical features of the sector.
Group No. 3, Subject No. 3—Railways.
Subject No. 4—Highways.
Group No. 4, Subject No. 5—Agricultural development and production.
Subject No. 6—Mineral resources, mining development and production.
Group No. 5, Subject No. 7—Industrial development.
Subject No. 8—Population and manpower.
Group No. 6, Subject No. 9—Seaports and waterways.
Subject No. 10—Power development.

It is proposed that Group No. 1 form the subject for consideration and discussion at the June meeting of the Post, and that the remaining groups be taken up at subsequent meetings in the order named. The meeting next following the completion of the last group will be given over to a discussion and formulation of a definite military problem, including the main problem and subsidiary problems. The various problems will then be discussed in detail at subsequent meetings in a manner similar to that proposed for the preliminary studies.

All papers and written discussions should be prepared far enough in advance of the meeting at which they are to be presented so that the secretary may prepare mimeograph copies for distribution among the members of the Post at the time the papers are presented. The secretary should be furnished with copies of all written and printed matter, and tracings of all maps should be furnished so that prints may be attached to mimeographed copies of papers and discussions. A file of these "Proceedings" will be kept in the files of the Post for reference at all times.

While it can not be stated definitely now just how much of the time of each meeting can be given over to the studies, it is proposed that the maximum period under any condition shall not exceed one hour.

Duties of Chairmen.

It shall be the duty of the chairman of each committee to see that the subjects assigned to his committee are adequately treated, making such assignments to the members as seem best, and preparing such synopsis as will insure covering the entire field. It is intended that the preliminary consideration and discussion of the military problem to be made at the June meeting will serve to indicate the general requirements in this respect.

Chairmen.

It is proposed that the presentation and discussion of the military problem in its preliminary aspects shall be undertaken by the board of directors acting as a special committee for this purpose. Other committees shall consist of from two to three members. The chairmen of these committees have been selected by the president, after conferring with the board of directors. The president will call a meeting of committee chairmen at an early date for the purpose of making final selection of all committees. The following members are designated as committee chairmen:

Group No. 2, Mr. G. N. Mitcham; Group No. 3, Mr. J. M. Garrett; Group No. 4, Mr. H. B. Battle; Group No. 5, Mr. A. E. Loder; Group No. 6, Mr. D. C. Trevarthen.

Tentative Schedule.

The following tentative schedule is proposed, covering the first seven months of the course:

June 11, 1921, Group No. 1; July 9, 1921, Group No. 2; August 13, 1921, Group No. 3; September 10, 1921, Group No. 4; October 8, 1921, Group No. 5; November 12, 1921, Group No. 6; December 10, 1921, formulation of definite military problem and adoption of subsequent schedule.

San Franscisco Post

DOUGLAS W. DODGE, Rialto Building, San Francisco, Calif.

The April meeting was replaced by a trip to the Mare Island Navy Yard, where the commandant, Captain Beach, received us most hospitably. A very interesting day was spent in inspecting the various activities of the yard, and the kindness of our hosts of the Navy will long be remembered.

The Activities Committee is making plans for an inspection of the coast defenses about San Francisco Bay, an observation trip over parts of the State Highway, a trip over the Hetch Hetchy water-supply project, and an inspection of the Disciplinary Barracks on Alcatraz Island.

The Program Committee, consisting of Mr. C. W. Backe, chairman; Fred C. Toklas, secretary; J. W. Williams and Raymond Salisbury, assigned to Lieut. Col. J. W. Williams and Major Grant the discussion of the subject "In what way can the interested civilian engineer be best trained in preparation for military emergency and how used to best advantage?" Col. Williams' paper on this subject received the unanimous indorsement of the Post. Major Grant and several other members discussed the various points brought out by Colonel Williams. [Colonel Williams' paper is published in full on page 351 of this issue.—ED.]

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The Current Events Committee, consisting of Prof. Charles B. Wing, L. J. Corbett, Secretary, and Chester K. Smith, will undertake to gather and condense into a report, to be read at each evening meeting, all news, orders and regulations of interest, and general information pertaining to military engineering, reserve officers and the engineer reserve.

The Publicity Committee, consisting of George A. Hunt, chairman; W. B. Cunnane, Jr., secretary, and Addison N. Clark, has established a record and file of reports covering the meetings and activities of the Post. It will be their duty to forward to THE MILITARY ENGINEER such material as it is desired to publish, to secure suitable publicity in news and technical publications, and to develop a library covering the subject of military engineering.

The Membership Committee, consisting of R. P. Hastings, chairman; Don E. Tripp, secretary; E. Ronalds Foster and R. E. Childs, will pass on all applications for membership in the San Francisco Post, after investigating records and qualifications. It will maintain a list of members and will take proper steps to increase the membership roll.

The Entertainment Committee, consisting of Thomas M. Ward, chairman; Stephen Malatesta, secretary; H. S. Hahn, J. M. McCoy and L. D. Kramer, are arranging outings, hikes and excursions, rifle-range practice, etc.

The Secretary of the Post, who is an ex-officio member of all committees, has circularized the advertisers of THE MILITARY ENGINEER, requesting their literature and catalogs. These are being filed and kept up to date, and are proving of benefit both to the members of the Post and to the advertisers. A central location is being sought where a general military engineering library can be developed.

It was proposed at the May meeting by the American Association of Engineers that the San Francisco Post adopt the official publication of that Association, *The Pacific Engineer*, as the official publication of the Post. Following a discussion it was moved and carried that the offer be declined, and that the Association be advised that the official publication of the Post and the Society is THE MILITARY ENGINEER.

At a meeting of all committees on May 17 a plan was approved for closing the charter membership in the Post as it now stands. A plan was also approved for having an occasional social evening to which the wives and lady friends of members will be invited.

Steps have been taken to secure from members articles suitable for publication in THE MILITARY ENGINEER and also suggestions for articles.

Pittsburgh Post

WM. M. MCKEE, Farmers Bank Building.

The Pittsburgh Post of the Society of American Military Engineers was initiated at a meeting held June 17, 1920, in the Federal Building at Pittsburgh, Pa.

The meeting was called through the efforts of Lt. Col. H. B. Ferguson, Corps of Engineers, who at that time was in charge of the U. S. Engineer Office in Pittsburgh.

Colonel Ferguson called the meeting to order, stated the purpose of the Society, read some instructions bearing on the procedure of organization, and asked for nominations for temporary officers. The following temporary officers were elected:

President—E. A. Gibbs.
Vice-President—E. F. Archibald.
Secretary—W. M. McKee.
Treasurer—F. W. Henrici.
Asst. Treasurer—W. H. Horton.

The temporary organization was effected, notices sent to the daily papers, and application was made for a charter for the local post, which charter was issued on October 4, 1920.

A meeting to effect a permanent organization of the Pittsburgh Post was held in the Oliver Building, Pittsburgh, on the evening of February 15, 1921, the meeting having been called by temporary president, Mr. E. A. Gibbs, who presided at the meeting.

Among those present at this meeting was Maj. J. F. Bell, Corps of Engineers, who is in charge of the U. S. Engineer Office, Pittsburgh. Major Bell gave an interesting talk on the relations of regular army, national guard and reserve corps, and outlined the purpose of the Society of American Military Engineers of keeping up interest among civilian reserve in matters concerning an army of the future.

Nominations were asked for permanent officers of the Pittsburgh Post and it was decided to retain the temporary officers until the end of the year, namely October 4, 1921.

The next and most recent meeting of the local post was an informal but very successful one on board the U. S. Engineer Boat *Swan*, through the courtesy of Major Bell.

On May 14th the members of the post were again the guests of Major Bell on the *Swan*. Starting down the Ohio on a tour of inspection, the first stop was made at Emsworth, where the party went ashore and was met by W. D. Fairchild, Assistant United States District Engineer, who escorted the guests on a tour of inspection of the Emsworth Dam which is being constructed by the government.

Work on the locks has been halted on account of Congress not appropriating enough money to complete the dam across the river and install operating machinery. The next stop was made at Lock No. 2, in the Ohio River, at Coraopolis, where Major Bell demonstrated to his guests the operation of a movable dam, the opening of a bear trap and the lowering and raising of wickets on a dam. Dinner was served on the boat on the return trip and the party reached the city shortly after 7 o'clock.

Among those who made the trip were: Major Bell, Colonel Gibbs, Maj. W. M. McKee, Lieut.-Col. E. K. Hiles, Maj. J. S. Bragdon, in charge of the Engineer R. O. T. C. unit at the Carnegie Institute of Technology; J. W. Arras, Mr. Fairchild, E. F. Archibald, Wm. Donley, E. J. Ducey, L. B. Duff, G. E. A. Fairley, O. D. Foster, W. B. Hayes, F. G. Lee, H. C. McCormick, M. M. McKee, B. E. O'Hagen, J. S. Roob, F. K. Rodgers, D. S. Rodgers, Burt Sapp and Reese T. Scully.

Detroit Post

Maj. RICHARD G. HEWITT, 712 Ford Building.

A meeting was called by Maj. Richard B. Hewitt, June 1, 1921, at Detroit Athletic Club at 12 o'clock noon for the arrangement of a general call to complete the organization of the Detroit Post of the Society of American Military Engineers.

Present—

Col. E. M. Markham, C. of E.
Maj. M. S. MacDiarmid.
Maj. H. Augustus O'Dell.
Capt. A. L. Schuffert.
Lieut. J. French Paddock.
Fred M. Mason.
Maj. Richard B. Hewitt.

After an explanation of the "Mission" it was moved and seconded by Major O'Dell that Colonel Markham be made chairman and Major Hewitt secretary of the meeting. Motion carried.

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Ordered by Colonel Markham that meeting be called for Monday, June 20, 1921, at 7:20 in the evening. Place of meeting, the Detroit Board of Commerce.

Instructions were given to Major Hewitt to prepare call for meeting and mail copies to all members of the society, reserve officers and ex-officers in the state, also to the Detroit members of the four national engineering societies, viz., civil, electrical, mechanical and mining; to post notices with all American Legion posts; to arrange for newspaper notices in Sunday issues 12th and 19th; to engage space at the Board of Commerce and secure speakers for the evening, both from civil and military life.

No other business coming before this meeting adjournment was taken until June 20, 1921, at 7:30 in the evening.

In preparation for the meeting of June 20th, the secretary mailed to 1600 engineers in the State of Michigan a four-page printed circular containing a notice of the meeting, an informal application for membership, and information concerning the organization and aims of the Society and its journal. The following paragraph is taken from this circular:

"Square Pegs Into Round Holes."

"If you took part in the late war or if you have talked with those who did, you will be aware that most of the discouragement, the bitter disappointment and heartburnings incident to the conflict were the result of men not finding the places in which they really belonged. Because of our stage of unpreparedness at the outbreak of the war, many engineers (and others) were assigned to duties without a knowledge of their experience and qualifications. Great numbers of them found their tasks uncongenial and suffered the chagrin of feeling that they were not permitted to render the service of which they were capable. It will be the function of our Society and especially its local posts to prevent a recurrence of such a situation in future."

A list of present members in various parts of Michigan was included in the circular and prospective members were urged to get in touch with them.

Los Angeles Post

C. M. Cram, 725 Central Building.

The first meeting of the Los Angeles Section of the Society of American Military Engineers was held on June 15, 1920, Maj. Frederick B. Downing acting as temporary chairman. At that meeting the following officers were elected:

President—Capt. Chas. T. Leeds.
First Vice-President—Carl B. Wirsching.
Second Vice-President—John A. Griffin.
Secretary—Burt Harmon.
Treasurer—Gerald Fitzgerald.

In addition to this meeting at which the local organization was perfected, meetings have been held on July 13, 1920, October 25, 1920, February 1, 1921, April 5, 1921 and May 3, 1921. The annual meeting will be held on June 7th, when new officers for the coming year will be elected.

At all the meetings of the section it has been the practice to gather around the banquet board at the dinner hour, after which the business of the meeting is transacted and the speaker of the evening is enjoyed. Of the six meetings, two have been in the banquet room of the Jonathan Club, one has been at the Philip Levy Cafe, and three have been at the Roma Cafe.

The section has been most fortunate in its ability to obtain competent and interesting speakers. Among these are James W. Foley, Colonel Deakyne, Corps of Engineers; Colonel Keller, Corps of Engineers; General Taylor, Corps of Engineers; Capt. Hans Kramer, C. of E., Professor of Military Science and Tactics at the California Institute of Technology; Mr. McCollom and Mr. Frank Mittenzwei.

Starting at the first meeting with a membership of 46, the local membership committee has built the local membership up to a present roster of 68 names, and the efforts of this committee will be felt for some time in a growing roster and a growing interest in the society and the affairs of the local section.

Washington Post

E. P. Ellis, 2007 O Street, N. W., Washington, D. C.

At an enthusiastic meeting held at the Army and Navy Club on May 26 of officers and former officers of the Engineers, U. S. Army, who are stationed or living in the vicinity of the national capital, the Washington Post of the Society of American Military Engineers was organized and the following officers elected: C. H. Birdseye, President; J. H. Wheat, Vice-President; E. P. Ellis, Secretary-Treasurer; H. S. Graves and Maj. J. J. Kingman, Directors.

With an initial membership of more than 50, the new post has an excellent prospect of success. As its principal objects will be the diffusion of knowledge of military engineering, fostering public interest in preparedness and the development of the Citizens' Military Training Camps, the new post will materially aid the Society of American Military Engineers in its efforts along these lines.

A smoker of the Washington Post of the Society of American Military Engineers was held at the residence of Maj. George Oakley Totten, Jr., on June 21, with President C. H. Birdseye in the chair.

The enthusiastic group of officers and ex-officers of the Engineers, U. S. Army, who were present augurs well for the future of the new post, which, though less than a month old, has a membership of more than 50.

The program of the evening included speeches by officers who took prominent parts in the rapid expansion of the Corps of Engineers to meet the war emergency.

Maj. Gen. W. M. Black, retired, formerly Chief of Engineers, deplored the reduction in the size of the army that is contemplated in pending legislation. As instructors for the training camps are drawn from the commissioned and non-commissioned personnel of the army, the proposed reductions will make it difficult to obtain instructors of the experience necessary to make the training camps fully effective in view of the short period of training that is given.

The general lack of public interest in military preparedness is not surprising in the opinion of Maj. Gen. Lansing H. Beach, Chief of Engineers, who stated that opposition to military expenditures is always strong following every great war. The War Department is making strenuous efforts to offset the reduction in size of the army and the failure to adopt universal military service by developing the summer camps. Maj. D. I. Sultan, of the General Staff, stated that while it may not be possible for the country to be fully prepared for war, the Citizens' Military Training Camps, which will be held this summer in all sections, will aid materially in creating a force having sufficient training to form a valuable military asset. In his opinion the veterans of the World War should not be expected to bear the burdens of another conflict, which must be borne by the young men now reaching maturity.

The plans for the camps this year, as outlined by Major Sultan, provide for basic training only, to be followed next year by more advanced work which will qualify for commissions in the Officers' Reserve Corps. The program outlined is one that will appeal to all red-blooded young men.

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With not more than five hours' work each day and ample opportunity for athletics and other amusements, those who go through the camps will be benefited physically and mentally and the associations can not fail to be uplifting.

Only 10,800 men can be accommodated this year at the camps. As the indications point to a far greater number of applications, candidates should not delay seeking admission. The camp for this locality will be at Camp Meade, August 1 to September 1.

At the conclusion of the speeches, Miss Floravianti, Jack Carter and Harlan Randall, of the Washington Opera Company, rendered operatic selections in the adjoining garden, and little Miss Jerry Williams danced, the attractive sylvan surroundings adding to the effect.

New Orleans Post

E. H. COLEMAN, 822 Perdido Street.

Arrangements have been made with the Louisiana Engineering Society to hold their next regular monthly meeting in conjunction with the local section of the Society of American Military Engineers. The usual technical paper will be replaced by an informal talk by Lieut.-Col. E. J. Dent, C. of E. The purpose of this meeting will be to familiarize the local engineers with the work and objects of our society and to establish closer relations with other engineering organizations here, preparatory to extending our membership.

Seattle Post

J. M. CLAPP, 602 Burke Building.

The first real effort to establish a post of the Society of American Military Engineers at Seattle was made by Brig. Gen. H. F. Hodges, then in command of the North Pacific Artillery District, and Lieut. Col. J. A. Woodruff, Corps of Engineers, then district engineer for Puget Sound. Invitations were sent to all interested engineers to meet at the U. S. Engineer Office, 602 Burke Building, on June 15, 1920. On this evening some eleven engineers, all but two of whom had seen service overseas, met and discussed the matter of organizing a local post. General Hodges presided at this meeting. A committee on organization was appointed, and Colonel Woodruff, who at the time was on an inspection trip in Alaska, was elected as temporary president.

A second meeting was held at the Seattle Chamber of Commerce rooms on August 15th, at which nine engineers were present. General Hodges again presided and gave many valuable and helpful suggestions. Colonel Woodruff having been transferred to another district, his successor, Col. E. H. Schulz, C. of E., was elected temporary president, and a temporary organization was completed by the election of Capt. Bertram Dean, Reserve Corps, as temporary vice-president, and J. M. Clapp, consulting engineer, as temporary secretary and treasurer. Committees were appointed, and the dues fixed at 50 cents per member for the balance of the year 1920 and $1.50 annually thereafter.

On October 8, seventeen members assembled at the Chamber of Commerce rooms, adopted a constitution and by-laws and fixed on December 3 as the date of the annual meeting and dinner. The program committee was instructed to arrange with General Hodges for a talk on the defenses of Puget Sound. However, the general was transferred from Seattle before this date, and other arrangements were made.

On December 3rd the society held its annual meeting and dinner at the Arctic Club, at which fifty-four members and guests were present. Addresses were made by Mayor Hugh M. Caldwell; Mr. T. S. Lippy, president of the Port Commission of Seattle; Claude C. Ramsay, chairman, County Commissioners of King County, and Lieut. Col. A. O. Powell, Engineer Reserve Corps. The principal speaker of the evening was Col. J. B. Cavanaugh, C. of E., who in his usual happy vein gave a very interesting talk on the Corps of Engineers and the relation of the reserve officers to the regular establishment. He also told of the great work that had been done in the World War, and showed the necessity of having a partly trained corps of civilian engineers, many of whom were better informed on special lines of engineering than were the regular officers. He pointed out the necessity for co-operation between the civil and military bodies, and how necessary it was to have some training before war actually did occur. He pointed out that the Society of American Military Engineers offered this medium of co-operation, and told of the organization of the Portland Post and of its contemplated activities, which was of much interest to those present.

Following the dinner, a business meeting took place and a permanent organization was effected. The present officers, elected at that meeting, are: Col. E. H. Schulz, president; J. M. Clapp, secretary; Maj. Oscar A. Piper, Reserve Corps, vice-president, and H. J. M. Baker, treasurer.

Two meetings have taken place since that date. At the first of these meetings, on March 11th, C. F. Uhden, chief engineer of the Skagit River development work, read a paper illustrated by slides showing the problems that had been met in that great work, and the manner in which they were solved. Much interesting information was given, illustrative of the power generated.

The second meeting took place on May 16, 1921, at which about forty members and guests had the pleasure of listening to two very interesting papers. One of these was by Sergt. E. H. Sirman, late of the 56th Engineers (Searchlight), and dealt with the activities of that regiment on the battlefields and with the operation of searchlights. The second paper was by Col. C. A. Seoane, of the Signal Corps, U. S. A., on the subject of the cables of the Pacific, including those of Alaska. His statements on this important subject were followed with keen interest.

The membership of the local post is now twenty-three and bids fair to be soon increased.

Cleveland Post

JAMES H. REDING, 1727 Bryn Mawr Road, East Cleveland.

This post has been holding meetings at intervals of about one month from the date of actual organization on January 21st up to the present. During July and August no meetings will be held. Our programs have consisted of talks, usually illustrated by slides and films, followed by discussion. Our membership is now about 52 and the attendance at meetings has varied between 34 and 39.

The speakers and subjects have been:

On February 28th—Speaker, Lieut. Col. Elliott H. Whitlock. Subject, Reminiscences of an Engineer Officer in the Late War. Colonel Whitlock, among other things, had charge of the engineer depot at Is-sur-Tille. He gave many interesting comparative statistics regarding engineer material and showed slides of military construction and destruction, all of which were made to live by the interspersed anecdote and description.

On April 4th—Speaker, Lieut. Col. Byron C. Goss. Subject, Gas Warfare in France. Colonel Goss was in charge of gas warfare in the Second Army and in the First Army prior to the formation of the Second. This talk was illustrated with both slides and films, showing

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types of gas shells and gas being used in action. The tactical use of gas was particularly emphasized.

On May 2nd—Col. H. J. Twelvetree. Subject, The Functioning of a Division; the Staff and the Engineers. Colonel Twelvetree was G-1 of the 37th Division and spoke interestingly and instructively from experience.

On June 6th, the last meeting before the summer recess, will be a smoker, to further good acquaintance and afford a better opportunity for discussing matters of post policy than there has been time for at previous meetings.

We are finding difficulty in laying out a program which is both feasible and will appreciably further the purposes for which the society and posts are organized.

Our post president, John R. McQuigg, has recently been promoted from colonel, commanding 112th Engineers, to brigadier general, 37th Division.

Philadelphia Post

Lt. Col. W. G. LADUE, 815 Witherspoon Building.

On March 24th, Major General Somerall spoke before the post on the work of the engineer troops at the front. His talk was most helpful and inspiring. Many interesting and instructive points were brought out regarding the engineer regiments as combat troops.

On April 28th Maj. Gen. W. C. Langfitt spoke to the post on the subject of the railways and railway service during the war. His talk was very complete in regard to railways with the British and also with the French troops. He supplied much valuable data, especially with regard to various types and characteristics of locomotives tried, discarded and used.

Lt. Col. G. A. Youngberg spoke at the May meeting on the work of the General Staff in France and laid stress on the engineer work.

New Posts

The following Posts are now in course of organization:

Akron Post—Lieut. Sears S. Day, Lock Box 254, East Akron, Ohio.

Baltimore Post—Capt. John S. Doyle (E. O. R. C.), 309 Custom House, Baltimore, Md.

Boston Post—Lieut. Louis A. Armistead, Room 701, 108 Massachusetts Avenue, Boston, Mass.

Buffalo Post—Mr. Albert F. Krause, Builders Exchange, Court and Pearl St., Buffalo, N. Y.

Cincinnati Post—Capt. Hugh J. Krampe (E. O. R. C.), 1608 First National Bank Building, Cincinnati, Ohio.

Denver Post—Mr. Charles H. Rankin, 700 Tramway Building, Denver, Colo.

Indianapolis Post—Capt. C. L. Harrod (E. O. R. C.), Public Service Commission of Indiana, Indianapolis, Ind.

San Antonio Post—Mr. Ray S. Quick, Box 262, San Antonio, Texas.

Twin Cities Post—Capt. John F. Druar (E. O. R. C.), 512 Globe Building, St. Paul, Minn.

Our List of "Who's Where"

In this issue will be found a list of over one hundred members and subscribers to THE MILITARY ENGINEER whose mail has been returned unclaimed from the latest address furnished us. Won't you please look this list over and inform us of the present addresses of any of your friends whose names are listed? Many of them have paid their dues for the current year and are entitled to their copies of the magazine.

Personals

Leave of absence for two months and twenty-five days has been granted to Col. SHERWOOD A. CHENEY, Corps of Engineers, at the expiration of which he has been ordered to Fort Leavenworth, Kansas, for duty as instructor at the General Service Schools.

Col. CLEMENT A. F. FLAGLER, Corps of Engineers, has been relieved from his present assignment and duties in the Hawaiian Islands.

Col. CHARLES KELLER, Corps of Engineers, in addition to his other duties, is designated, during the absence of Lieut. Col. WM. KELLY, Corps of Engineers, to represent the War Department on the Advisory Board of the Superpower Survey which is being conducted under the Department of the Interior.

Col. GEORGE P. HOWELL, Engineers, and Lieut. Col. CHARLES Y. BROWNLEE, Medical Corps, have been detailed as members of the Army Retiring Board appointed to meet at Headquarters, Fourth Corps Area, Fort McPherson, Georgia.

Leave of absence granted to Col. CHARLES L. POTTER, Corps of Engineers, has been extended one month and fifteen days.

Lieut. Col. ALBERT E. WALDRON, Corps of Engineers, has been detailed for duty as Instructor, Engineers, Pennsylvania National Guard.

Maj. ROBERT W. CRAWFORD, Corps of Engineers, has been relieved from his duties at Cornell University, Ithaca, N. Y., and ordered to Washington for assignment to duty in the office of the Chief of Engineers.

Maj. BEVERLY C. DUNN, Corps of Engineers, has been relieved from his duties at Camp A. A. Humphreys, Virginia, and ordered to New York City.

Maj. GLEN E. EDGERTON, Corps of Engineers, in addition to his other duties, has been designated as official representative of the Corps of Engineers on the Government Division of the National Research Council and also on the Technical Committee for the War Department.

Maj. PHILIP B. FLEMING, Corps of Engineers, has been transferred from New York City to Camp A. A. Humphreys, Virginia, for duty as instructor at the Engineer School.

Maj. ALFRED L. GANAHL, Corps of Engineers, has been transferred from the Canal Zone to Camp A. A. Humphreys, Virvinia.

Maj. CRESWELL GARLINGTON, Corps of Engineers, has been detailed as a member of the Board of Officers appointed to consider a system of National Highways in connection with the rural post roads.

Maj. WM. A. JOHNSON, Corps of Engineers, in addition to his other duties, has been assigned to the Third Engineers and has been ordered to report to the Commanding General, Hawaiian Department, for assignment to duty as Department Engineer, relieving Col. CLEMENT A. F. FLAGLER, Corps of Engineers.

Maj. THOMAS B. LARKIN, Corps of Engineers, has been designated as alternate representative of the Corps of Engineers on the Technical Committee for the War Department.

Maj. DAVID MCCOACH, Jr., General Staff (Corps of Engineers) has been ordered relieved from further detail in the General Staff Corps effective August 21, 1921.

Maj. GEORGE MAYO, Corps of Engineers, has been transferred from Camp A. A. Humphreys, Virginia, to Portland, Oreg.

Majs. RICHARD C. MOORE, MARK BROOKE, WARREN T. HANNUM, all of the Corps of Engineers, have been detailed as instructors at the General Service Schools for a period of two years.

Maj. ROGER G. POWELL, Corps of Engineers, has been transferred from Washington, D. C., to the First Engineers, Camp Dix, New Jersey.

Maj. XENOPHEN H. PRICE, Corps of Engineers, has been relieved from further detail as a student at the Massachusetts Institute of Technology, Cambridge, Mass., and ordered to San Francisco, Calif.

Maj. DANIEL D. PULLEN, Corps of Engineers, has been ordered to report to the Commanding General, Panama Canal Department, for assignment to duty as Department Engineer, vice Col. CHARLES S. RICHE, U. S. A., Retired.

Maj. RUFUS W. PUTNAM, Corps of Engineers, has been ordered from Camp A. A. Humphreys, Virginia, to Chicago, Ill.

Maj. CLARENCE S. RIDLEY, Corps of Engineers, has been ordered to report to the Governor, Panama Canal, for assignment to duty.

Maj. WM. F. TOMPKINS, Corps of Engineers, has been transferred from Washington, D. C., to Camp A. A. Humphreys, Virginia.

Capt. PIERRE A. AGNEW, Corps of Engineers, has been relieved from duty at Camp A. A. Humphreys, Virginia, and ordered to report to the Chief of Engineers for assignment to duty.

Capt. LEONARD B. GALLAGHER, Corps of Engineers, has been transferred from the Panama Canal to the First Engineers, Camp Dix, New Jersey.

Capt. LLEWELLYN B. GRIFFITH, Corps of Engineers, has been relieved from further detail as a student at the Massachusetts Institute of Technology, Cambridge, Mass., and ordered to report to the Chief of Engineers for duty in his office.

Capt. HARTLEY M. HARLOE, Corps of Engineers, has been ordered to New York City and report for assignment to duty.

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Capt. HENRY HUTCHINS, Jr., Corps of Engineers, has been granted leave of absence for one month and twenty days.

The following named officers have been transferred from Camp Benning, Georgia, and assigned to the organization indicated: Capt. WARNER A. LYON, Fourth Engineers, Camp Lewis, Washington; Capt. JOHN A. STRANG, Second Engineers, Camp Travis, Texas; Capt. F. RUSSELL LYONS, Twelfth Engineers, Camp Grant, Illinois.

Capts, JAMES C. MARSHALL, ANDERSON T. W. MOORE, EUGENE M. CAFFEY, and First Lieut. DAVID W. GRIFFITHS have been ordered assigned to duty as instructors at the Engineer School.

Capt. THOMAS H. MESSER, Corps of Engineers, has been granted leave of absence for three months on account of sickness.

Capt. RAYMOND G. MOSES, Corps of Engineers, has been granted leave of absence for one month and fifteen days.

Capt. ALEXANDER N. NEILSON, Corps of Engineers, has been ordered from Camp A. A. Humphreys, Virginia, to Washington, D. C., for assignment to duty.

Capt. DAVID L. NEUMAN, Corps of Engineers, has been relieved from his duties in the office of the District Engineer, New York City, and ordered to report to the Commanding General, New York General Intermediate Depot for duty.

Capt. ROBERT R. NEYLAND, Jr., Corps of Engineers, has been granted leave of absence for one month and twenty-three days.

Capt. DANIEL NOCE, Corps of Engineers, has been granted leave of absence for twenty-one days.

Leave of absence granted to Capt. GEORGE J. NOLD, Corps of Engineers, has been extended one month.

The resignation of Capt. ALBERT W. PIODA, Corps of Engineers, has been accepted by the President.

Capt. STANLEY L. SCOTT, Corps of Engineers, has been granted leave of absence for one month and twenty-four days.

Capt. AMOS B. SHATTUCK, Jr., Corps of Engineers, has been transferred from Camp A. A. Humphreys, Virginia, to the Fourteenth Engineers, Manila.

Capt. WM. A. SNOW, Corps of Engineers, has been relieved from further detail as a student at the Massachusetts Institute of Technology, Cambridge, Mass., and upon the expiration of leave of absence for one month and fifteen days, has been ordered to report to the Chief of Engineers for duty in his office.

Capt. CHARLES H. SWICK, Corps of Engineers, has been relieved from his present duties at Wilson Dam, Florence, Ala., and assigned to the Third Engineers, Honolulu, T. H.

Capt. LUDSON D. WORSHAM, Corps of Enggineers, has been granted leave of absence for one month.

First Lieut. VERE A. BEERS, Corps of Engineers, has been granted leave of absence for thirteen days.

First Lieut. FRANK O. BOWMAN, Corps of Engineers, has been transferred from Camp A. A. Humphreys, Virginia, to the Third Engineers, Honolulu, T. H.

The following named officers of the Corps of Engineers are relieved from their present duties at Camp A. A. Humphreys, Virginia, and assigned to the organization indicated after their names: First Lieut. BENJAMIN F. CHADWICK, Second Engineers, Camp Travis, Texas; First Lieut. JOHN S. NILES, Second Engineers, Camp Travis Texas; First Lieut. KARL B. SCHILLING, Second Engineers, Camp Travis, Texas; First Lieut. LESLIE R. GROVES, Jr., Fourth Engineers, Camp Lewis, Washington; First Lieut. WILLIAM V. HESP, Eighth Engineers, Fort Bliss, Texas; First Lieut. JOSEPH J. TWITTY, Eighth Engineers, Fort Bliss, Texas; First Lieut. WILLIAM C. BENNETT, Jr., Ninth Engineers, Fort Sam Houston, Texas; First Lieut. ROBERT E. YORK, Thirteenth Engineers, Camp A. A. Humphreys, Virginia; First Lieut. ORVILLE E. WALSH, Ninth Engineers, Fort Sam Houston, Texas; First Lieut. HOWARD V. CANAN, Twelfth Engineers, Camp Grant, Illinois; First Lieut. CHARLES D. JEWELL, Twelfth Engineers, Camp Grant, Illinois; First Lieut. WENDELL P. TROWER, Twelfth Engineers, Camp Grant, Illinois; First Lieut. JOHN H. ELLEMAN, Twelfth Engineers, Camp Grant, Illinois; First Lieut. FREDERICK B. BUTLER, Thirteenth Engineers, Camp A. A. Humphreys, Virginia; First Lieut. MARK M. BOATNER, Thirteenth Engineers, Camp A. A. Humphreys, Virginia; First Lieut. DAVID T. JOHNSON, Thirteenth Engineers, Camp A. A. Humphreys, Virginia; First Lieut. EDWIN G. SHRADER, Thirteenth Engineers, Camp A. A. Humphreys, Virginia; First Lieut. OTTO PRAEGER, Jr., Thirteenth Engineers, Camp A. A. Humphreys, Virginia; First Lieut. JAMES P. JERVEY, Jr., Thirteenth Engineers, Camp A. A. Humphreys, Virginia; First Lieut. EUGENE L. VIDAL, Thirteenth Engineers, Camp A. A. Humphreys, Virginia; First Lieut. ARTHUR J. SHERIDAN, Ninth Engineers, Fort Sam Houston, Texas.

First Lieuts. CLAUDE H. CHORPENING and JOHN P. DIETRICH, of the Corps of Engineers, have been transferred from Camp A. A. Humphreys, Virginia, to the Third Engineers, Honolulu, T. H.

First Lieut. HARRY HAIGH, Corps of Engineers, has been granted leave of absence for two months on account of sickness.

First Lieutes. NEWELL L. HEMENWAY and BEVERLY C. SNOW, of the Corps of Engineers, have been transferred from Camp A. A. Humphreys, Virginia, to the Fourteenth Engineers, Manila, P. I.

First Lieut. JOHN B. HUGHES, Corps of Engineers, has been transferred from Camp A. A. Humphreys, Virginia, to the Eleventh Engineers, Canal Zone.

First Lieut. HOMER B. PETTIT, Corps of Engineers, has been transferred from Camp Pike, Arkansas, to the Eleventh Engineers, Canal Zone.

First Lieut. VOLNEY A. POULSON, Coast Artillery Corps, has been transferred to the Corps of Engineers and assigned to duty with the Second Engineers at Camp Travis, Texas.

The orders affecting First Lieut. THOMAS H. STANLEY, Corps of Engineers, have been amended to read "Eighth Engineers, Fort Bliss, Texas," instead of "Second Engineers, Camp Travis, Texas."

The resignation by First Lieut. HAROLD A. TAYLOR, Corps of Engineers, of his commission as an officer of the Army, has been accepted by the President.

Cols. WILLIAM W. HARTS, and WILLIAM P. WOOTEN, both of the Corps of Engineers, have been assigned to duty as student officers at the General Staff College.

Cols. GEORGE M. HOFFMAN and FRANK C. BOGGS and Lieut. Col. GEORGE B. PILLSBURY, all of the Corps of Engineers, upon completion of their duties at the General Staff College, Washington Barracks, D. C., have been ordered to report to the Chief of Engineers for duty in this office.

Col. WILLIAM B. LADUE, Corps of Engineers, has been transferred from the First Engineers to the Eleventh Engineers, Panama Canal Zone.

Maj. PAUL T. BOCK, Corps of Engineers, has been transferred from New York City to Washington, D. C., for duty in the office of the Chief of Engineers.

Maj. ROBERT C. WILLIAMS, Corps of Engineers, has been transferred from the Infantry School, Camp Benning, Georgia, to Vicksburg, Miss.

Capt. WILLIAM M. HOGE, Jr., Corps of Engineers, has been assigned to duty as a student at the Massachusetts Institute of Technology.

Capt. HAROLD R. RICHARDS, Corps of Engineers, has been assigned to duty as a student at the Carnegie Institute of Technology.

Eah of the following name dofficers of the Corps of Engineers is relieved from further duty at the place specified after his name and assigned to duty as a student at the Massachusetts Institute of Technology; Capt. WILHELM D. STYER, Cambridge, Mass.; Capt. CHARLES H. CUNNINGHAM, U. S. Military Academy, West Point, N. Y.; Capt. DWIGHT F. JOHNS, U. S. Military Academy, West Point, N. Y.; Capt. ELROY S. J. IRVINE, Office Chief of Engineers, Washington, D. C.; Capt. ROBERT G. GUYER, U. S. Military Academy, West Point, N. Y.; Capt. ROBERT A. SHARRER, U. S. Military Academy, West Point, N. Y.; Capt. FREDERICK W. BONFILS, U. S. Military Academy, West Point, N. Y.; Capt. WILLAM F. HEAVEY, U. S. Military Academy, West Point, N. Y.

Leaves of absence varying from 23 days to 1 month and 15 days have been granted to First Lieuts. HOWARD V. CANAN, JOHN H. ELLEMAN, LESLIE R. GROVES, Jr., NEWELL L. HEMENWAY, JOHN B. HUGHES, KARL B. SCHILLING, BEVERLY C. SNOW, WENDALL P. TROWER, all of the Corps of Engineers.

First Lieut. BERNARD S. STEARNS, Corps of Engineers, has been transferred from Camp A. A. Humphreys, Virginia, to the First Engineers, Camp Dix, New Jersey.

Each of the following named officers of the Corps of Engineers has been relieved from further duty as a student officer at the Engineer School, Camp A. A. Humphreys, Virginia, and assigned to the duty indicated: First Lieut. WILLIAM W. WANAMAKER, Professor of Military Science and Tactics, Missouri School of Mines, Rolla, Mo.; First Lieut. CORNMAN L. HAHN, Assistant Professor of Military Science and Tactics, Virginia Polytechnic Institute, Blacksburg, Va.; First Lieut. MORRIS W. GILLAND, Assistant Professor of Military Science and Tactics, Virginia Military Institute, Lexington, Va.; First Lieut. CHESTER K. HARDING, Assistant Professor of Military Science and Tactics, University of Cincinnati, Cincinnati, Ohio; First Lieut. VERE A. BEERS, Assistant Professor of Military Science and Tactics, Alabama Polytechnic Institute, Auburn, Ala.

Addresses Wanted

The Secretary of the Society would be pleased to receive any information concerning the present addresses of the following named members, whose mail has been returned unclaimed:

Lieut. Col. Frederick W. Albert, The Tuxedo, Apt. 304, Washington, D. C.
Capt. J. D. Arnott, 134 York St. Vallejo, Calif
Lieut. Ben Badgley, 708 B St., San Diego, Calif.
Capt. H. L. Baker, Woolwich, Me.

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Lieut. E. C. Ball, 814 Carroll St., Saginaw, Mich.
Lieut. John T. Bancroft, 40 Morgan, Philadelphia, Pa.
Capt. William A. Bassett, Mill Basin Inn, Mill Basin, Brooklyn, N. Y.
Capt. W. G. Baxter, 53 Eddy St., Providence, R. I.
Lieut L. H. Belk, Glen Ullin, N. Dak.
Mr. C. M. Binford, Riley, W. Va.
Mr. Ridgely Brewerton, care of Fortification Dept., Panama Canal, C. Z.
Lieut. A. H. Brown, Brunswick, Ga.
Capt. Edward W. Bullard, care of Johnson Bronze Works, New Castle, Pa.
Capt. B. R. Butt, Clarksburg, W. Va.
Capt. G. B. Byam, 1600 Q St., Washington, D. C.
Lieut. Col. Ralph E. Comeron, 435 Woodward Ave., Detroit, Mich.
C. L. Catlin, 728 S. Denver St., Tulsa, Okla.
Capt. J. L. Church, Montana Club, Helena, Mont.
Capt. Wm. A. Clark, Third Engineers, Manila, P. I.
Lieut. E. S. Cloud, 1751 19th St., Cleveland, Ohio
Harry R. Cooper, 2154 Esplanade Ave., New Orleans, La.
Capt. John T. Costello, Room 408 Majestic Building, Atlanta, Ga.
Capt. Harry M. Crawford, 500 Pearl St., So. Brownsville, Pa.
Capt. Marvin L. Davis, 100 College Ave., Princeton, W. Va.
Mr. John K. Deloach, 52 Sterling St., Atlanta, Ga.
Capt. John H. Devine, First U. S. Engineers, Camp Knox, Kentucky.
F. P. Dickson, Jr., Amarillo, Texas.
Lieut. R. G. Dillaway, 123 N. 9th St., Miles, Mont.
Mr. J. D. Dixon, Chico, Calif.
D. J. Donovan, 316 19th St., Milwaukee, Wis.
J. L. Doyle, Box 732, Johnstown, Pa.
Mr. H. K. Dyer, care of Aberthaw Construction Co., West End Trust Building, Philadelphia, Pa.
C. S. Elliot, 613 Mills Building, El Paso, Texas.
Mr. N. E. Emmons, 27 Lewis St., Hartford, Conn.
Mr. J. H. Feehan, 207 S. 45th St., Philadelphia, Pa.
Mr. Calvert Burke Filbert, Maison Blanche Annex Building, New Orleans, La.
Maj. Thomas D. Finley, C. of E., 7th Engineers, Camp Gordon, Georgia.
Mr. J. H. Flood, San Francisco, Calif.
J. J. Flynn, Lakehurst Proving Ground, Lakehurst, N. J.
Mr. Everett L. Fornyou, B. & O. Building, Baltimore, Md.
N. C. Frith, care of A. W. Shaw Co., 299 Madison Ave., N. Y. City.
Second Lieut. Wm. G. Gardner, 417 Union St., Schenectady, N. Y.
Mr. E. C. Garvin, Court House Building, Brunswick, Ga.
Lieut. N. Gerten, 41 Elmhurst Ave., Long Island, N. Y.
Capt. F. M. Gibson, 2273 83d St., New York City.
Capt. D. E. Godfrey, 312 Union League Building, Los Angeles, Calif.
E. L. Gonyou, 907 Delaware Ave., Wilmington, Del.
H. K. Graf, 708 A. O. U. W. Building, Little Rock, Ark.
Mr. G. T. Granger, 1609 Cadiz, Dallas, Texas.
Col. Ernest Graves, Commanding 2d Engineers, Camp Travis, Texas.
Mr. Wallis Green, Thornton, W. Va.
Mr. B. C. Grey, Columbus, Ohio.
Lieut. K. S. Hall, 1260 State St., Portland, Oreg.
Mr. M. J. Hennessey, 2043 Linden St., Wilmington, Del.
Lieut. R. R. Hetz, 1401 Forest St., Carthogue, Mo.
George F. Hill, M. E,. 51 E. 42d St., New York City.
Lieut. G. A. Holmes, 820 8th St., Indiana Harbor, Ind.
Col. G. E. Humphrey, C. of E., 107 Armistead Bridge Ct., Norfolk, Va.
Mr. Guy S. Hynes, Cheyenne Hotel, Tulsa, Okla.
Capt. C. V. Imeson, Const. Quartermaster, Eagle Pass, Texas.
M. O. Jenkins, 509 W. 110th St., New York City.
Capt. Jno. E. Johnson, Madisonville, Ky.
F. L. Johnston, 1131 Chapala St., Santa Barbara, Calif.
Capt. E. Kitchen, Constructing Quartermaster, Army and Navy Hospital, Hot Springs, Ark.
Capt. Lou M. Louis, P. O. Box 1652, Fort Worth, Tex.
H. Loveridge, 1333 21st St., N. W., Washington, D. C.
Mr. Edward Lyndon, 136 W. 16th St., New York City.
Mr. W. M. McIntosh, 34 Gilton Ave., Brooklyn, N. Y.
P. D. Mackie, Zona, La.
Mr. J. W. MacNaul, Wilmington, Del.
H. H. Martindale, 337 Hastings St., Pittsburgh, Pa.
Capt. William Michener, Fort Sill, Okla.
Mr. A. M. Miller, Bowling Green, Ky.
Mr. M. A. Neumaier, Camp Jackson, S. C.
F. J. O'Hara, 1010 Balboa Building, San Francisco, Calif.
Capt. D. M. Oltarsh, 375 Lexington Ave., New York City.
Col. C. W. Otwell, C. W. S., Lakehurst, N. J.
Mr. H. G. Pallin, B. M. Wilson Dam, E. Florence, Ala.
Lieut. Col. H. B. Per-Lee, Engr. R. C., 106 W. 86th St., New York City.
W. L. G. Perry, 1710 H St., N. W., Washington, D. C.
Maj. John T. Rice, Barbara Worth Hotel, El Centro, Calif
Lieut. Wm. C. Richenbach, 315 Franklin Ave., Wilkinsburg, Pa.
Lieut. J. C. Rickner, Mt. Engrs., Camp Baker, Fort Bliss, Texas.
Lieut. R. O. Sayner, 818 E. 15th St., Davenport, Iowa.
Mr. F. L. Sellew, St. Johns, Ariz.
A. G. Shafer, 38 Baker Ave., Dover, N. J.
Capt. W. A. Shaw, Inf. Att. M. T. C. Motor Command 29, Marfa, Texas.
Lieut. C. H. Skellie, care of Const. Quartermaster, Fort Leavenworth, Kans.
Mr. James J. Smyth, P. O. Box 625, Ranger, Texas.
Lieut. H. G. Stoeckmann, 227 N. Oakdale Ave., Medford, Oreg.
Capt. J. E. Sumpter, Executive Officer, Camp Dodge, Iowa.
Mr. J. C. Terrell, Lakehurst Proving Ground, Lakehurst, N. J.
S. Ticknor, 424 S. Hull Ct., Montgomery, Ala.
Mr. Rudolf Umfug, 1347 29th St., N. W., Washington, D. C.
Robert E. Van Bergen, 1202 Mills Building, El Paso, Texas.
A. E. Warren, 1629 Calvert St., Baltimore, Md.
Mr. Rees W. Weston, 1412 Riverview Ave., Wilmington, Del.
Lieut. Virgil V. Whaley, 519 Walnut St., Macon, Ga.
Capt. A. D. Whitman, E. O. R. C., 1618-A S. Quaker, Tulsa, Okla.
Capt. Henry D. Williams, 302 New Call Building, San Francisco, Calif.
T. S. Williams, 1123 Pratt Building, Chicago, Ill.
Edgar Wilson, 904 S. Magnolia, Palistine, Texas.
Mr. H. E. Wilson, 127 State St., Harrisburg, Pa.
Col. J. M. Wright, 1051 Spruce St., Philadelphia, Pa.

Silver Button Winners

One hundred and seventy-five new members within sixty days! This is indeed an excellent showing and is proof that members take an enthusiastic interest in building up the Society. So many requests have been received from members securing one or two new members that additional time be allowed for them to bring their total up to three, that it has been decided to extend *for thirty days the time limit of members who already have one or two applicatios to their credit.* A complete list of silver button winners follows:

L. R. Lohr, Camp Humphreys, Virginia	8
Philip B. Fleming, Whitehall Building, New York City	6
S. M. Felton, 1121 Peoples Gas Building, Chicago, Ill.	5
L. E. Atkins, Military Department, U. of I., Urbana, Ill	4
Wm. P. Cowles, 3227 Portland Avenue, Minneapolis, Minn.	4
C. B. Falley, Fort Sam Houston, Texas	4
W. A. Hill, 135 Seventh Ayenue, La Grange, Ill.	4
J. D. Schmidt, Custom House, New Orleans, La.	4
R. C. White, 1022 Railway Exchange Building, St. Louis, Mo.	4
E. G. Bliss, Munitions Building, Washington, D. C.	3
P. S. Bond, 22d Regiment Armory, New York City	3
B. B. Browne, 12th Engineers, Camp Grant, Illinois	3
L. J. Canfield, Missoula, Mont.	3
Frank J. Clark, 42 Cedar Street, Dobbs Ferry, N. Y.	3
E. K. Coe, City Engineer, Duluth, Minn.	3
F. W. Greene, 6203 Washington Avenue, St. Louis, Mo.	3
F. W. Henrici, 962 Kennebec Street, Pittsburgh, Pa.	3
Richard B. Hewitt, Birmingham, Mich.	3
F. G. Jonah, Frisco R. R. Co., St. Louis, Mo.	3
Wm. R. Lee, Minneapolis, Minn.	3
B. A. Miller, Chief Engineer, A. F. G., Coblenz, Germany	3
E. B. Murray, Camp Travis, Texas	3
H. L. Peckham, Box 629, Rolla, Mo.	3
W. H. Peters, Fort Jay, N. Y.	3
Clarence E. Raynor, 917 Bell Building, Montgomery, Ala.	3
Willis R. Tenney, 50 Court Street, Brooklyn, N. Y.	3
Dwight Trevarthen, Box 763, Montgomery, Ala.	3
W. B. Tuttle, San Antonio Pub. Service Co., San Antonio, Texas	3
F. B. Wieners, Air Service Pilot School, March Field, California	3

Dues for 1921

Are you one of the 4 per cent?

Ninety-six per cent of our members have paid their dues for 1921. This is an excellent showing, but the Engineers have always had a 100 per cent record!

If you are one of the "hold-outs," won't you reduce the 4 per cent list by one?

Dues for 1922

In order to simplify our accounts we have arranged to have all memberships expire at the end of the year. All members whose dues are payable after the receipt of No. 70 of THE MILITARY ENGINEER (the present issue) will be billed for $6.00—$1.50 for the balance of 1921 and $4.50 for 1922, and all members whose dues are payable after the receipt of No. 71, will be billed for $5.25—75 cents for the balance of 1921 and $4.50 for 1922.

It is earnestly hoped that members will co-operate by paying their dues promptly, thus reducing clerical work and postage incident to sending duplicate bills.

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The Civilian Engineer

How can he best be trained for military emergencies, and how used to best advantage?

A paper read before the San Francisco Post, Society of American Military Engineers

By

J. W. Williams

Lieutenant Colonel, E. O. R. C.; Chief Engineer, Northwestern Pacific Railroad; formerly Lieutenant Colonel, 18th Engineers

This article has reference only to the training and use of civilian engineers in the technical service of the army and is not intended to apply to other arms of the service. It has particular reference to the engineer reserve officer, but some comment will be made in regard to the use, during war, of engineers who may not be reserve officers.

During the war I had a good opportunity to observe the problems, efficacy and shortcomings of the engineer reserve officer in the supply service, and feel that I can speak with some authority on that phase of the subject. A somewhat different training may be desirable for the combatant engineer, but as a technical officer the fundamentals of the training should be the same.

The principal value of an engineer reserve officer to the army is his experience as an engineer and his ability to direct men engaged on engineering projects. If he has not acquired this in his civil training, the limited amount of military training which can be given him in a training camp, or elsewhere, can not make of him a satisfactory officer of engineers.

Proper assignment of engineer reserve officers is more important than their military training. So far as practical the assignments should be made in advance of an emergency, when there is time available for an orderly and thorough study of the officer's qualifications. The reserve officer's personal statement of his qualifications should not be accepted as the sole guide in assigning him. The engineer officers of the regular army should by careful verbal inquiry among members of technical societies and leading engineers, determine the civil rating of the reserve officer, the work he has done and is doing, and the success with which he has handled his work. Such inquiry if tactfully conducted would not embarass the reserve officer. It is realized that this would be a task of great magnitude if applied to all engineer reserve officers, but if we are to have an efficient engineer reserve corps, some means must be found of assembling and keeping currently corrected an accurate record of reserve officers' qualifications. This is the base on which the entire structure must be built and if it is not reasonably sound, months will elapse after war is declared before the engineer reserve officers can be fitted into the armies in positions which they are best qualified to fill.

In order to make the suggested plan more workable, the inquiries of the regular officers as to the qualifications of reserve officers could be limited to the reserve officers of field officer grade and the reserve field officers could be required to gather and correct the data relative to officers of lower grade, subject to review by officers of the regular establishment charged with such duties. If reserve officers are assigned to skeleton organizations in time of peace, they can readily be made responsible for keeping correct records of the reserve officers who will come under their command when called to active duty.

No system of examinations can as satisfactorily determine the qualifications of engineer reserve officers as personal observation and inquiry.

The War Department's roster of engineers should not be confined to reserve officers only, but should include all engineers of special qualifications whose services might be used to the public good in time of war. This would apply especially to those incapacitated for active military duty by age or physical disability. In compiling and currently correcting such a roster, the engineer reserve officer could be of great assistance.

What are the qualifications of a satisfactory engineer reserve officer?

Good character, good physical condition, experience in planning and executing engineering projects, ability to lead, cheerful submission to discipline and a desire to acquire a knowledge of military matters. The term engineering is used in a general sense. A good superintendent or foreman of construction or operation is better fitted for some duties assigned to engineer officers than a technically educated engineer.

As the engineer reserve officer is to be used in time of war only, some qualifications which may be necessary for a regular officer can be dispensed with in the case of the reserve; for example, the social graces. During both peace and war, the regular officer is frequently assigned duties of a diplomatic nature or as an agent of the government where polish and education are necessary to the credit of the United States. A reserve officer lacking in those attainments can be assigned to duties where they are not particularly necessary. The rough diamond type of hard-hitting leaders of men and builders of works, should not be overlooked in building up the Engineer Officers' Reserve Corps.

The training camp offers the only satisfactory method of training the enlisted personnel of the engineer reserve corps and the most satisfactory method of educating the officers in military matters, but the training of officers should not be limited to the training camp nor should the retention of a commission in the engineer reserve corps be dependent on attendance at a training camp. If training camp attendance is made obligatory, a large number of the ablest engineer reserve officers will be compelled to resign, and many who should and would be in the corps but who have not applied for commissions, due to uncertainty as to the obligations involved, will remain out per-

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manently. This class constitutes a large number of both the older and younger public spirited men who are in actual direction of engineering projects analogous to those required with the armies in time of war. It is inevitable that a large number of this class will be offered and will accept commissions in case of war and it is better that they be commissioned in the reserve and given such training as is possible outside of the training camp, than to be accepted in time of emergency without any previous military training.

Those officers assigned to skeleton organizations whose service when called to active duty will be with troops, should unquestionably be required to attend the training camps. Those selected for staff, administrative and other duties not involving the command of troops, can receive military training otherwise.

Military administration and law, army regulations, court-martial procedure, customs of the service, military reports, orders and correspondence, army financing and requisitions and similar subjects, can be taught by a carefully prepared correspondence course which all reserve officers should be required to take.

Reserve officers residing in the vicinity of corps headquarters, army posts or other military centers, could be required to attend lectures and classes conducted by regular officers and following a carefully prepared program.

If the law permits, or can be amended to permit, reserve officers on inactive status could sit as members of courts-martial and army boards and the few having the advantage of this special training could, when called to active service, materially assist those officers who had received a more meager training in such matters, which are of unusual intricacy to the civilian.

Reserve officers residing in the vicinity of army posts could be formed into voluntary classes for military drill and an officer or non-commissioned officer of the regular army detailed to instruct them.

These measures are not submitted as preferable to the training camp, but only as a suggestion for supplementing it and for giving the best possible military training to such experienced engineers as desire to serve in case of war, but are unable to attend a training camp two weeks or more annually on account of the exacting nature of their civil duties. Many busy engineers can spare an evening, a half day or day quite frequently for military training obtainable in close proximity to the scene of their work or homes, who could not absent themselves from their work for two weeks or more continuously, at a time designated by the military authorities. Many men of family who take only two weeks vacation each year would be reluctant to spend their entire vacation at a training camp, where their families could not participate in the vacation. This applies particularly to the older engineers in the active practice of their profession who can not spare the time, and the younger men who, due to limited means and inability to secure consent of their employers, can not be absent from their business longer than two or three weeks in any one year. Each of these classes is needed in the engineer reserve. An engineer officers' reserve corps composed largely of dilettanti and well-to-do idlers will not make an efficient organization for war purposes.

The training of reserve officers, either at the training camp or elsewhere, should not be left entirely to the younger officers of the regular army. Although most of them are fine fellows, enthusiastic, efficient and with a fine sense of public duty, only the experience that comes with age and through long contact with men of all classes, qualifies a man to teach mature men with that tact, firmness and consideration which secures the most efficient results and develops respect, loyalty and love of the service.

The reserve officer should feel that he is a part of the Army. It is to be hoped that the engineer reserve officer will have the same pride in and affection for the Corps of Engineers that the active engineer officer has. This society should, and I believe will, contribute to a marked degree in developing this spirit. So far as his own personality justifies, the reserve officer should be admitted to the army fellowship which is so attractive to any one familiar with the regular army. This will be mutually advantageous to the active and reserve officer. It will help to develop an *esprit de corps* in the reserve and the reserve officer can materially assist in obtaining legislation beneficial to the army and the national defense and in creating a better understanding and appreciation of the army by the public.

Specially qualified engineer reserve officers and engineers not in the reserve, can be profitably consulted in regard to army equipment and plans.

Reserve officers assigned to skeleton organizations can assist in selecting and recruiting for the enlisted engineer reserve corps, competent non-commissioned officers for the organizations to which they are assigned.

Engineer reserve officers can assist in preparing plans of defense with special reference to areas with which they are intimately familiar. Possibilities of military transportation by railroad, highway and waterway, water supply, topography and natural resources in every district of the United States, could be reported periodically by well-qualified engineer reserve officers whose daily work is in connection with facilities which would be utilized in time of war for these purposes. Such reports could be made to conform to plans prepared by the general staff. Such work will stimulate the interest of the reserve officer, will make him feel that he is an important part of the army, will acquaint the military authorities with his ability and be of benefit to the national defense.

Promotions in the reserve should be made with the greatest care and should never be permitted to become perfunctory. Merit and ability being equal, seniority should govern.

It would be advantageous to have reserve officers sit with regular officers on boards making recommendations as to promotions of or issuance of original commissions to reserve officers.

In conclusion, permit me to say that it is my opinion that the civil and professional duties of a civilian engineer are more important to his country, family and self than his military training, and that the latter should be conducted, so far as possible, so as not to interfere with his civilian occupation, but the preparation for national defense is of great public importance and the patriotic engineer should place the greatest possible amount of his time, consistent with the proper discharge of his civic, professional and family duties, at the disposal of the military authorities to be utilized in military training.

Membership Cards

Have you received your membership card for 1921? We mailed our new cards last month to every member who had paid his dues for 1921, *and submitted a formal application for membership.*

The latter step is essential before membership card or Society emblem can be furnished. An *informal* application submitted last year will insure your being classed as a charter member, but the formal application is necessary to complete your installation. Blanks may be had upon application.

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Combat Operations of 110th Engineers

In the Meuse-Argonne Offensive

By

E. P. Rankin, Jr.
Formerly Captain, 110th Engineers

[NOTE.—The 110th Engineers were recruited in Kansas City, Mo., with the exception of Company A, which was recruited in Topeka, Kans. Among its officers and non-coms were many engineering graduates of the University of Kansas. The staff was largely composed of Reserve Corps officers.

The regiment went overseas in May, 1918, and served with the 35th Division. Captain Rankin, who was regimental adjutant at the time, gives a vivid picture of the work of the regiment in late September, when it was thrown into the line in an emergency to help the infantry, and acquitted itself with great credit, in spite of heavy losses. Two officers and seven enlisted men received the Distinguished Service Cross for their work during this period. On page 329 of this issue, Major Mitchell refers to another exploit of the 110th Engineers in connection with the crossing of the Meuse.

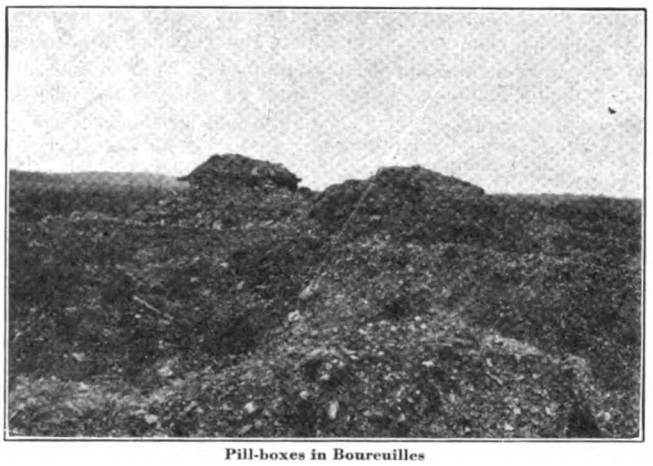
Col. T. C. Clarke, who commanded the regiment, died on May 25, 1921, from pneumonia, following an operation.—ED.]

In an advance the division commander, on the recommendation of the division engineer, makes assignment of the small groups necessary for accompanying each assaulting battalion, and after other special details have been made, the bulk of the engineers and all unemployed labor troops available are used for making passable the roads within the divisional area.*—*Col. C. O. Sherrill.*

SECRET FIELD ORDERS No. 44, 35th Division, dated September 24, 1918, at 5:00 P. M., contained these paragraphs:

* * * "The First Corps attacks on the front VAUQUOIS (inclusive) -LA HARAZEE (inclusive) with the 35th, 28th and 77th Divisions in line from right to left in the order named.* * *

* * * "The 35th Division attacks with the 91st Division of the Fifth Corps on the right, and the 28th Division on the left." * * *



Pill-boxes in Boureuilles

The same orders directed the 110th Engineers to concentrate efforts on the roads crossing No Man's Land, putting them in shape for animal-drawn transport, but leaving them at once thereafter to corps troops. Additional instructions were to examine and post drinking-water supply points, to install advanced material dumps, to utilize captured engineer materials and to consolidate captured enemy positions. All these duties were performed. Assignments of details to operate with the attacking brigade were as follows:

"One company of engineers will be reported to the Commanding General, 69th Brigade, for use in wire-cutting and overcoming obstacles.

"Two platoons of engineers will be reported to the Commanding General, 69th Brigade, to accompany the moppers-up in order to look for traps and concealed mines.

"One company, less one platoon, will be reported to the Corps Tank Officer, to be used in assisting the advance of the tanks."

The 110th Engineers was then in bivouac in the southerly reaches of the Argonne, opposite Rarecourt. Shacks and shelter tents mitigated discomfort. Total strength approached fifteen hundred. The staff was filled, the battalions were commanded by captains, and there were about three officers per company. A divisional dump, established at Neuvilly, had been hastily stocked with bridge timbers, road and bridge tools, sign-boards, wire-cutters, bangalore torpedoes and a miscellany of other materiel.

Col. T. C. Clarke, in command, selected for the work with combatants, Company A as wire-cutters, three platoons of Company B to assist the tanks, and the fourth platoon of B, together with the second platoon of Company C, to accompany infantry as mine searchers. Special instruction from the latest obtainable information concerning "booby-traps" was given the two platoons last named on the 24th and 25th. Company F left camp at night, on September 24, to make some forward road repairs, reporting back to the second battalion after midnight, twenty-four hours later, under our barrage. Company B, less one platoon, had marched out the previous night (corps orders received on the 22d had stipulated these details) to report to the 344th Tank Battalion. To us were attached, for road work on the 26th only, the opening day of the attack, a battalion of the 53d Pioneer Infantry.

The regiment, thus both depleted and augmented, left camp at 6:30 P. M. on the 25th, marching 16 kilometers up to Neuvilly by way of Auzeville and Aubreville. Combat wagons were with the battalions. Ration wagons, water-carts and rolling kitchens had been ordered left behind. The march to position was halted more than once, not only because roads were crowded, but to await the subsidence of periodic German shelling. We entered and cleared three husks of towns without a hit in our column, although the night fire switched back and forth over us. During the later hours of the march the horizon was scintillant far east and west, from the barrages beyond Verdun and behind the Argonne, distracting the bosches from attending to nine divisions being compressed into the intervening 18 miles. On the outskirts of Neuvilly, at midnight, the first battalion, with two companies of pioneer infantry attached, turned to the right into the Forest de Hesse, while headquarters and the second battalion, with the remaining

*PROFESSIONAL MEMOIRS, Sept.-Oct., 1919.

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pioneer infantry, continued on the road toward Boureuilles, thence into the woods topping Cote 215. The regimental commander was with the Division P. C. on the reverse slopes of Les Cotes de Forimont. Maj. E. M. Stayton, second in command, personally supervised the road work. We halted for three hours in old reserve trenches under our barrage, while in reply the whine and sickly burst of gas shells sounded at lengthening intervals from the lower woods. At 5 A. M. on the 26th both battalions went furiously to work on their respective assignments. "Zero hour" was 5:30. Before 6:30 the second battalion cleared the woods and ran into machine-gun fire (Vauquois was avoided by the leading infantry and mopped up in dense, rolling fog and smoke by a battalion detailed for that purpose). The first battalion on the extreme right of the sector was delayed by the deploying of 91st Division Infantry on its road. Capt. Orlin Hudson, first battalion commander, reconnoitered two lanes leading toward Vauquois, refused to lend his men as riflemen to the 364th Infantry, and turned his attention to a road leading to the left of Mt. des Allieux, working it across No Man's Land to a junction with the paved highway running behind the German front toward Varennes, this proving the most practicable of the possible routes on his side. The second battalion head reached Boureuilles, in the German front position, by 9 o'clock. Capt. W. W. Taylor, in command, reported that his road into it would be ready for light traffic by noon. In fact he sent word at 9:40 that machine-gun carts were using it to the edge of town. Inside the area of broken walls, however, the road was badly blown about, slowing up his progress. The preliminary road work by Company F on the 25th had consisted in part of rough repairs to culverts, draining ditches and filling in holes, with rock where available, but otherwise with tamped dry earth.

On the road to Boureuilles this company made 300 meters of corduroy over swampy ground by cutting poles in the nearby woods, three inch diameter being the largest used, cleaning off old material and tamping the subgrade; laying three stringers in longitudinal trenches, tying mats of 3 to 5 inches in thickness across the stringers; and finally covering the corduroy thus formed with several inches of shale. One platoon of fifty men was left on this stretch, to keep it in shape and boost field-pieces across it.

New crossings were found necessary, to pass French and German trenches. No spans were used. All work was done with pick and shovel. Trenches were filled with logs and rock, with a transverse corduroy of poles near the top, surfaced with earth. Where new road was required it was first marked by peeling off the vegetation, and then leveled and tamped. Wire was cut and laid to one side, and shell holes filled with whatever solid materials were available.

These roads encircled the blasted hell that had been Vauquois. We had no use that day of the wide, paved highway to Varennes, bordering the Aire in its northward flow, but had to make over for the entire up-movement these boggy lanes which for years had received no attention except that directed towards their obliteration. In front of us, from the right, Buanthe Creek entered the sector, meandered diagonally ten kilometers across our paths and emptied into the Aire at Baulny.

Headquarters detachment passed into Boureuilles shortly after noon. There was then a jam of traffic on the second battalion road, shelled at frequent intervals. Corps engineers were already in Boureuilles. Across the Aire machine guns rattled without ceasing at the forest's edge, where the 28th Division was sweeping their side of the river "trough." The second battalion was on an earth lane, running first east, then north, from Boureuilles, across higher ground skirting the silenced nests clustered in the Bois de Rossignol and the Ouvrage d'Aden. Advancing on this route there appeared in view ahead the trench-furrowed orchard and other heights before Cheppy. From steel-plate nests at its rim the Boches had spat across Buanthe Creek, at the road forks south of the bridge, which ground had been opened at noon by the little tanks after earlier assaults under lifting fog had failed.

The first battalion pushed into Cheppy over the right-hand road between two and three o'clock, followed by its train. The train had used its road repaired across No Man's Land, as had also a number of tanks, and an ammunition train of the 91st Division. Headquarters detachment, the message center, was put at 4:00 p. m. into a German strongpoint just beyond Buanthe Creek, at the edge of the road, and were shelled into dugouts that evening and irregularly during the following days. Runner service back to the regimental commander had been well maintained despite the increasing distance (from two kilometers at daybreak to seven by mid-afternoon). The mounted section expedited messages and was further detailed to boost traffic on the new up-road. The second battalion reached Cheppy during the evening and night, improving there the connection with the road over which the first had come. The first was then at the forward edge of town on the road leading to Very. During the night a combat train was turned over to the 70th Brigade, which, after having partly leap-frogged the leading brigade before Varennes early on the 26th, was to attack on the 27th. On the right of the sector Germans were in Very until midnight. Four hours later, at dawn of the 27th, engineer reconnaissance patrols gained entrance to Very but were told by the infantry to stay out.

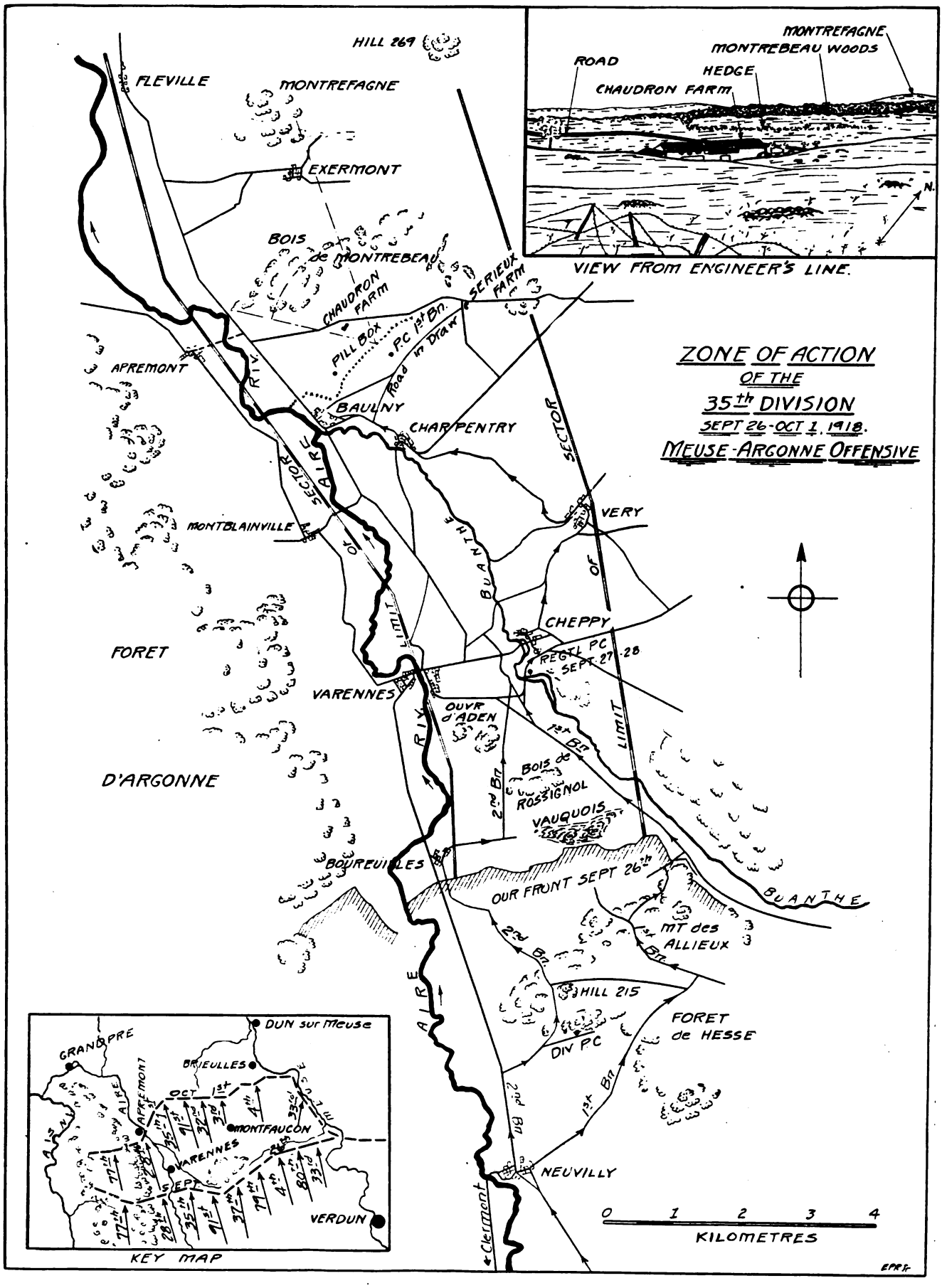
Little traffic had passed the strongpoint. A battery had used the second battalion road to get into the Bois de Rossignol in time to fire after 5 p. m. on the 26th, but in respect of other use the night and following morning were distressingly quiet. At noon on the 27th artillery passed up, and went into action on the right and left of Cheppy, supporting the brilliant afternoon attack which ended the second day, giving us Charpentry and Baulny as further prizes.

On the 27th Col. Clarke relinquished his easy connection with the Corps Chief Engineer and made the Buanthe bridge message-center his post. Master engineers inventoried and arranged for distribution a German engineer dump in Cheppy. The first battalion was in Very by mid-morning, and scouting towards Charpentry. It regained during the day most of the details released by commanders of the infantry and tanks, and the regiment fed at its work on their exploits.

Half of Company A had reported to the 138th Infantry. It was ordered back to the engineer battalion. Captain Hudson wrote Colonel Clarke at 6 a. m. on the 26th, "C.O. 138th Inf. has returned to me one-half of A Company, saying that he has absolutely no use for them and that the detail was a piece of damn foolishness." The other platoons of Company A went to the 137th Infantry and attacked with them, in four-man wire-cutting groups. The commander's report does not specify how much wire was found to cut, but the third platoon took nine prisoners and three guns, and the fourth platoon captured an equal number of men and one gun. After release by the infantry these platoons rejoined Company A on the 27th.

The three platoons of Company B spent the 24th and 25th with the tanks, officers getting instructions and making reconnaissance for favorable routes. Two platoons

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HILL 269
FLEVILLE
MONTREFAGNE
EXERMONT
BOIS de MONTREBEAU
CHAUDRON FARM
SERIEUX FARM
PC 1st Bn.
PILL BOX
Road in Draw
APREMONT
BAULNY
CHARPENTRY
MONTBLAINVILLE
VERY
CHEPPY
REGTL PC SEPT. 27-28
FORET D'ARGONNE
VARENNES
OUVR D'ADEN
Bois de ROSSIGNOL
VAUQUOIS
BOUREUILLES
OUR FRONT SEPT 26th
MT des ALLIEUX
HILL 215
FORET de HESSE
DIV PC
NEUVILLY
Clermont
RIV AIRE
RIV BUANTHE
SECTOR
LIMIT
ROAD
HEDGE
CHAUDRON FARM
MONTREFAGNE
MONTREBEAU WOODS
N.
VIEW FROM ENGINEER'S LINE.
ZONE OF ACTION
OF THE
35th DIVISION
SEPT 26-OCT 1, 1918.
MEUSE-ARGONNE OFFENSIVE
0 1 2 3 4
KILOMETRES
DUN sur Meuse
GRANDPRE
BRIEULLES
OCT 1st
MONTFAUCON
VERDUN
KEY MAP

went over on the 26th with American tanks, and the third with a French section. They helped the tanks over some very difficult trenches and country on that day, digging many out of mud. Their work was perhaps hottest before Cheppy, where Lieutenant Dinglestedt, a platoon commander, received wounds from which he never recovered. The fourth platoon of Company B, assigned as mine-searchers, went to Vauquois with moppers-up, located several mined dugouts and assisted in the capture of several officers and fifty men. The second platoon of Company C on the same duty, was held without instructions by the



German pill-box covering Buanthe Creek

infantry until 8 a. m. on the 26th. They went A.W.O.L., reporting to Major Stayton, and worked ahead of the second battalion into Cheppy. Thus Captain Hudson got back his men, replacing the pioneer infantry which had withdrawn on the afternoon of the 26th under corps orders.

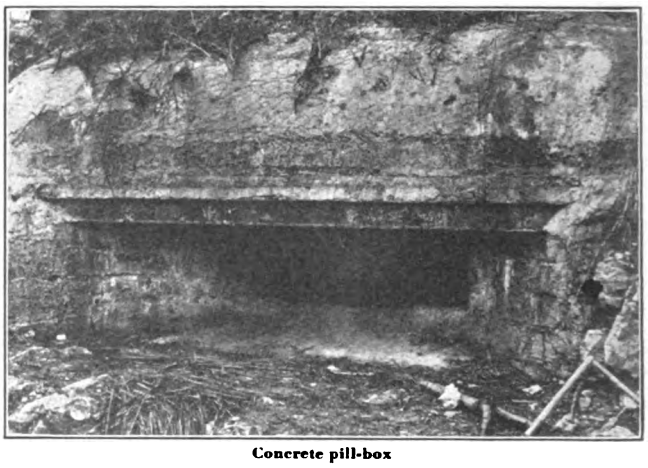
During the second and third day both battalions were on the Cheppy-Very-Charpentry road, held up by the slowing down of infantry advance. They crossed high clear country, shelled from north of Exermont and out of the Argonne. The first battalion moved forward from Very at 2:30 a. m. on the 28th, mending the road to Charpentry en route, at daylight burrowing into foxholes bordering the road running northeast from Charpentry. The day was spent there under irritating fire. The head of the second battalion touched them late on the 28th. Their task had been, in addition to removing mud from the rock road-base, that of filling shell holes as fast as they blew in, using rock and old surfacing. Though corps engineers worked rapidly to Cheppy, none had advanced beyond that point. At 6 a. m. on the 28th the supply officer was called up to the Buanthe bridge headquarters, and the engineer train directed to bring eight trucks of bridge materials and nails, with oil and gas for itself, to Cheppy via Varennes (not over our brush-corduroyed lanes). On the same day several batteries of divisional artillery used our road to take positions in Very and Charpentry.

At noon Colonel Clarke advised both battalion commanders to be ready to jump to the infantry's aid with tools and help. Montrebeau Woods was then being held with difficulty by mixed infantry units. At 2 p. m. he sent word to the battalion commanders, Captains Hudson and Taylor, "Infantry are to dig in. Send forward your part of their combat transport with an officer, to get in touch with the right-left (respectively) infantry flanks. Better see the regimental C. O.'s and offer technical help. Noonan starting with balance of train. Lots of wire here at dump." In compliance with these instructions an officer of Company C delivered in Montrebeau Woods 300 picks and 200 shovels at ten o'clock that night. On similar duty, transport of the second battalion drove into a Boche machine gun post on the Baulny-Fleville road, the detail was scattered in the dark and three men were captured by the Germans.

Some of the divisions in the Argonne got cut down to three or four hundred men to the regiment. Under such conditions, if the division must still stay in—and it must at times—the Division Commander must put in the engineers as infantry. * * * When a reaction starts from the enemy, the engineers are going to be used not only to dig, but to actually defend a second line.*—*Col. George R. Spalding.*

The division commander informed Colonel Clarke and Major Stayton at 8 p. m. on the 28th that the regiment would be placed immediately in divisional reserve. The train proceeded to carry rations and ammunition to Charpentry, while Major Stayton conferred, in a dugout on the edge of Charpentry, with the battalion commanders, staff and company commanders. The battalions were reported to the brigade commanders. Rations, tools and ammunition were distributed. Both battalions marched through Charpentry, a mud pit poisoned with the bodies of dead animals. The first turned to the right on a road up the draw heading near Serieux farm. It dug in on the reverse slope back of that draw, in front of Charpentry. The second battalion kept to the road, deploying before reaching Baulny. Companies E and F went to the ridge northeast of Baulny. Company D extended the line from the left of E to the Aire. At daybreak Company E was withdrawn from the center to support D down by the river, the two front companies extending towards one another to close the gap thus formed.

The regiment thus awaited developments while the division commander in person, in Baulny, with what officers were left and located with their commands, arranged for the storming of Exermont, the corps having ordered, "No



Concrete pill-box

definite objective. Division will push forward at 5:30 a. m. without regard to divisions on right or left."

The second battalion advanced with the attack. At 10 a. m. it reached the south edge of Montrebeau Woods, outside the zone of carnage ahead. The first battalion remained in its early morning lines until 9:30 a. m., at which time, under brigade orders, it crossed the draw up which it had marched the previous night. A position of resistance was located under general instructions of a brigade commander, on the front slope of the next ridge ahead, which slope extended gently down to the Chaudron farm buildings and the road running east therefrom. En-

*Professional Memoirs, Sept.-Oct., 1919.

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gineer officers selected and taped the ground under direction of Major Stayton. The battalion cleared the crest at 11 a. m. in excellent thin lines, Company A to the right, Company C on their left, B in support at 150 meters. The two leading companies passed through a belt of Boche wire. All started underground, B behind the wire but also fully exposed to view. The panorama of heights beyond Exermont was partly screened by the smoke of large fires in and near Fleville. To the extreme left sharp machine gun chatter rose from Apremont and the wooded slope of the Taille l'Abbe. Observation became blurred



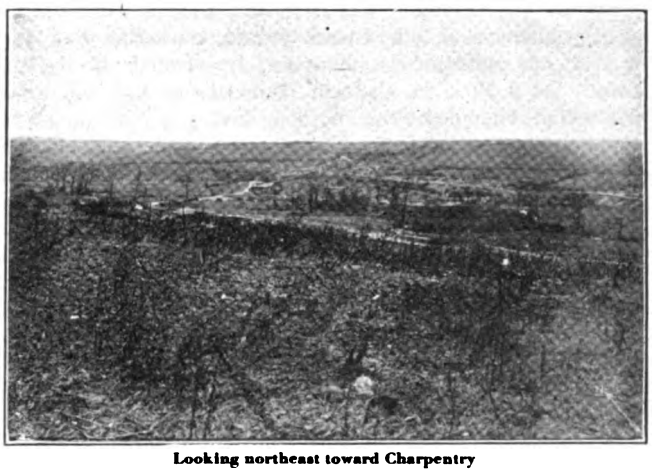
Looking north into Baulny

and quickly restricted to the work at hand, by the wicked arpeggio of high explosive and gas which immediately fell upon the sweating engineers. They were in full view from Hill 269, taken and held brilliantly a week later by the First Engineers. From there a large number of 155s rained in slow screeches, throwing up black earth and rolling clouds of acrid, yellow smoke. From the left rear, out of the Argonne, came high-bursting shrapnel hail. At noon Colonel Clarke reached, from Cheppy, a concrete "pill-box," even with the front line but to the left, half way between Baulny and the Chaudron farm buildings, on the exposed slope. In the wire over that way was a crashed French plane, spread out like a giant butterfly.

At noon both the battalion commander and the C.O. Company B were wounded. At 12:25 word went to the colonel that Major Stayton was reconnoitering to the right because numbers of men were retiring on that side beyond the battalion, that Lieutenant Hanly was killed, that two other lieutenants were gassed and evacuated. At 12:50 word was sent back that the artillery fire against us was largely transferred to our left, that the first contact aeroplane of the day was then at work for our artillery, and that we had received additional ammunition. Shells were then breaking viciously around the pill-box. Our first battalion runners found out that Colonel Clarke was there at the time, though we did not for an hour later. At 2:10 p. m. the long-range mixture of high explosive and gas was again turned on us in force. Infantry was doggedly backing out of the woods, across the road to us. At 3 I wrote him, "As infantry filters through us we are under incessant machine gun fire from the north. We have no machine guns, grenades, etc." At 3:30 he replied from the concrete P. C., "We, the regiment, are to hold the ridge and dig in. Machine guns are on right and left flanks. We let the infantry through tonight and then give boche hell if he follows, which he won't." That message was our first ray of sunshine of the day.

By mid-afternoon the first battalion was well under horizontal cover, at a cost of thirty per cent of its strength. The first holes were individually dug, in frantic haste. The evening and night were spent in connecting them into short runs of trench, deepening them to below a fire-step, and in laying out necessarily irregular traverses. Infantry, with their officers, had quickly and willingly stopped to garrison our line, and to start three additional lines on the reverse slope along the road to Serieux farm. They would not, however, exert themselves with pick and shovel. Meanwhile the second battalion was holding its position ahead and to our left, on lower ground. At 2 p. m. it was ordered to retire and extend our line, resting its left on the river uncomfortably close to Apremont. Company F was directly in front of Colonel Clarke's P. C. and outposts from that company organized and patrolled, two hundred meters ahead of the wire encircling Baulny, the left half of the sector, from the Baulny-Fleville road to Chaudron farm, while infantry straggled through during the afternoon and during the lively day following.

That night, the 29th-30th, was fairly quiet but a ticklish situation existed down at the Chaudron farm buildings, from which wounded in large numbers were being evacuated, protected by an infantry detail spread fan-like towards Montrebeau Woods. At midnight Colonel Clarke was worried. He sent word to Charpentry, to brigade headquarters which had moved back through us, "Rockets have gone up on my direct front, three all different, sent up in woods. Warn artillery to be sure rockets are from my lines. Have no report yet that wounded are evacuated. No officer to explain French rocket, so I am unable to call barrage." Confusion is further indicated by a message of his at 1:20 a. m., "Please telephone for me asking status of command here. Colonels Walker and Delaplane have taken over east end of sector without a word. My first battalion now in reserve. This place much too thickly populated. If no attack develops recommend immediate withdrawal of troops to below hill. I don't know how many men Colonel



Looking northeast toward Charpentry

Walker has put in but in places they are two and three deep. I learn Colonel Walker did not speak to my adjutant or battalion commander saying he now commanded. Think command should revert to infantry and my command again go into reserve." The statement that we were in reserve was partly correct. Most of the engineers had been withdrawn behind the wire, but Company A still held the trenches they had dug. Nothing was heard further about a change in command and Colonel Clarke was held in charge of the sector. Meanwhile a medical officer of our regiment was operating the most advanced dressing station, on the Serieux farm road. Working in mud and

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filth and gaseous air he requisitioned boche dugouts for blankets and protection for his cases.

At dawn on the 30th Colonel Clarke called for a trial barrage, having learned that Chaudron farm was cleared of wounded and guards. At 6:50 he reported, "Barrage produced no signs except a few machine gun bursts on our left in edge of woods." At nine o'clock Fritz came out of Montrebeau Woods and his artillery weight fell with great force on our entire line, punctuated with bullets. To exercise observation and to direct our fire officers and non-coms found it necessary to stay on top, out of any



Looking north across Buanthe Creek toward Cheppy

protection. The Germans used their favorite tactics, "filtering" singly and in pairs by way of the hedge and other protected spots to where they could assemble a machine gun and put it into action within a few seconds. They did not appreciate the solidarity and depth of our position, nor the grim obstinacy with which nerve resources were holding out against wounds, exhaustion and dysentery. They fell under our splendid barrage, breaking in the open and on the south edge of the woods, fell under the crack of twelve hundred rifles—and fell under machine guns which the 138th Infantry had pushed across the road at our right, in the clumps of trees north of Serieux farm. At 9:30 a. m. Captain Hudson sent word suggesting certain changes in our artillery fire. At 9:50 he wrote Colonel Clarke saying the situation was well in hand and that the machine gun fire from our right had been handled with good effect. At 10:25 he wrote, "The co-ordination between artillery, infantry and machine guns has been splendidly maintained and if kept up we can hold this hill until the cows come home." On the left the second battalion reported at 1 p. m., "Everything O. K. on left flank. Machine guns and personnel intact. I have now twenty-five men guarding three guns on my left flank. Will make every effort to increase this. Will notify you in writing at once if conditions change." This message went to Colonel Clarke at Baulny, to which he had wisely moved the P. C. after several men had been killed near the pill-box and after it had suffered a direct hit on the north (open) side during the counter attack of the morning.

German litter-bearers were active in front of and in the edge of Montrebeau Woods. During the afternoon the fire on our line was intermittent. Units of the 82d Division, skirmishing from Charpentry, were shelled to retirement, with the exception of two companies of machine gunners and infantry, which entered our lines. The 82d later assisted the 28th in scaling the heights west of the Aire, from Apremont north towards Fleville. Towards sunset a group of tanks waddled up the draw to the 91st Division sector, attracting the attention of a boche battery in the Argonne in front of the 77th Division. This battery also bothered the second battalion, whose officers believed it to be located on stated co-ordinates two kilometers southwest of Apremont and asked for its reduction.

At 6:25 the Train Commander reported from Charpentry, "I am informed we are to be relieved tonight. We are prepared to send rations up. Will the relief change this arrangement? Shall we hold some rations back? If I don't hear from you will forward all rations after dark." This inquiry concerned a repetition of good work which had been carried out on previous nights. Cans of beef and tomatoes, and bread, had been distributed in the lines. Rolling kitchens which had somehow found their way up once reached our draw, except B Company's, which was blown up by shell-fire on the Very-Charpentry road.

Towards midnight much more gas was put down on us, not less than fifteen hundred shells in three hours. The night was chilly and very damp, without moving air. At 3 a. m. on October 1st the 1st Division took over our lines. The third battalion, 18th Infantry, skirmished over the hill to our rear, and came up, precisely as our first battalion had done two days before. Captain Hudson showed their C. O. our lines and Chaudron farm, as well as could be in the inky darkness. By previous arrangement Companies A, B and C filtered back and assembled near Charpentry. The second battalion was likewise relieved by a battalion of the 16th Infantry and was assembled on the Baulny road. The regiment marched to Cheppy, where a hot breakfast was served, and on the following morning the 110th Engineers took their place in the division column southward bound, Company F assisting the divisional trains. On the evening of the 5th rest billets were reached at Conde-en-Barrois, where six days prepared the regiment for three weeks of road work in the line east of the Meuse, from Fort Vaux to Fresnes-en-Woevre.

I believe the most important points bearing on the successful use of the engineers with a division * * * are: First, The *spirit of service* * * * This * * * is the most important single factor affecting the success of any divisional engineer regiment, for no matter how well disciplined, trained or perfected it may be * * * unless it is constantly helping the other troops * * * in battle, on the march or in camp, * * * it has failed as a divisional engineer regiment.*—*Col. Francis B. Wilby.*



Concrete pill-box used as regimental P. C. on September 29 and 30

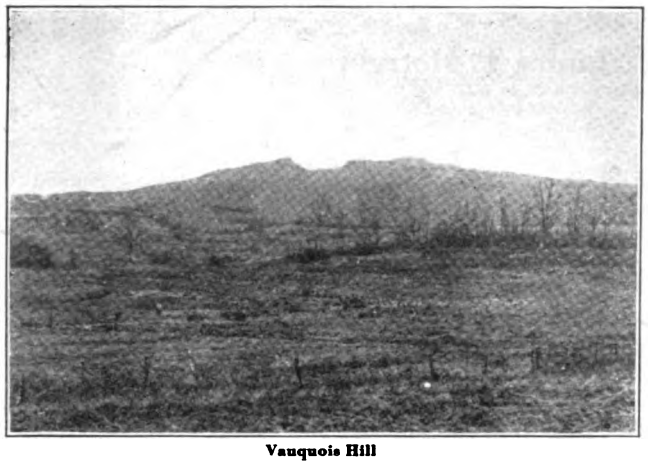
This week of action stimulated the lively working morale of the regiment, heightened its spirit of loyal service to its division, and enriched the National Guard traditions of Missouri and Kansas, whence it came. Major Stayton and both battalion commanders received prompt promotion. The cost of the work was high. Total casualties

*Professional Memoirs, Sept.-Oct., 1919.

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were more than three hundred. Eighteen men were killed on the field, eight officers were killed or wounded. Over one hundred cases were caused by gas, because it was difficult to make the men wear their masks while digging. Fifty animals of the regimental train were killed or captured during the week. It was necessary to use the divisional engineers as combatants because with their exception the division lost, by September 28, the power of manœuvre in large, intact units.

Well-deserved recognition was accorded while the regiment worked, four months later, at Camp Pontenezen (famous adornment of Brest) in this form:



Vauquois Hill

AMERICAN EXPEDITIONARY FORCES
Headquarters Services of Supply
Office of the Chief Engineer, A. E. F.
24 February, 1919.

From: The Chief Engineer, A. E. F.
To: Commanding Officer, 110th Engineers.
Subject: Letter of Commendation.

1. Before issuance of definite orders for your regiment to return to the States it is my desire that the command be advised that they have met the conditions imposed by the conflict just concluded in a most satisfactory manner.

2. The construction of field fortifications and bridges across the Somme, the front line construction, tunneling and road work in the Vosges were notably well done. The excellent record made in front-line service is a matter of pride to the Chief Engineer as it should be to each soldier in your regiment.

3. I desire that you and your command know that the services rendered were highly satisfactory and deserve commendation.

W. C. LANGFITT,
Major General, U. S. A.

Comments on "The Metric System"

By Harvey A. Hall

I have certainly enjoyed reading the excellent May-June number of THE MILITARY ENGINEER, although time has not permitted me to get all of the material that it contains as yet.

I have a decided objection to the article in the editorial section, "The Metric System," as I believe that the metric units are so much more satisfactory than the British system that they will soon be in general use and the British system gradually and thankfully forgotten.

The advantages of the metric system are acknowledged in the second paragraph of the editorial article. But in regard to the necessity of the British system in industry there is opportunity for difference of opinion. I fail to agree as to the necessity of continuing the old system indefinitely.

In any industry there is constant development. New ideas call for new equipment, and it is doubtful that much of the equipment used now will remain in use any great length of time, especially that part which may be based directly on the units of the system in use. Therefore since in any event there must be change, if such change will bring into use such distinct advantages as the metric units possess, then the change will be of far more advantage.

The argument for a possible *decimal* system seems faulty. Should any one unit of the British system be adopted, then as far as I know *every other unit* of the system would be affected by the change to a decimal system, and I fail to see why the almighty (little) *inch* must control all other units, when with almost the same amount of change to the metric system a thoroughly developed system of units in constantly increasing use at the present time will give the advantages that are admitted to be offered by the decimal system.

By Norman M. Macleod

Our contact with the French showed us that they can calculate more rapidly than we can; therefore the French system is a *time-saver* compared with the British system.

The time saved in the next ten or twenty years will pay the manufacturer many times over the cost of making the change. A saving will be effected by the reduction of errors.

The chief difficulty in the way is the fact that almost all of the measuring instruments are owned by the workman, while the advantage resulting from a change of instruments would be chiefly in favor of the employer. The workman must buy new tools at least once in ten years; therefore, if the change is made gradually over a period of ten years, the cost will not be great and the manufacturer should stand it.

The makers of measuring tools are arranging for double scale rules, and for the changing of barrels and screws on micrometers, so that the workman can change from British to metric and vice versa without difficulty, and with almost the same tools.

A great misunderstanding exists among the manufacturers, as they believe that this change means a change in the *product,* whereas a change in the *system of measuring* is the only change contemplated, and the only material affected is the measuring instrument. "A rose by any name will smell as sweet." A piece of pipe is the same size whether we measure it in British or French units.

Using decimals of feet and inches will not help, as they are irregular.

Change in Harbor Nomenclature

Owing to a diverse usage of the terms "inside" and "outside of harbor lines," certain ambiguities are often introduced into literature concerning harbor and harbor improvements. The same term is often used with opposite meanings, being applied in some cases to the land side and in others to the channel side of the lines. To avoid misunderstanding both by the public and in the Engineer Department the Chief of Engineers has directed that hereafter the designations "inside" and "outside" shall not be used in official correspondence to describe position relative to the harbor lines. Such positions will hereafter be described by the terms "Shoreward (or landward) of harbor lines"; "Channelward (or riverward) of harbor lines."

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"New Organization of the Engineer Service"

Discussion

By

John A. Miller, Jr., and James T. Metzger
Formerly First Lieutenants, 104th Engineers

THE article on "New Organization of the Engineer Service," appearing in the January-February number of THE MILITARY ENGINEER, discusses a subject that is unquestionably of absorbing interest to all who served as engineer officers during the war. Probably the most striking feature of the table of organization there described is the difference between the new one and that of 1918, and in some cases between the new and the actual organization as it functioned in the A. E. F.

The best method of deciding the questions of reorganization would seem to be by interpreting in the light of probable future military needs the varied arrangements actually adopted during the war. It may be pertinent, therefore, to make a comparison between the new table and the way that one unit, the Headquarters Detachment 104th Engineers, really functioned in the field. Apparently few combat engineer regiments in France were equipped with sufficient horses to supply mounts to the mounted section of the headquarters detachment, and there is perhaps something to be learned from the experience of the 104th Engineers that would not be so noticeable in the histories of other regiments.

For the purpose of making such a comparison, a roster of Headquarters Detachment 104th Engineers was taken and divided according to the duties which the various soldiers performed during the year the regiment was in France. This roster contains one hundred and ten names, slightly fewer than demanded by the old table of organization, and while there was considerable change in the personnel of the company during that time, the assignment of duties remained essentially the same. From this it was possible to draw a very definite conclusion concerning the number of men required for each kind of work. Examination was next made of the new table of organization to see whether sufficient men were allotted to each section of headquarters company to perform the work that would be required again under similar circumstances. It was seen at once that there would be a shortage in some cases, and it is for the purpose of drawing attention to such a condition that this is being written.

The table of organization of the Act of June, 1920, provides one less clerk for the adjutant's office than was always needed at regimental headquarters 104th Engineers; six less men for the topographical office; and six less for the regimental supply office, as well as three less for the company headquarters and one less for the kitchen. While none of these deficiencies is of serious moment, yet it appears that the shortages would actually exist with the new regiment in the field, and the method of meeting the situation involves a principle of rather wide application.

Such a deficiency may be filled by the assignment to special duty of men belonging in another section, or even in another company, or it may be filled by regularly organizing each unit with sufficient men to do the expected work. It is thought that nearly all former company officers of the A. E. F. will agree that a great deal of confusion resulted from the use of soldiers for other duty than that to which they were nominally assigned.

This was particularly true of Headquarters Detachment 104th Engineers. In order that the various departments already mentioned should function properly, men were temporarily assigned from the mounted section to those duties. The proper care of their horses then became a troublesome problem for the Detachment C. O. The men themselves were too busy to attend to the animals, other soldiers had quite enough to do without caring for extra mounts, and the condition remained unsatisfactory until casualties among the horses reduced the excess. It appears that this situation would be exactly reproduced by the new organization of the engineer headquarters company. Would it not be better to provide more dismounted men?

Such an arrangement could be made by reducing the mounted section or by increasing the headquarters section. The latter plan would leave a good-sized mobile detachment for rapid movement, although it would increase somewhat the total strength of the company. It seems, however, that a mounted cook to travel therewith is an oddity. One could nearly always judge the discipline of a command by the condition of the cooks' rifles, these soldiers being habitually disinclined to care for their military equipment properly. A cook would hardly be more apt to take good care of a horse. In the emergencies when the mounted section is called upon for quick work at a distant spot, they might very well get along for a time without a regular cook. Similarly it seems that the sergeants major scarcely need mounts, and will have little time to devote to them.

A suggested organization has therefore been outlined providing in the headquarters section sufficient men to do the work found necessary in France, leaving in the mounted section the topographical N. C. O. and privates but not counting upon them for the work of the topographical office proper, and omitting the cook from the mounted section The transport platoon had no parallel in the Headquarters Detachment 104th Engineers, and no change is suggested in it save that the company supply sergeant and the clerk be placed in the headquarters section rather than with the transportation. The band section was not organized in the regiment until the spring of 1919, and no comparison is possible on that account.

The new organization will, without doubt, receive the

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most enthusiastic support of former officers of combat engineer regiments. Particularly to be praised is the combination of the engineer train and the old headquarters detachment. This suggestion is offered, therefore, merely to draw attention to a condition that was a cause of minor difficulties in the past and that might, if continued, cause the same difficulties to again arise.

The following table shows the organization used in the Headquarters Detachment 104th Engineers, that effected under the Act of 1920 and that recommended by the writers:

TABLE OF ORGANIZATION HEADQUARTERS COMPANY COMBAT ENGINEERS.

Section	104th	Act 1920	Recommended
Headquarters			
At Regimental Headquarters—			
Master Sergeant Personnel	1	1	1
Sergeant Major	1	1	1
Sergeant	1	2	2
Corporal	1	1	1
Mail Clerk	1	1	1
Private	3	1	2
Total	— 8	— 7	— 8
At Topographical Office—			
Master Sergeant	2	2	2
Technical Sergeant	1	3	3
Sergeant	--	1	1
Corporal	1	--	--
Private	9	1	7
Total	— 13	— *7	— 13
At Supply Office—			
Master Sergeant	1	1	1
Supply Sergeant	2	--	2
Private	4	--	4
Total	— 7	— 1	— 7
At Company Headquarters—			
First Sergeant	1	1	1
Supply Sergeant	1	--	1
Cobbler	2	--	--
Private	--	--	2
Total	— 4	— 1	— 4
At Company Kitchen—			
Mess Sergeant	1	1	1
Cook	5	1	2
Private	1	--	1
Total	— 7	— 2	— 4
General—			
Master Sergeant	13	1	1
Technical Sergeant	--	5	5
Color Sergeant	2	2	2
Battalion Sergeant Major	2	2	2
Private	--	2	2
Total	— 17	— 12	— 12
Section Total	56	30	48
Mounted			
Staff Sergeant	1	1	1
Stable Sergeant	1	1	1
Sergeant	2	1	1
Corporal	**5	4	4
Bugler	2	2	2
Cook	--	1	--
Horseshoer	1	1	1
Private	18	24	18
Section Total	30	35	28
Transportation			
Master Engineer	1	--	--
Staff Sergeant	1	1	1
Stable Sergeant	1	1	1
Supply Sergeant	--	1	--
Sergeant	--	3	3
Corporal	1	8	8
Chauffeur	1	23	23
Clerk	--	1	--
Cobbler	--	1	1
Cook	--	2	2
Horseshoer	1	1	1
Motorcycle	6	4	4
Saddler	1	3	3
Wagoner	10	19	19
Miscellaneous	--	2	2
Section Total	22	70	68
Band			
Staff Sergeant	--	1	1
Band Sergeant	--	2	2
Sergeant Bugler	1	1	1
Corporal	--	4	4
Musicians	--	27	27
Section Total	1	35	35

NOTE.—* Three additional in mounted section. ** Two for message center at regimental headquarters.

SUMMARY.

Section	104th	Act 1920	Recommended
Headquarters Section	56	30	48
Mounted Section	30	35	28
Transport Platoon	22	70	68
Band Section	1	35	35
Detached Service	1	--	--
Grand Total	110	170	179

Comments by F. B. Wilby

Major, Corps of Engineers

The above comment on the new organization for the headquarters and service company of the combat engineer regiment is very interesting and shows careful thought on the part of its authors. The general comparison presented by them, with the experience in the headquarters company of the 104th Engineers during the war, seems to confirm in general the adequacy of the personnel in the new organization.

No increase in the personnel allotted to the headquarters and service company can be provided without taking away an equal number of men from the companies in the regiment, already now so small as to be barely effective (106 men per company). It was recognized that the strength of the headquarters and service company should be kept to the absolute minimum in order to maintain the six companies at as large an effective strength as possible without exceeding the permissible total of 800. For this reason there are practically no extra privates in the headquarters and service company to provide for sick and other absentees, except the 16 miscellaneous privates in the mounted platoon.

The internal organization of the headquarters and service company is not restricted to the distribution shown by Lieutenants Miller and Metzger above, or even to that shown on the approved tables of organization. The organization commander is only limited by the number of men shown in each grade in the "Total" column and the number of specialists' ratings allotted to the organization in the column of "Remarks" on the approved table. Within these limits he is at liberty to organize his unit as he desires. It is believed that no two organization commanders will allot their available personnel in exactly the same manner, as they will be influenced by personal preferences, and the different situations to be met. The distribution shown on the approved table is believed to be a good working basis for average conditions in this country.

With reference to the suggestion that the mounted platoon should be reduced, I am afraid I cannot agree with this suggestion. Prior to the war each engineer company had a mounted platoon of 36 men for companies of 164 enlisted strength, and a mounted platoon of 25 men for companies of 109 enlisted strength. These platoons were found very effective for service in this country. They were not authorized, and rightly so, for service in France as the different theater of operations did not require their use. The new table of organization provides only 35 mounted men for the entire regiment, or less than 25 per cent of the number provided prior to the war for a regiment of about the same size.

It is believed that this is the minimum necessary for service in this country, and it was regretted that the limit placed on the size of the regiment prevented retaining a mounted platoon of six squads (one available for each company if desired) instead of the smaller platoon of four squads as shown.

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Military Sketching as a Hobby

By

George W. Rappleyea
Member S. A. M. E.

Bearing in mind that the *raison d'etre* of The Society of American Military Engineers is "Preparedness" and that nearly every man has a hobby, some hunting, some fishing and some golf, I have chosen for myself a hobby that has three desirable attributes: first, it is healthful and interesting, as it involves exercise and brings one into close touch with nature; second, it develops skill that can be turned to military uses in time of emergency; and third, it is a source of profit rather than an expense, as I shall show later. This hobby is military sketching.

The art of military sketching is something that cannot be acquired merely by reading a book of instructions. Handling a sketching case is like handling a billiard cue; considerable practice is essential to proficiency in the use of either.

The average civil engineer who has for years been trained to tack-point, hair-splitting accuracy, finds it hard to break away from his old habits and cultivate the apparently loose and inaccurate methods that are used by the skilled military sketcher. In pursuing my hobby I often use my holidays, Saturday afternoons and vacations and with my sketching outfit I hike for the country. I generally go over one road a distance of five miles or so and return by another. With a counter I get the distances by pacing and sketch the topography on both sides of the road as I go. On returning home I take off the sketch, put on a new roll of paper and file the finished sketch. After several such trips I piece the several sketches together and make a tracing of the completed map, which generally covers an entire township and sometimes a county. The publication and sale of such maps proves profitable and well repays one for the extra trouble.

The average civil engineer spends at least six months in one locality, just about long enough to secure all the data necessary to construct such a map during his spare time.

I always try to bring along with me on my trips a fellow engineer and when he sees how interesting, instructive and profitable the work is and that it means doing something for preparedness, he generally becomes an enthusiastic devotee of the sport of military sketching.

On most of my trips I walk and thus get the distances by pacing. Sometimes I use a horse and buggy, tying a piece of rag to one of the wheel spokes and counting the revolutions with a hand counter. Sometimes, in hilly country, I use photo-surveying, utilizing a plain box camera equipped with two small spirit levels and a small compass. I have read many works on photo-surveying but I consider that General Reed's book on the subject gives the clearest and simplest explanation.

Recently I have been experimenting with a liquid marine compass, set in gimbals, attached to the instrument board of an automobile and with a properly constructed deviation table and revolution counter arranged like a speedometer, I have secured some surprising results at high speeds. Two men are required; one drives the car and calls out at the turns; the other keeps his eyes on the instruments and as the compass card swings back and forth notes and records the average course and when the driver calls "turn" the recorder notes and records the figures on the revolution counter.

Of course there still remains considerable work to be done after the trip in the way of reducing and platting the notes. This system has a further disadvantage because only a plane survey has been made and no topography has been taken, making the resulting map almost worthless for military purposes; however, two men in the rear seat equipped with clinometers and barometers might secure a limited amount of topography.

With the development of the gyroscopic compass I see no reason why an automatic automobile surveying instrument could not be perfected, that would record on a paper tape the course of the machine say at intervals of every one hundred feet. I have such an arrangement in mind and see no reason why it should not work. For want of a better name we might call it the "Auto-map-o-graph." The principle made use of involves the so-called step by step method of producing synchronous motions between the compass card of a gyroscopic aeroplane compass and a recording device provided with a wheel having around its periphery three hundred and sixty divisions to correspond to the three hundred and sixty degrees of the compass card. Also another circuit connected with the speedometer of the machine to force a strip of paper at intervals of every fifty or one hundred feet, up against the wheel, which would have rubber type set on it thus producing a printed record of the true courses and distances traveled by the machine. Now, then, if some bright young army officer would only invent some method of getting topography on both sides of the road automatically the problem would be solved.

The use of automatic moving picture cameras, placed in gimbals on each side of the car and so connected with the speedometer that the resulting photos will overlap, naturally suggests itself, but the large amount of office work required to plat the data thus obtained makes this method out of the question for military use, although topography could be secured in such a manner.

The profile of the road itself could be easily obtained by the use of a self-recording barometer. Perhaps the day is not far distant when topographic and military sketches will be made automatically from an automobile travelling at a high rate of speed.

Comment on "The Army Uniform." By F.W. Harris

Major Embury's design for a field service uniform is practical from the top of the fedora hat to the soles of the russet shoes. The constructive criticisms were fine. (1) Place company and regimental letters and numbers on reverse side of collar. (2) Lengthen the coat. (3) Make the eyelets in shoes large. Major Embury's idea of avoiding form-fitting clothes, especially breeches and leggings, should control the design of a service or work uniform. Keep to the trousers big enough to put on over the shoes. A 10-inch top-boot cannot be beaten for all-round use. It weighs but little more than the ordinary shoe, and the additional leather required would not be any real objection in quantity production in war.

The suggested design is practically the style of clothing adopted by the loggers and engineers of the Pacific Northwest. Difference of opinion in the utility of such a uniform is the difference between practical experience and theoretical ideas. These opposites generally deadlock all constructive ideas and plans.

Every soldier needs two uniforms, one for work and the other for dress. Veterans of the war would be glad to see the miscellaneous fit of breeches and the vest-like coat disappear into the limbo of things that have had their day.

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A Plea for Articles about "Little Jobs"

By

Lucien S. Johnson
Assistant Engineer, Second Cincinnati District

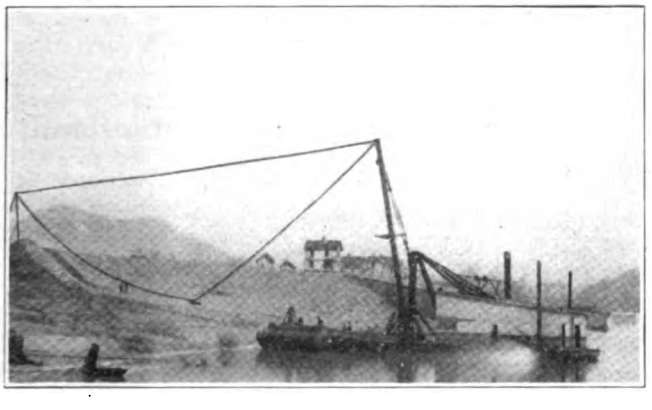
The tendency of technical magazines is to give accounts of construction works of large size and to ignore the "little jobs" as of no interest. It is true that these large works interest the entire profession and are entitled to plenty of space; yet there are frequently details in the comparatively trifling works that would be of interest and profit to many.

The little fellow has to accomplish his ends frequently with improvised plant, and his ingenious applications of old means are nearly always of direct benefit to someone else, and I would like to see a column or two devoted to any unusual use of an old or new idea, after the style of "Workshop Wrinkles" in the trade papers.

Now that the engineering districts having river and harbor works, especially in maintenance, are making repairs by hired labor to a greater extent than ever before, these little things have values they never before had. These repairs cover the whole range of construction work in wood, stone, concrete, and steel, and nearly always have to be made at a distance from a supply base and with inadequate or improvised plant; and it is for short accounts of such works that I plead.

Many little jobs are done by main strength and awkwardness where a little imagination might adapt some old piece of plant to use and save time and labor. Even if the method tried should not have been a howling success, it might still be of interest and keep someone else from making a similar mistake.

Just as a starter, and to give a concrete idea of what I mean, I give below an adaptation of an old idea as used on the Kentucky River to place rip-rap on the banks, which costs practically nothing and does away with the old method of wheeling in barrows or the more usual carrying of stone in the arms, if beyond the farthest reach of the boom.



Most improved rivers have derrick-boats and barges, but few of them have cable-ways or drag-line outfits; and if they did, the jobs are nearly always too small to warrant mounting elaborate plant.

Handling one-man stone down hill is an altogether different proposition to working them up hill when done by hand. With the rig shown the skip loads of stone are placed anywhere desired between the water and the top of the hill, so we have all down-hill movement to final position.

The rig has just finished carrying from the barge to the top of bank at another set about 50 yards of stone for a small repair to a road. It easily paid to mount the rig for just that little work.

The accompanying illustration is all the description really needed, but a few words may help. Nothing is needed aside from the derrick boat and barges except pieces of timber or poles about 30 feet long for the legs of an A-frame and a sill piece to move it on. This A-frame is stood up on top of the bank and back-guyed with an old wire rope and manila fall for easy adjustment. The barge of stone is placed next the shore and parallel with it, the derrick-boat is outside and head-on to it. The derrick boom is hoisted nearly vertical in order to place the skips on the barge. One of the wire ropes is led from the engine over the tip of the boom, through a sheave at the head of the A-frame, and back to the skip; the other line is led from the tip of the boom to the skip, back-haul and return.

When the skip is loaded, the back-haul is pulled and enough brake applied to the other drum to keep the skip barely clear of the ground until the desired dump point, or the A-frame, is reached. In returning, the empty skip is held rather high in the air when nearing the boom and is dropped with speed enough to overhaul the long rope until the skip hangs properly to lower on the barge.

No claims for novelty are advanced, and it is thought more than likely that many readers have used the same thing many times; it's the sort of thing that is too simple to talk about, yet its simplicity and adaptability make it worth keeping in mind. It doesn't cost much, and really saves a world of back-breaking labor.

In particular, the clear span as shown by the illustration was 240 feet; the lift from barge to top of bank, 42 feet; the load, 1¼ cubic yards of limestone.

The times of movement as taken the first day the crew operated the rig were:

	Min.	Sec.
Loading the skip (only one used that day)	3	48
Hoisting to the full limit	1	18
Dumping	0	23
Returning to barge	0	52
Round Trip	6	21

The cost on a raw winter day was:

5 laborers loading skips, 8-hour day	$15.00
4 laborers placing stones, 8-hour day	12.00
1 foreman	5.00
1 engineman	4.30
1 fireman	3 30
1 timekeeper, part	1.60
Cost for 81 cu. yds. placed	$41.20
Cost per cu. yd., barge to place	0.51

As a matter of interest in this connection, a single skip load of rock was dumped as far back as possible with the derrick-boat and placed in the upper slope in the old manner. The mere placing of this single load, aside from the unloading and dumping charge, required 3 hours' labor of one man, or $0.90 per yard.

"Our success in the war was not due to forethought in preparedness, but to exceptional circumstances which made it possible to prepare after war had been declared. It is my belief that if America had been adequately prepared, our rights would never have been violated, nor our safety threatened.—*General Pershing.*

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Report of Chief of Air Service, A. E. F.

The first chapter of the final report of Maj. Gen. Mason M. Patrick, Chief of Air Service, A.E.F. (now Colonel. Corps of Engineers), rendered in March, 1919, and recently published by the Chief of Air Service, Washington, D. C., contains the following summary of the achievements of the Air Service during the war:

When hostilities ceased on November 11, 1918, there were actually assigned to armies 45 American squadrons and 767 pilots, 481 observers, 23 aerial gunners, and the complement of soldiers. These squadrons were equipped with 740 airplanes, with armament of the latest type, and the flying personnel, trained in Air Service schools, was second to none in the world for aggressiveness and skill. Twelve of these squadrons were equipped with American built airplanes and Liberty engines. This engine in actual service fulfilled the highest hopes of it which had been entertained in the United States.

On the Marne, at St. Mihiel, and in the Argonne our air forces were pitted against the best which Germany could produce, and the results show that the enemy more than met his match. Our pilots shot down 781 enemy airplanes which were officially confirmed, and many others, too far behind the lines to be confirmed by our own witnesses, but which were nevertheless undoubtedly destroyed. They also destroyed 73 (confirmed) enemy balloons. Our total losses in air battles were 289 airplanes and 48 balloons brought down by the enemy.

Our squadrons, in round numbers, took part in 150 bombing raids, during which they dropped over 275,000 pounds of explosives on the enemy. They flew 35,000 hours over the lines and took 18,000 photographs of enemy positions, from which 585,000 prints were made by the Photographic Sections attached to observation groups. On innumerable occasions they regulated the fire of our artillery, flew in contact with infantry during attacks, and from a height of only a few yards machine-gunned and bombed enemy batteries, convoys and troops on the march.

Of the 35 balloon companies then in France, with 446 officers and 6,365 men, there were 23 companies serving with the armies at the front. This balloon personnel had also been trained in American Expeditionary Forces schools and in every test proved its worth. Our balloons at the front made 1,642 ascensions and were in the air a total of 3,111 hours. They made 316 artillery adjustments, each comprising all the shots fired at one target; they reported 12,018 shell bursts, sighted 11,856 enemy airplanes, reported enemy balloon ascensions 2,649 times, enemy batteries 400 times, enemy traffic and roads and railroads 1,113 times, explosions and destructions 597 times.

Air Service depots to supply the squadrons and balloon companies at the front were in full operation and others were being prepared to maintain this force, which was to be increased rapidly. Needed steps had been taken to provide for the equipment of this force as it was placed at the front, and it was certain that it could be fully maintained. A production plant had been built and was in full operation, where some 10,000 men were employed in assembling airplanes and in repairing airplanes, engines, and balloons which had seen service at the front.

Our balloons were attacked by enemy airplanes on 89 occasions; 35 of them were burned during such attacks, 12 others were destroyed by shell fire, and 1 blown over enemy lines. Our observers jumped from the baskets 116 times; in no case did the parachute fail to open properly. One observer lost his life because pieces of the burning balloon fell on his descending parachute.

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Making Highway Bridges Safe for Modern Traffic

An interesting article which appeared in a recent issue of the *Engineering News-Record* emphasizes the importance of the problem of making our highway bridges safe for modern traffic, under the conditions created by the increase of motor vehicles. Such loads give heavy concentration on individual trucks, but, owing to the dimensions of the trucks and to traffic conditions, these concentrations are not as a rule unduly close together.

It is pointed out that the design loading should comprise a heavy concentration or concentrations for the flooring, stringers, and floor beams and a uniform load say of 100 or 125 pounds per square foot for the trusses, *using also* a single excess load for the trusses which may be placed anywhere and which is equal to the difference between the end shear on the floor beam produced by the concentrated live loading and that produced by the uniform live loading. The use of this excess load insures that all the details of the truss will support the maximum load which the floor can carry, while at the same time it avoids the needlessly heavy truss which would result from maximum floor beam reactions at all panel points at once. The importance of not underestimating military loads is mentioned.

The possibility of the extension of the use of the trailer for more economical transportation leads to tractive force. which can only be gained by weight on the driving wheels of the tractor, and this fact exerts its influence towards increasing wheel loads. Highway surfaces will continue to improve and loads will continue to increase. Restrictive legislation will be repealed as transportation demands increase, and bridges designed for too light loads today will be rebuilt tomorrow because of their inadequacy.

It is stated that the weak part of the floor under modern truck loads is generally the floor beam and that wooden plank floors of ordinary construction are proving to be inadequate to sustain the heavy concentrated loads now encountered. In fact, it is very doubtful if plank floors are now economical, at any rate east of the Rocky Mountains. The wooden stringer is in turn giving way to the steel I-beam, while failures of steel I-beams are generally due to crippling of the web.

Under preferable types, there is mentioned for truss bridges a 6-inch concrete slab floor with heavy steel stringers and floor beams and a moderate truss. In masonry arches, including reinforced concrete, the distributed live load capacity of an arch ring with sound abutments is practically unlimited and it therefore seems undesirable, where avoidable, to place a superstructure of beams, whose capacity is decidedly limited, on top of an arch ring of practically unlimited strength. When financially practicable, an earth filled concrete arch is recommended because of its unlimited live load capacity and because it needs no maintenance other than that given to the highway surface.

The matter of repairing and strengthening weak structures is touched upon, since in many cases proper study and the exercise of a little ingenuity may economically prolong the life of the old structure very considerably at far less cost than the cost of a new bridge.

The Corps of Engineers had sold up to March 25 surplus supplies that cost $124,918,472. The sum of $108,550,237, or 86.89 per cent of the original cost, was realized from the sale.—*Statistics Branch, General Staff.*



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Sub-Drainage Design and Foundation Difficulties of Eel River Dam

The gravity section concrete dam for power purposes, now under construction on the Eel River, 150 miles north of San Francisco, is noteworthy as to design for provisions against underflow. The dam has a crest length of 765 feet of which 485 feet is spillway, and a height of 135 feet.

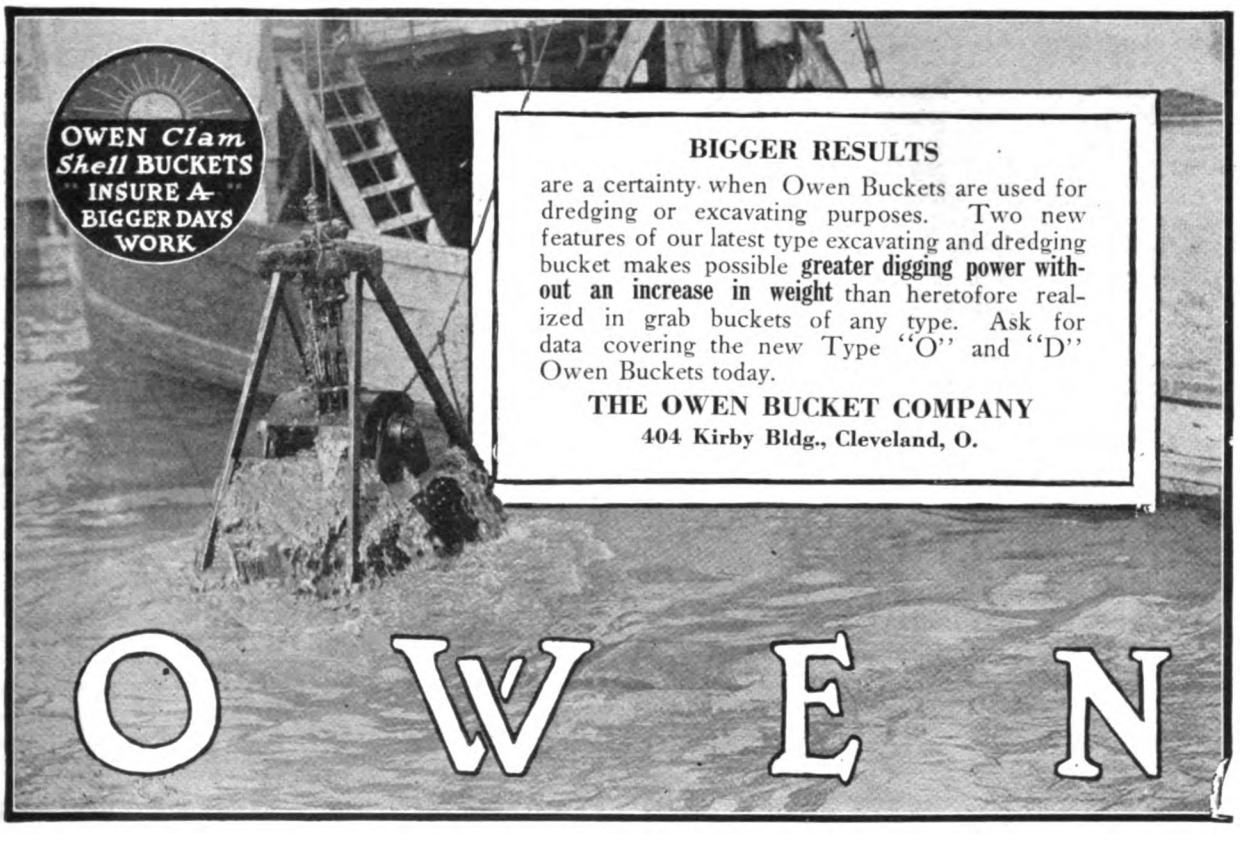
On examination of foundation conditions at the site of the dam a shale formation with talcose intrusions was disclosed. The shale was pronounced firm enough to carry the weight of the dam, provided water was kept out of the foundation. Accordingly, the axis of the dam was shifted until the structure could rest entirely on the shale, and provision was made for grouting below the cut-off wall to make the seal at the upstream face as effective as possible. Furthermore, a network of underground drains was specified to carry off seepage water which might find its way under the structure.

The excavation made before the first concrete was poured extended 15 to 25 feet below the ground surface for the full width of the dam and a cut-off trench on the upstream face, 5 feet wide, was carried 10 feet deeper than the adjacent excavation. Before pouring concrete, 3-inch pipes were left in the cut-off wall forms, spaced 5 feet apart and placed so that their tops would protrude on the upstream face of the concrete just above ground level. Through these pipes 1¾-inch drill-holes were driven to a depth of 30 feet below the bottom of the cut-off wall and when the concrete had hardened, these holes were grouted under a 200-pound pressure.

The drains under the dam consist of porous concrete tile in 18-inch sections, 3, 6, and 8 inches in diameter. Lines of drains were laid parallel with the axis of the dam and on 15-foot centers under the entire structure. These longitudinal drains are all 3 inches in diameter, except the line nearest the upstream face, which is of 6-inch tile. By means of risers each of these lines is connected every 80 feet to cross lines of 8-inch tile imbedded in the concrete 5 feet above the bottom of the excavation. The 8-inch lines are in turn connected to a gutter at one side of a 3 by 5-foot inspection gallery which runs entirely through the dam beginning at levels near the top at both ends of the structure and extending thence down to a central level 85 feet below the crest of the dam. From its lowest point this gutter discharges through a 12-inch pipe leading to the downstream toe.—*Engrg. News-Record.*

Galileo

How helpful and suggestive to an engineer is a story of Galileo's accomplishments and difficulties. As Prof. John F. Woodhall relates in a recent number of the *General Science Quarterly,* Galileo was a professor at twenty-five, on the faculty of the University of Pisa, at about the same time that a young man named William Shakespeare was seeking his fortune around the London theaters. Because of his inquiring and controversial spirit, Galileo found his dogmatic colleagues impossible to live with, and he left Pisa in disgust; in fact, he was practically driven away by their dislike and calumnies. Later, at the University of Padua, where he remained for 18 years, he lectured to audiences of a thousand and two thousand persons at a time, including distinguished foreigners who came from all over Europe to hear him. At 70 years of age, in 1633, 90 years after Copernicus had published his heliocentric theory of the world, Galileo, a frail old man, was haled before 10 red-robed Cardinals, or "Inquisitors-General," and made to recant his teaching of the Copernican system, because the "Theological Qualifiers" ruled that the propositions that the sun is the center of the world and that the earth moves are "absurd, philosophically false, and formally heretical!" —*Engineering and Contracting.*



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Aerial Stereograms

The stereogram (stereoscopic photograph) has constantly grown in favor in army photography, because it far surpasses the ordinary photograph in clearness. It bears a similar relation to the latter that a relief model of a region bears to its map, since it enables the immediate recognition of all differences of elevation and the perception of houses, road-banks, battery emplacements and other details, just as bodily as the objects in one's immediate vicinity.

Like every stereogram, the aerial stereogram always consists of two pictures which, on superficial inspection, *look alike, but really differ* from each other in their reproduction of details. In like manner, the bodily shape of objects is recognized directly by means of our two eyes, the left eye seeing more of the left side and the right eye more of the right side, thereby giving the impression of depth. In a similar way, the two parts of a stereogram must be taken from different view points.

The further apart these view points are (within certain limits which depend upon other considerations), just so much more distant and smaller objects can be brought into relief on the stereogram. The same laws hold good for it, as for the folding field glasses, which give a greater relief, the farther apart the arms containing the lenses are spread. By direct observation, the eyes, on account of their small distance apart, can only see perfectly within a short radius. For example, an aviator does not see the hills and valleys in relief at the usual flying altitude, but only when he is within a few hundred meters of the ground in landing, often with painful surprise at the true character of his chosen landing place. These limits of natural perspective vision are immensely increased by the aerial stereogram, since its components may be taken from points 100 to 1,000 meters apart, or from 1,500 to 15,000 times the distance between a person's eyes. The result is, for example, the reproduction in relief of such small differences in depth as protection trenches, taken from an altitude of several thousand meters, or of wire entanglements in balloon stereograms from a distance of 6 kilometers.

Discussion of "The Army Uniform." By C. E. Carson, formerly Major, Transportation Corps

I have read with much interest the article on "The Army Uniform," by Major Aymar Embury, II, supplemented by various other officers of the Army to whom it was referred for comment, and who, I presume, are connoisseurs on the subject of military dress.

Everything from hat to boots is discussed in a masterly fashion, but practically nothing about a "Sam Brown belt." If there was any part of the uniform worn by our overseas officers during the late war in which they took an especial pride, it was the Sam Brown belt. Sometimes they might be seen with shoes unshined, but it was seldom that the belt was not glistening. This belt not only served to give the uniform a military appearance, but was useful to the officer in carrying, on the march, his military accouterments. After wearing it a few times an officer felt "undressed" without it.

When these overseas officers were returning home, they were instructed to remove the Sam Brown belt, which caused more bitterness among them than any other regulation to which they were subjected. They had sent home photographs which showed the S. B. B. in all its military splendor, and when they reached home with belt in hand, they felt like a "houn' dawg" without a collar.

As one evidence of the popularity of the belt, General Pershing, the only officer of the Army who may prescribe his own uniform, still wears it.

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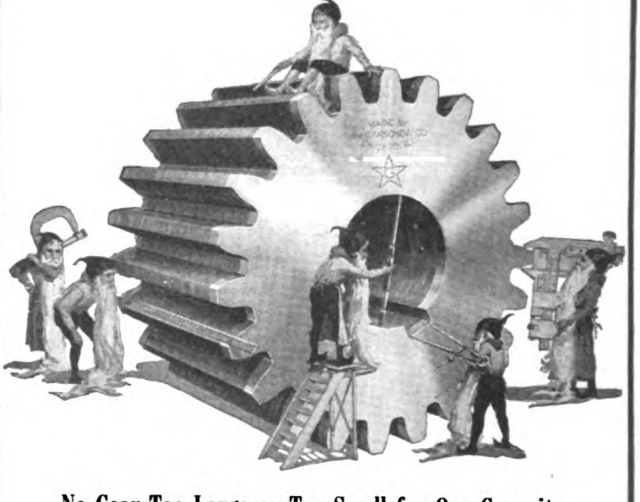
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Map Reading

(Continued from page 335)

Discussion

George H. Cameron
Colonel, Cavalry; Commandant The Cavalry School

Major Adams' interesting and valuable personal observations should not have been introduced by a half apology, viz: "To point out, at this late date, mistakes that were made in training officers for the World War, may seem a useless expenditure of paper and ink," etc. We must all endeavor to record worth-while experience, and, in my opinion, mistakes are best pointed out "at a late date," *i. e.*, when we have had time for sober reflection.

An excellent example of what I mean can be seen in the gradual changes in opinion on doctrine, armament, etc., since the armistice. Early in 1919, many officers, both in our own army and in those of Europe, presented views based on their only war service—that in France—and while its incidents were still vivid in their minds. They adhered absolutely to the methods of close trench warfare that prevailed on the western front in the World War. Step by step, but quite noticeably, there has been a return to old sound principles under the realization that conditions in France were abnormal.

A parallel to the lamentable ignorance that Major Adams portrays was shown in the lack of knowledge in the A. E. F. concerning animals and their care. But our Remount Service profited by the bitter experience, and is now firmly founded and working along excellent lines. Further, a manual on the "Care of Animals" has just been completed by the Cavalry Board; in our next training camps the emergency officer will learn the hygiene of both man and beast.

In the same way we must take steps to remedy the evils pointed out by Major Adams. There is no lack of textbooks. Major Spalding's very recent manual, a public document, shows a clear insight into the difficulties of beginners; his chapters on day and night guiding are especially useful. But when we are again called upon to develop officers in thousand lots, we need for proper training in map reading: 1st, qualified instructors, and plenty of them; 2d, active support and sympathy of higher commanders.

Here, at the Cavalry School, we have an extended course in map reading, as have, of course, all service schools, and I am not willing to admit that there is anywhere a better instructor than is in charge of this section. But our classes are very large, and we constantly observe where the student has gone astray through lack of individual attention. Hence, as I have said, we must have *plenty* of instructors.

It seems hardly necessary to say that the colonel and the brigade commander whom Major Adams cites as unable to point out on the map the routes of elements of their own commands, would not be very keen in pushing and supervising instruction in a subject concerning which they had been content to remain in a state of total ignorance. The truth of the matter is that map making was regarded by the last generation as a specialty, and even proficiency in topographical map reading was not realized to be just as essential to an officer as his ability to read the English in an order. But there are better times ahead, and we may look to higher commanders not only for intelligent support, but for

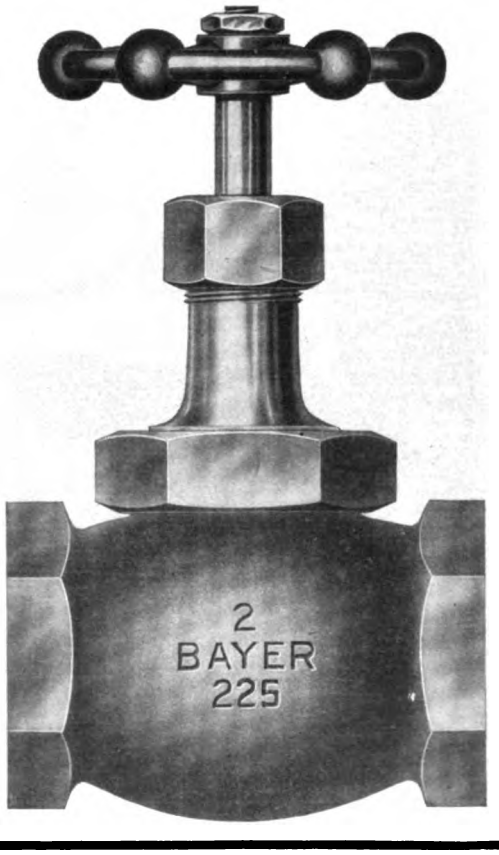
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vigorous measures to insure Major Adams' "fair degree of ability to read maps on the part of all ranks and branches."

To the incidents mentioned by Major Adams may be added the following much more serious case. In the Argonne offensive, a division reported that it had captured a certain hill in the sector of an adjoining division, and requested that its troops be relieved by elements from its neighbor. When an order to this effect had been passed up by telephone, a company of infantry marched straight up the hill to take possession. It was received with withering volleys and was driven back after heavy loss. The facts were reported, but previous instructions were repeated On this occasion a field officer with a suitable force was sent in rear of the lines to the P. C. of the officer who had reported the capture of the hill and thence to the position actually held.

It proved to be not the designated hill, but a knoll on a spur of the hill, and distant many hundred yards from the point indicated, which was still held by the Germans.

G. C. Marshall, Jr.

Major, General Staff; Aide-de-camp to General Pershing

Ability to read a map is one of the necessary qualifications of an army officer to-day, yet a reading of Major Adams' article on this subject would indicate that few officers in France were sufficiently trained in map reading. From the viewpoint of divisional, corps and army general staff officers, one of their most difficult daily problems was to secure accurate information regarding the location of the most advanced line in time to serve as a basis for the preparation of battle orders. One reason for this was, undoubtedly, the inability of many infantry officers to locate correctly their ground positions on the map. Air observers' reports were frequently misleading for the same reason.

No discussion seems necessary to demonstrate the importance of map reading, but, I believe, considerable discussion or argument is required to demonstrate that:

(1) A large number of officers who think they can read a map correctly and with the necessary facility, can not do so, and,

(2) Ability to read a map rapidly and correctly is seldom acquired except by practice in making maps.

There is nothing abstruse or difficult about the subject, but an efficient working knowledge can only be acquired by much practice. Merely to understand the principles involved and the conventional signs used is wholly insufficient.

R. G. Alexander

Lt. Col., U. S. Army, Professor of Drawing, U. S. Military Academy

Unfortunately, the incidents given by Major Adams, as showing the inability of American officers to read and use maps were all too common and too typical. They were not limited to junior officers either. In one case a general officer came to the map room at G. H. Q. and asked for a map covering *all France, on a large scale,* and *about two feet square, one that he could put in his pocket.*

This ignorance was all the more striking when compared with the excellent and very practical knowledge of maps common to all grades in the German army. German soldiers taken prisoners by our troops, when examined by our



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intelligence officers, could almost always point out clearly and without hesitation all the important points in their sectors as well as the main and subsidiary routes of communication; this, too, on our maps, to which they were not accustomed.

The allowance of maps to the American troops was far more liberal than that in any other army in the war, and yet, as Major Adams has shown, very little use was made of them. The trench maps placed in the hands of all officers and platoon leaders were the latest intelligence information from all sources, and in great detail. They left little to be desired, and yet requests were constantly being received for relief maps, photographs, and picture maps, because the information on the regular maps could not be appreciated and correctly interpreted.

The trouble lay in the lack of elementary and detailed instruction in map reading. There were so many things to be learned by our new troops and so little time in which to learn them, that it is not surprising that some were neglected. There was probably too great an assumption that anyone could read a map and too little appreciation of the amount, character, and value for practical purposes of the information on the map. Many people consider themselves proficient in map reading when they can laboriously scale off a distance on the map or work out the direction of one point from another. They never really study the information presented or acquire the ability to visualize ground from the map.

The difficulty can, in my opinion, be overcome by starting at the very beginning and taking nothing for granted. Last summer, for the first time, the fourth classmen at West Point were given a course of twenty lessons in map reading during their first month at the Academy. The course was very elementary, including exercises in scaling distances by road and by direct line, learning the principle conventional signs, the meaning of contours, and the representation of typical ground forms, plotting simple profiles, courses by bearing and distance, the location of points by co-ordinates, and practical exercises in the field illustrative of the above.

The results were at once apparent in the ability of these cadets to use their maps in field problems under the tactical department, and later in their better preparation to take up the work of surveying under the Department of Practical Military Engineering. They will this year have a course in topographical drawing and field sketching, and will later on have advanced map problems, both indoors and in the field. The repeated drill in theory, combined with practical application to actual problems, should produce the desired results.

C. L. Hall
Major, Corps of Engineers; M. Am. Soc. C. E.

The "horrible examples" enumerated by Major Adams of the ignorance of map reading displayed by the American Army are but too typical. The writer's official position made him conversant with the map situation over the entire American front, and there is no manner of doubt that lives were lost as a result of lack of proper training among emergency officers. However, the blame for this condition does not lie upon them. Ignorance of maps and mapping was a common failure in our army prior to the war. This ignorance took two forms, first in issuing instructions for the preparation of maps which were technically impossible of fulfillment; second, in inability to use the maps in question, or, indeed, any maps, after they were prepared and furnished.

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While it would undoubtedly be valuable, as Major Adams suggests, to prescribe a course in map reading during the instructional period of our next war, this measure will be totally insufficient unless the officers of the regular army receive complete and accurate instruction in map reading themselves, and unless, also, they have sufficient knowledge of map preparation and map reproduction to enable them to issue intelligent instructions to the technical staff. Colonel Alexander is to be congratulated on the course which he is giving at West Point.

The writer ventures to suggest the following additional remedial measures:

I. Instruction in map reading, as such, to be made compulsory in the basic courses of infantry, cavalry, field artillery and coast artillery schools.

II. Lectures are to be given at all these schools in the technique of surveying and the technique of map reproduction to make it certain that an officer calling for maps will know what time and labor are required to comply with his requests.

III. Instruction in map reading in all R. O. T. C. instructions to be standardized.

IV. Instruction in map reading to form a part of the course at the Blue and White Citizens' Training Camp.

The office of the Chief of Engineers is preparing a manual of topography, the first chapter of which—Map Reading—will shortly be issued to the service. It is to be hoped that this chapter will be digested by all combatant officers, and that the inspectors of tactical organizations will assure themselves that the officers of those organizations are able to comply, on the ground, with orders laid on a map.

The method which was at one time fashionable in the military service of securing acquaintance with map reading by requiring every officer to become a sketcher is somewhat outworn. It is true that every first-class sketcher is a competent map reader, but many men, perfectly capable of learning map reading, lack the manual dexterity requisite to finished sketching. Therefore, when time is limited, any hours spent on the technique of sketching can be had only by the sacrifice of time otherwise available for valuable practice in map reading. Under such conditions, to insist on facility in sketching as a part of every combatant officer's store of learning is undesirable. Men *can* be taught map reading by reading maps on the ground. This is the simplest method of instruction, and it is unwise to insist on any more complicated one.

R. A. Wheeler

Major, Corps of Engineers; Senior Instructor, Second Section, Department of Military Art, The Infantry School

In modern war, maps are the basis of all tactical plans. A mere superficial knowledge of map reading will lead to disaster. Every officer must possess a critical eye for the ground and the ability to interpret, visualize and vividly remember the conformation and character of the ground shown on the map.

For obvious reasons map reading is the first subject taught to classes entering The Infantry School. Briefly, the course embraces the usual fundamentals with practice in orientation through terrain and "map-comparison" walks, visibility problems and study of domestic and foreign maps.

This course is but an introduction to the other school work required of the student. Throughout the course he constantly improves his ability to read maps, and by association and repetition develops that "eye for terrain" essential to his success as a military commander.

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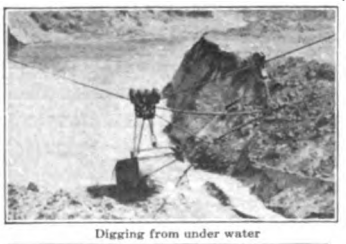
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Reorganization of the Engineer Service in the French Army
(Continued from page 339)

devices should certainly be used where possible, but very frequently the tactical situation will make their use impossible.

The infantry division is a fighting unit. It operates in the battle zone, where man power is the chief reliance. Engineers with an infantry division must not be burdened with a lot of mechanical devices, which will never be used, or used only in exceptional circumstances, and whose transportation is always troublesome. They, too, must rely on man power. In the emergencies where such mechanical devices may be needed, aid will be given by corps or army troops.

Discussion

by

F. B. Wilby
Major, Corps of Engineers

In commenting on this brief outline of the reorganization of the engineer service in the French army, it is rather difficult to draw accurate comparisons to our own new organization, as some details of the French scheme are missing, and some of the terms used, such as "transportation," are more or less indefinite and not quite clear as to just what they cover. In general, however, the *"Duties of engineers in the field,"* the allotment of engineer personnel, and duties of the chief engineer, as given under *"Engineer troops of a large unit,"* and the general principles enumerated under the heading *"Remarks,"* are almost identical with the accepted principles for the use of engineers in our service. This similarity is especially noticeable in the creation of a general reserve of engineers; the realization that a large proportion of common labor will be needed, and its segregation into special labor units, and the elimination of many of the mechanical devices developed during the war, with the consequent reliance upon man power, especially for units in the forward areas, such as the engineers with the infantry and cavalry divisions.

The fundamental difference between the French organization as outlined in the above article and the new organization for the engineers in our service, lies in the *"classes of engineer troops"* adopted. It is interesting to note that the French have adopted the company unit as standard for all engineer troops assigned to units above the division, with the exception of railroad regiments and transport battalions. This conclusion is in agreement with the recommendation of many of our engineer officers during the recent war, especially the engineers from civil life, whose military engineering experience was confined to that obtained during the war. It was not adopted for our service for the following reasons:

(a) The company unit, although most efficient from a technical standpoint for engineering work in rear areas where the jobs are widely scattered and often capable of being handled by one company of skilled engineers supplemented by the necessary amount of labor, is not an efficient unit for administration, movement, supply or training from a military standpoint, especially when the number of separate companies permanently required by any unit becomes great.

(b) It is difficult to create and maintain "esprit de corps" in a unit as small as a company, whereas, this much-to-be-desired esprit is more easily created and maintained for units the size of a regiment.

(c) The opportunity for advancement, both for the en-

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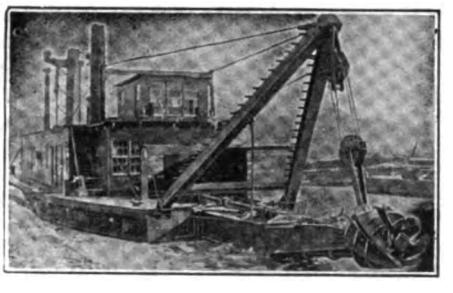
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listed man and the officer, is very much restricted with an organization consisting of a large number of separate companies, whereas there is a normal flow of promotion provided if these companies are organized into regiments.

In the French organization there seem to be a large number of special engineer units, such as mining companies, bridging companies, standard and narrow gauge railroad regiments, electrical companies, water-supply companies, forestry and hut construction companies, road companies, and several engineer trains and transportation units. In the new engineer organization for our service, constant effort has been made to eliminate special units wherever possible, substituting general engineer troops capable of performing all kinds of engineer construction work. This difference, it is believed, is most important for our engineer service, which may be called upon for duty in widely varied theaters of operation, and under various conditions of service, whereas in the French army the general prospective theater of operations is restricted and the conditions of service are very well known beforehand. It would be interesting to know the proportion of special units provided in the new French organization as compared with the number of general engineer units. In our service the proportion will be 15 per cent special units to 85 per cent general.

The number of different kinds of railroad troops provided in the French organization is not quite clear from the data given. It would seem that there are to be at least two kinds, one for standard gauge railroads and another for narrow gauge railroads, but whether each of these is subdivided again into construction, operation, and shop units is not made clear. In our service it is proposed to handle all railroad construction by general engineer troops, and all railway operation (no matter what gauge) by one type of railway operating battalion. This method, I believe, will differ from that proposed for the French army.

The "Cyclist Engineer Unit" with cavalry divisions in the French organization is most interesting, and in this connection it is pertinent to state that the supply of Ford automobiles for at least 50 per cent of the engineer personnel with cavalry divisions has seriously been advanced for the British army, although when mentioned to our own cavalry authorities this suggestion created only amusement.

Examinations for Regular Army

After the selection of the successful candidates who took the examination on April 25, 1921, for appointment in the Regular Army, there will remain more than 3,000 vacancies in the grades of 1st and 2d lieutenants. Some of these will be filled by examination for appointment as second lieutenants to be held on August 22, 1921, Appointments will be made in the infantry, cavalry, field artillery, coast artillery, engineers, air service, signal corps, quartermaster corps, ordnance department, chemical warfare service and Philippine scouts The number of appointments in each will be announced later. The general provisions covering preliminary examinations prior to the final examination on August 22 are similar in general to those governing the examination of April 25, which are given in full on pages 135 and 165 of THE MILITARY ENGINEER, No. 68, for March-April, 1921. Readers are urged to bring this matter to the attention of such of their younger engineer friends as they consider will be interested. Detailed information may be secured from any military post or station, or from the corps area headquarters.

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Why Work for Uncle Sam?

By

Brehon Somervell

Major, Corps of Engineers

IN an effort to increase its efficiency the Administration has announced its intention to reorganize the Government departments. Undue duplication of effort should undoubtedly be eliminated, and if certain work now being done by a number of the departments can be handled more advantageously by being transferred to a single one of them, or by the creation of a new one, surely no one will oppose such a move.

The only danger in rearranging the work of the various departments is that the matter may be overdone. It must be reasonably certain in advance that with the proposed rearrangement the work will be handled with better technique, greater expedition, and more advantage to the departments for which the work is being done and therefore to the nation at large. Until these conditions are assured changes should be made with caution. For example, the proposal to create a Department of Public Works does not show on its face that these requirements will be satisfied by its establishment. The proposal to combine in a Department of National Defense the activities of the army and navy should also be carefully examined. A statement was made in the last Congress that 93 per cent of the money appropriated by the government to date has been spent in connection with past and future wars. This figure, of course, included pensions and other items of like nature which are not under the War and Navy Departments. Whether or not it is too large, it is certain that the bulk of government expenditures have been brought about by the national defense. In other words, the greater part of our taxes are expended directly or indirectly to maintain the policy, or lack of policy, in respect to the army and navy. Are we to combine in a department of National Defense 93 per cent of the government's activities and have 1 per cent assigned to each of seven or eight others. Such a proposal does not seem logical.

Before proceeding with the reorganization which is undoubtedly necessary along certain lines, there are certain fundamental faults existing in the present departments which must be eliminated before a change in organization will produce any real improvement.

Inasmuch as we are particularly interested in the War Department, the rest of this paper will be devoted to an exposition of those faults which prevent it from attaining its greatest degree of usefulness with the funds appropriated for its support.

Mr. Crasson, editor of a London magazine, asks for the reason why all government departments the world over are operating with a reduced output: "Speaking quietly, without rage and prejudice, can any one tell why it is that all government departments in all countries are slow, wasteful and incompetent? There must be some basic reason for this, as the individuals in these departments cannot all be inferior to individuals in private firms * * *. The fact seems to be that a man simply cannot be competent in a government job for these ten reasons:

(1) There is no payment by results.
(2) There is no fear of discharge.
(3) There are no profits to be made.
(4) There is no danger of losing customers.
(5) The main thing is accuracy, not success.
(6) Time is of no consequence.
(7) The work is impersonal.
(8) There is no competition.
(9) Routine is put ahead of service.
(10) There is no enthusiasm."

This is certainly a formidable indictment if applicable to the War Department, and a condition which, if true, should be eliminated before or during reorganization.

(1) *There is no payment by results.* This charge is true of our department as regards both military and civilian personnel. One receives as much for doing badly as one does for doing well, except in a few instances, and their number is so small as to be wholly negligible. This is really the worst evil of our system. Two officers may sit at adjoining desks in the same room. They may be of equal rank and draw equal pay, both may be promoted on exactly the same day. One is capable of much accurate work, the other manages to escape Class B by a narrow margin, and yet there is no reward for the man of superior ability in the way of advanced rank or pay. The high grade man knows this and wonders why he works hard when his neighbor accomplishes little and receives the same reward.

An officer's efficiency report has been indorsed to the effect that he is inclined to be careless when no incentive is offered. Can any one blame him for that? Persons who work merely to be at work are few and far between. Even preachers work for reward in heaven. Most are seeking more tangible results and an earlier reward for their labor.

As long as promotion by senility and not by ability continues in force, incentive is lacking and so are results. Until some scheme for promotion by ability is devised progress and output will be retarded.

What has been said about officers applies with equal or greater force to the civilian employees. Some superannuated, doddering clerk will hold a position merely by reason of length of service and, indeed, in many cases, when he has nothing else to recommend him.

(2) *There is no fear of discharge.* This is not entirely applicable to our War Department, but the legislation and regulations governing discharge are so clumsy and bound up with red tape that it requires a great effort to rid oneself of any undesirable subordinate. Ordinarily he is transferred, not discharged, and some other executive finds himself burdened with a piece of dead wood.

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(3) *There are no profits to be made.* The War Department is not a business concern as are some of the other government departments, such as the Post Office, which show a yearly deficit. However, it does handle immense sums yearly, and every taxpayer should demand their economical expenditure in time of peace. War is not inexpensive and cannot be made so, but expenses will be reduced by adequate preparation in time of peace and the provision of competent officials to regulate expenditures in peace and war. The idea that "there is no possibility of bankruptcy and that the Treasury has plenty" should be scrapped for good and all.

(4) *There is no danger of losing customers.* The War Department has no customers but it can estrange its supporters by wasteful and inefficient methods.

(5) *The main thing is accuracy and not success.* With the present system of efficiency reports the timid or overcautious individual is afraid to try something new for fear that he will fail and receive a black mark on his record. The result is obvious. His idea is to avoid mistakes. The less he does the fewer mistakes he makes. No one knows what per cent of the Department is affected by this form of disease, but indications are that it is rather high.

(6) *Time is of no consequence.* One has so many years to do before one retires. What is the use of hurrying a job along when another is bound to show up? Nothing results from getting this one finished. It is somewhat like eating in that one has to eat a certain amount to live; any more causes discomfort of some sort.

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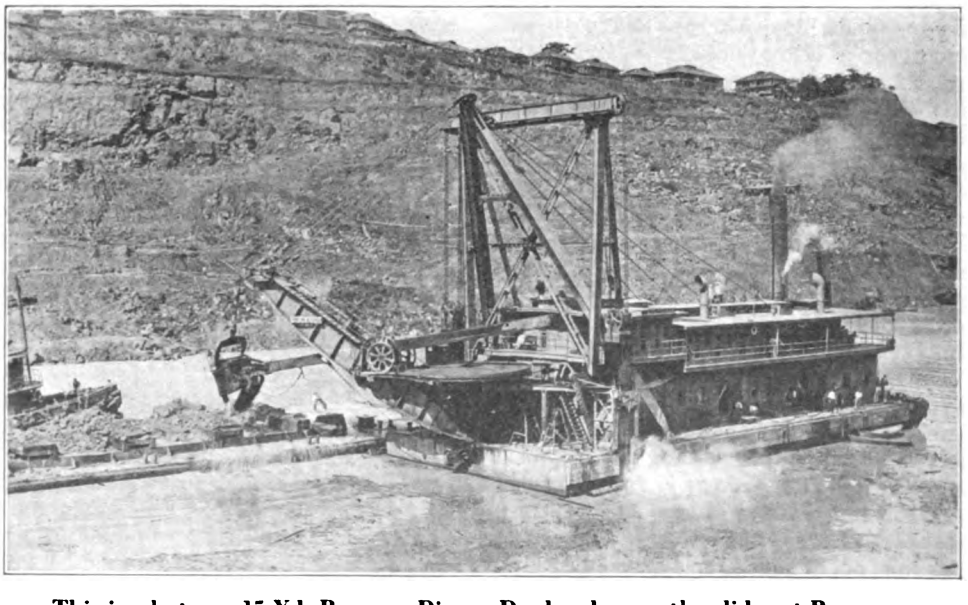
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(7) *The work is impersonal.* An improvement along this line is noticeable but "the buck is still passed" many times a day. The clerks generally arrange a system whereby no one of them is to be blamed no matter what happens.

(8) *There is no competition.* This is not exactly true of our War Department, as we have the Navy and Marines to line up with on certain occasions. Competition is generally severe at the service schools and there are always applicants for soft jobs. What is the reason for taking a hard one when the individual gets just as much compensation and advancement for taking the easy one? The result is competition for easy instead of for responsible jobs, or for pleasant stations instead of those affording better opportunities for real work.

(9) *Routine is put ahead of service.* The file clerk thinks the office is run to provide him with papers to be put away. Months are often consumed in getting a complete set of visas on requisitions instead of shipping promptly the articles called for. The auditor is just closing accounts of disbursing officers who ceased to function in 1918.

(10) *There is no enthusiasm.* This is one of the charges which can be denied in part. If some officers did not have a conviction that the service is the best as well as the oldest profession the army would go to pot in a short time. These are the enthusiasts who have prevented a collapse when incentive or reward were lacking and who confidently hope that some day the War Department will function on a sound basis. This hope, which has never been closely realized except in the A. E. F., where conditions more nearly approximated those demanded by correct principles, is all that has kept the army going.

With the present system there is practically no hope for enthusiasm among the civilian personnel. No real career is offered them and they are reduced to being bread winners and nothing more.

From the above analysis it seems that Mr. Crasson's arraignment of the faults of all government departments is applicable in almost every specification to our War Department—the most expensive of all our government agencies.

Before proceeding with the reorganization of the government let us eliminate the faults which he has pointed out. An improvement can be secured only by providing (1) proper incentive by means of reward for good service in a reasonably short time; (2) instant elimination of the incompetent and unfit; (3) suitable competition, which will result from providing a proper incentive; (4) definite chains of authority and responsibility. Until this is done, little if any increase in efficiency will follow a mere reallotment of government functions. A change in form, though helpful, does not go deep enough and will not make the departments efficient machines.

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Principles Governing the Use of Combat Engineers

With Illustrative Examples

By

W. A. Mitchell
Major, Corps of Engineers

(Continued from Page 331)

Principle: *The problem of the engineers to-day is different in almost every operation, and the assignment of engineers must be varied according to circumstances.* The following is quoted from the report of St. Mihiel operation, showing how the 2d Engineers were divided up for this battle.

"It was evident that the Engineers must make preparation to cross the river at Thiaucourt and must assist every one in getting over 'No Man's Land;' the artillery needed help, the tanks needed help, and we had plenty of work of our own to prepare the bridges for crossing the Rupt de Mad at Thiaucourt. Studies of the map were made, aerial photographs were thoroughly gone over, and all possible information was obtained from the French records. The regiment was finally divided as follows for the operations:

"(a) Two companies, less a few detachments, as wire cutters (almost a whole company of these two later diverted to take care of the large tanks).

"(b) Four platoons at Noviant Dump to load and unload material and for emergency work which would later arise.

"(c) Nine squads to go with the small tanks.

"(d) Six squads to go with the artillery.

"(e) Two trap-hunting platoons, one to follow each attacking infantry regiment and look for traps and do other effective work.

"(f) Balance of the regiment (about two and one-half companies) to follow in rear of the advancing troops and repair roads.

"(g) Map section to follow the 3d brigade and report concerning the character of the roads, and what work would be advisable on them.

"As it was believed that the Thiaucourt bridges would be destroyed, 24 standard trestles, 10 feet high, were made and placed ready on trucks so that they could be run forward for repair of these bridges. Three special squads from the platoons at Noviant Dump were detailed for this work.

"Two officers were specially detailed to study up beforehand and look out for the water supply. They were instructed to label such water as could be found and to be prepared to furnish all possible information, with their recommendations, as to development of water points. In this instance a water monograph was obtained from the army engineer, and this information proved to be of great value to the divisional engineer troops in the advance of water reconnaissance. It was seen that it would constantly be of much benefit if the divisional engineers were, prior to each operation, furnished a copy of the water monograph of the sector to be covered in advance. This was not always done; in fact, it was the exception and not the rule. For this reason it was impossible in many cases to obtain very valuable information contained in these monographs relative to water-supply systems, bridges and river bottoms.

"For road work, small bridges of the 'Cheney' model, in half sections, were prepared and loaded on artillery caissons and engineer wagons and transported, so that they would be thrown over the old and new trenches in 'No Man's Land.'

"Also, fascines were built for the tanks, so that ditches and trenches could be filled. They were not considered as of much value, but the tanks wanted them, and we built them.

"Two wagon loads of tools had been delivered at convenient points for each of the two regiments (9th and 23d Infantry) which formed the attacking brigade, and four extra loaded wagons were held in reserve for the two regiments of the 4th brigade, as they stated that they did not want any tools for the present.

"The army and corps engineers had stocked up engineer dumps at St. Jean, Noviant, Dieulouard, etc. Consequently, there was no lack whatever of engineer material."

The following is quoted from a message from a battalion commander concerning the work of the platoons hunting booby traps and pit-falls, showing the varied character of their work:

"Lieut. Slade reports our tanks going up to line; occupation of Jaulny completed yesterday p. m. One squad of Lieut. Slade's detachment under Sergt. Poteet captured 7 Germans and a machine gun in Bouillonville 12th Sept., and with 8 infantry from the 89th cleared the town and captured several prisoners, including 10 officers; prisoners turned over to 89th Am. Div. He further reports the main 3-way road to Jaulny clear. Two-way steel bridge (girder), 50 meters long, was in shape for heavy traffic last night; mine chambers emptied. One trestle pile bent, wooden bridge alongside needs repair of one bent on enemy side before possible for traffic. He reports narrow gauge line, Thiaucourt-Ese to 5th Div. front, was ready for operation last night. His steel gang, with work trains, is laying rail to meet Company 'B.' He (Lieut. Slade) has taken steam engineer and work train to Thiaucourt and works north of Jaulny. One detail is going on to Jaulny, presumably to reconnoiter, and rest of platoon is ready to go forward. Complete itemized inventory at dump at 364.9-240.2 has been made and filed there. A copy will be sent here later. I ordered Lieut. Slade to remain on the job. Herewith copy of list of materials at Thiaucourt received last night from Lieut. Slade. An itemized list of narrow gauge railroad material and supplies at Thiaucourt received last night from Lieut. Slade. An itemized list of narrow gauge railroad material and supplies at Thiaucourt turned over to Lieut. Wyman by me this morning."

The following is quoted from the official report showing the varied character and amount of work done by the engineers in the Blanc Mont Campaign:

"Summary of Results. It is believed that in this operation the engineers did about all classes of work that could have been expected of engineer troops, and some classes of work which need not have been expected of engineer troops. The following is a summary of the results accomplished between October 2 and October 10, inclusive:

"(a) Thirty kilometers of wagon roads were repaired and put in shape.

"(b) Twelve kilometers of two-way paved road were repaired, including actual paving of 200 yards of two-way road by means of rock hauled principally by the engineers with its engineer train transportation, and the temporary construction of 600 yards of side roads at the point, to carry traffic in the meanwhile.

"(c) Regulation of traffic during two nights along seven kilometers of two-way road and fifteen kilometers of wagon roads, and during two more nights along seven kilometers of two-road way.

"(d) Two bridges about 20 feet long were built to carry light traffic, one of the bridges requiring about 100 linear feet of fill in its approach.

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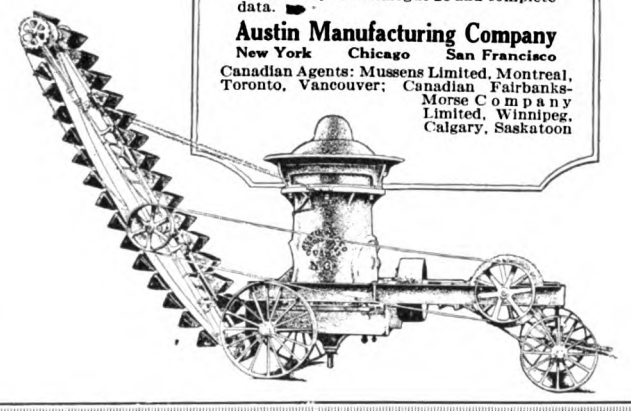
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"(e) A pile bridge, 22 feet long, was constructed, capable of carrying the heaviest traffic.

"(f) All necessary tools were furnished to the infantry at places selected.

"(g) Maps showing engineering information were prepared and distributed daily, when necessary.

"(h) Two or three pumps were repaired and the water supply materially improved thereby.

"(i) Considerable material was hauled, about 500 loads of stone being hauled by the 2d Engineer Train.

"(j) Probably 1,000 German prisoners were fed while awaiting evacuation.

"(k) About 200 yards of roads were built for various field hospitals.

"(l) Electric light equipment of one field hospital was repaired and put in shape.

"(m) Two dumps of engineer material, captured from the Germans, were taken over and lists made of their contents and furnished to the Chief Engineer, American Expeditionary Forces, so that the United States would get credit for the material. Later, we obtained receipts from the French for these dumps and forwarded them.

"(n) A gap was filled in the right of the fighting lines; supports and reserve were placed back of this gap and other portions of the line. Four machine guns and thousands of rounds of ammunition were taken by us from the Germans in front of us. These machine guns were then manned by engineers and used effectively against the Germans.

"(o) Two companies were placed in the left of the fighting line, and one company in support, thereby closing a very large gap. A few prisoners were captured.

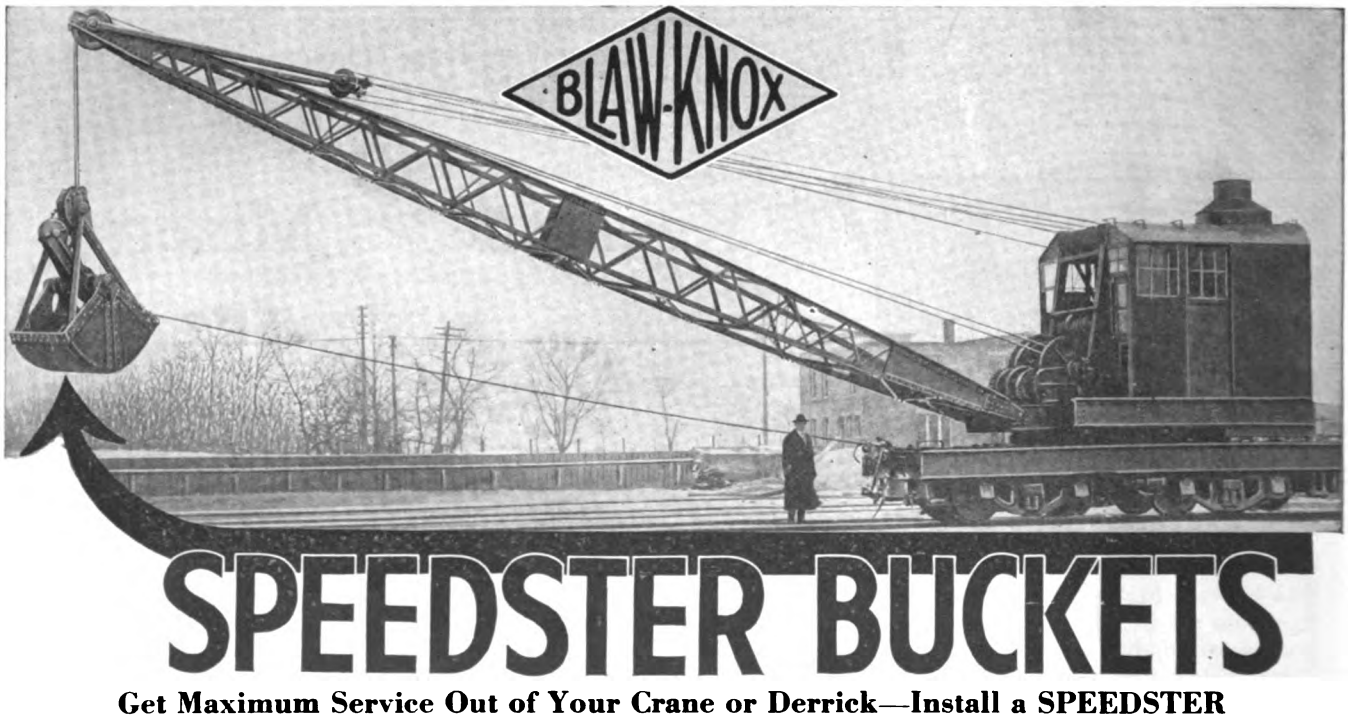
"(p) Four American machine guns were partly manned by engineers specially detailed for this purpose.

"(q) A platoon built roads for the rapid movement of the artillery, and at one time, believing that a counter-attack was imminent, this platoon gathered together some Browning and Hotchkiss machine guns and manned them preparatory to repulsing any dangerous break-through by the Germans."

Principle: *In general, communications are the main work of a division engineer regiment. The main duty is to get the division forward. When not otherwise occupied, the engineers will work on roads or railways or bridges to be used by the division.* At the St. Mihiel campaign the 2d Engineers (2d Division) repaired the light railway from "No Man's Land" to Thiaucourt without orders. In the Blanc Mont sector they repaired 12 miles of light railway in order to connect up with the French. In the Meuse-Argonne they repaired several miles of railway at Landres-et-St. Georges in order to help out the light railway troops. Reconnaissances were made into adjacent sectors in order to determine just what railways should be repaired. In the Meuse-Argonne these reconnaissances showed that the railways were very badly broken in both adjacent sectors.

Principle: *Combat engineers are equipped for superficial road work only; systematic road work should be done by engineers having the necessary trucks and road equipment.* It takes over 2,000 3-ton truck loads of broken stone to build a mile of 2-track road. As a combat engineer regiment can at most use for such work some 8 or 10 trucks, it is evident that its work will not be very effective.

At St. Mihiel and the Argonne, especially at Avocourt, the combat engineers carried rock in their hands to repair the roads. This was necessary because no road troops were available and the roads were blocked by vehicles which should have not been forwarded at this time; but if road



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troops had been available and the combat engineers could have been used on the more effective work of getting forward the division units, it is very probable that the advance would have been more successful.

In the last phase of the Argonne almost every combat engineer regiment had to drop behind in order to work on roads. This work was very inefficient, but had to be done because there were no road troops available and food and ammunition was needed at the front; moreover, the crossing of the Meuse was delayed thereby because the engineers could not be with the leading elements of the division to help them in their crossing.

The 1st Engineers scraped the mud off of part of the Bugancy-Stenay road with shovels. Probably a thousand engineers spent one day on work that could have been done in half the time by three men, a truck and a road scraper.

Principle: *Engineers should move with the infantry lines if necessary in order to take care of the technical engineer work.*

The principal work before the engineers in the Meuse-Argonne was seen to be the maintenance of roads. A study of the map showed that the whole 2d Division trains would have to go through Landres-et-St. George; consequently this was the critical point, and the 2d Engineers decided that they must clear the streets and get across the creek at that point with the utmost possible speed. One whole engineer company was ordered to follow the infantry support into the town of Landres-et-St. Georges, fix the bridge and clear the streets of the town. They did this as ordered and lost twenty-four men. However, it is thought that the advantage gained was worth the losses, because this road through Landres-et-St. Georges was, for a time, the most popular line along the whole corps front. It was used by all of the three divisions, by portions of two other divisions, and by corps and army troops.

Principle: *Engineers should be used as infantry when necessary. When used as infantry, they should be used on special duty assigned by a division commander; they should not be split up and farmed out to infantry brigades or regiments.* The 2d Engineers, in the battle of Chateau-Thierry, were used in many ways as infantry. In some cases the companies were separated and sent to do engineer work with different infantry regiments. In such cases, the infantry commander immediately figured that he had just that many more riflemen and generally proceeded to use them solely as riflemen. In the Chateau-Thierry campaign it is possible that this could not be helped in several of the cases in view of the fact that this battle was at first in the nature of a meeting engagement; but when possible this practice should be avoided.

Before using engineers as infantry, a division commander should consider certain things, viz:

1st. Has he any infantry left that can properly do the work? There was at least one case where engineers were used as infantry when there was plenty of infantry available and suitable for the purpose.

2d. Is the emergency sufficient to justify using his engineers?

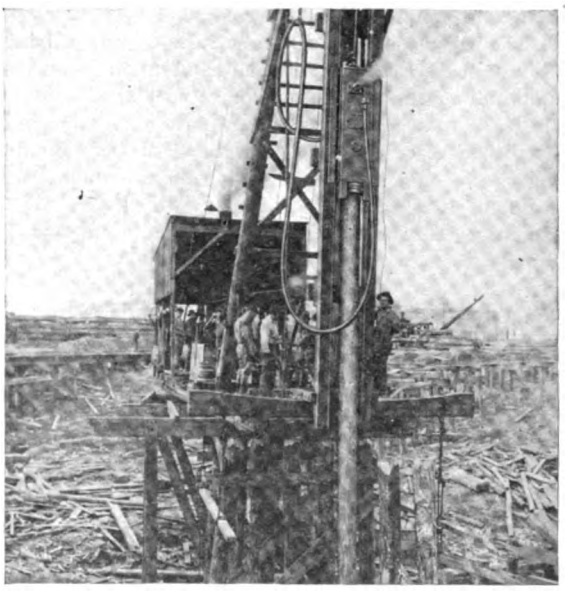
3d. If he wins, will he not find that he made a mistake in using his engineers, in view of the immediate need of them for road and bridge work?

4th. If he loses, will he not find that he made a mistake in using his engineers in view of the immediate need of them for demolitions and for rear guard?

After considering all these things, he should use them as infantry when necessary and count them "expended" as infantry for that particular day's work. As stated in the discussion regarding training, he is responsible for the results.

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and he should train and use his troops properly; otherwise he is not fully acquainted with the duties and capabilities of the troops of his division.

There were many cases of improper use of engineers as infantry; but more often the combat engineers were used on road work when they could have been better employed in helping the artillery, machine guns, etc., or even as infantry. One case was reported where an engineer platoon was ordered to stand up and dig holes for a certain number of infantry who were lying down and shooting; the engineers did not dig long, as some of them lay down unintentionally and some of them lay down intentionally and began shooting.

The following is quoted from an official report of a combat engineer regiment:

"To the division staff, engineers are specially trained men, who can fight as infantry, but to an infantry brigade or regimental commander, engineers reporting to him represent only an additional force of infantry and generally are used immediately as such. This battle showed, and it was promptly adopted as a future policy in this division, that the engineers must be kept under the direct control of the division commander; that they should be kept generally on engineering work under his control; that they should never be attached to infantry brigades or regiments except for a specific task as engineers or even as infantry; and that they must be returned to the direct control of the division commander immediately upon completion of the specific task in which they have been assigned."

The following are examples of excellent use of engineers as infantry:

(a) The 1st Engineers in the Argonne captured and held Hill 269, an important hill on the right of the division line.

(b) The 2d Engineers at Soissons and Blanc Mont were ordered by battalions into certain parts of the line to assist a much exhausted infantry.

(c) The 6th Engineers (3d Division) in the Argonne materially assisted the infantry in a desperate and successful attack against part of the German line.

(d) The 316th Engineers (91st Division) sent a battalion into the fight at Eclisfontaine in the Argonne which made the final and successful effort to drive back the Germans.

(e) The 110th Engineers (35th Division) were thrown across the front of the sector of the 35th Division during the emergency and intrenched and held the whole front of the sector of that division for nearly two days.

Principle: *Combat engineers who have been used as infantry understand conditions and work more effectively as engineers.* It is admitted by all that corps and army engineers did not work as rapidly or effectively as combat engineers. It is even claimed by some that the 1st, 2d and 6th Engineers were the best workers in the army because they had experienced more fighting.

The men of the battalion of the 316th Engineers (91st Division) that fought at Eclisfontaine always had the edge on those of the other battalion and called them "supply troops."

One combat engineer regiment sent forward to build a bridge, sent back wild reports to the effect that the bridge could not be constructed and that the engineers had been forced to retire by the heavy firing; investigation showed that not a man had been killed or wounded. This combat engineer regiment had previously had no fighting experience.

Principle: *It is an error to have the engineers do nothing while waiting in reserve; they should be ordered to work on communications, being prepared however to assemble at a certain selected point for use as infantry.*

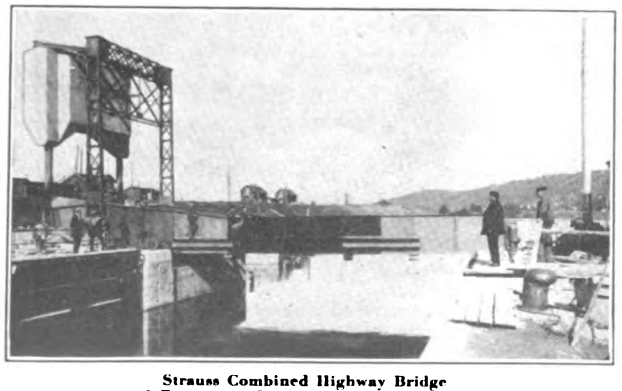
In the Meuse Argonne the 1st, 6th and 316th Engineers were used as infantry. In all of these cases they were being used on road work before being used as infantry. There is no criticism of the use of engineers as infantry, and it was proper to make them work on roads until needed as infantry, having in mind their physical condition after toiling on the roads.

At Soissons the 2d Engineers, while waiting as division reserve, without orders cleared the Paris-Soissons road. This work was very useful, as troops from many directions used this road within the next twenty-four hours.

Principle: *Combat engineer troops need rest just like other division troops.* If they work as they should work when work is to be done, they get tired physically and mentally, just like other troops, and a division commander should take care of his engineers just as he takes care of his other troops.

When the last phase started in the Argonne, many of the artillery and engineer units had been about thirty days with the front-line divisions. During this time the infantry had been withdrawn, rested, and were ready for a new tilt with the enemy. The artillery and engineers were tired, and they showed it. During the next ten days one combat engineer regiment lost over 7 per cent from sickness alone, and the artillery reported that they had left only about one-half of the able horses that they needed. In one case it was necessary to build them a narrow gauge railroad to carry ammunition, because they did not have horses to haul it the usual distance from an ammunition dump. One engineer company wore itself out on this work and another company had to be substituted.

Principle: *It is not practicable to throw a large bridge across a river when the enemy holds the opposite bank.* A bridge is a defile, with the added difference that the defend-



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ers of the defile may scatter in a line perpendicular to the defile and shoot the bridge builders at their leisure. Such bridge building has been impossible in wars before the World War, and the greatly increased power of modern weapons makes an attempt at such bridge building even more inadvisable.

At Fredericksburg the Union engineers attempted to construct a ponton bridge across the river while the opposite bank was held by the Confederates. Many men were killed and no progress was made. Finally, infantry was ferried across, seized the opposite bank, and the engineers built the bridge.

In the work of the Union cavalry to protect the flank of the Union army marching to cross the James and advance on Petersburg, the cavalry complained very greatly because the engineers did not build a bridge across a small stream so that cavalry could cross and drive the Confederates from the opposite bank. Finally, the cavalry crossed and drove the Confederates from the bank, and the bridge was then built.

Principle: *It is possible by surprise to construct a foot-bridge across a small river held by the enemy on the other side; such a bridge can be made of rafts and the whole bridge lifted and shoved across the stream. A raft bridge can ordinarily be made of material taken from any lumber yard or of pieces taken from old wooden houses.*

At the point selected by the 2d Division for crossing the Meuse River, it is 168 feet wide and 5 to 20 feet deep. The stream is not swift, consequently it is possible to push a series of rafts across the river without fear that the current will carry them downstream too fast.

A series of rafts 12 feet long and 6 feet wide were built at Beaumont, 3 miles away, carried in wagons to the site and lashed end to end. Two complete bridges were lashed perpendicular to the stream. At the word of the commander the 2d Engineers, assisted by details from the 9th Infantry, shouldered the bridges and pushed them across the river. The time consumed from the beginning of the lashing of the rafts together on shore to the time when the bridges hit the far side of the Meuse was seven minutes for one bridge and eleven minutes for the other. During all this time, and before and after, the enemy was firing in that direction with artillery and numerous machine guns. Actually, however, very few were killed on the bridge, although some 250 infantrymen, marines and engineers were killed in that vicinity during the night.

Principle: *For ordinary bridges, regular bridge equipment is not needed by combat engineers. It is possible to build small bridges in almost every case with material found on the site.* In the World War, so many bridges were built by the combat engineers with material on the site that no mention need be made of the special cases. In one combat engineer regiment four ordinary bridges were built in one day, two for horse-drawn vehicles and two for heavy trucks.

Principle: *A ponton bridge can be constructed by a combat engineer regiment without previous training in ponton work, but naturally it will take longer to build the bridge.*

After the infantry of the 2d Division had crossed the Meuse on foot-bridges, it became necessary to build ponton and trestle bridges. For the ponton bridge the engineers used pontons of various patterns—German and French. The bridge was a good one and was used; but it took the division engineers one and one-half hours to build the 200 feet of bridge, this long time being necessary because they had never had the training in building ponton bridges.

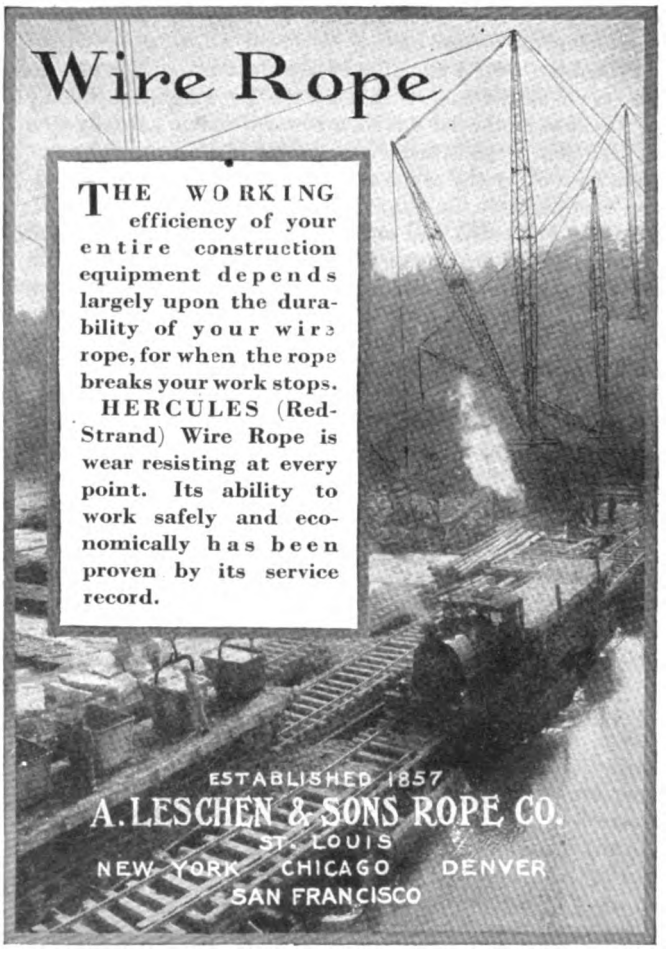
Principle: *In any movement the engineer map section should issue at suitable times a map showing engineer information, such as condition of roads, watering points, condition of railroads and future prospects on these points.*

"As soon as we began to advance it was found that the trucks, and even the troops, were very much in the dark as to the roads which they could profitably use; consequently the engineer map section issued maps showing conditions of roads, location of water points, strength of bridges, etc."

Principle: *The engineers in any advance can materially assist the artillery in many ways in advancing over fields and poor roads and in maintaining themselves in position* The following is quoted from a letter from one of the officers detailed with engineers to accompany and assist the artillery:

"The road for the 15th Artillery on left was opened through to advance. The artillery took position behind ridge. Two trench mortars, German, continued to shell


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road after infantry had passed. We located them to left of division sector about 200 yards from road. I sent Sergt. Farce and six or seven men to get them; they did, turning four prisoners over to an artillery lieutenant. Fifteenth Artillery finally moved to within about 500 yards of front line. They then received machine-gun fire from the right. I went after this gun, but failed to find it. However, it ceased firing and evidently moved out, since we were not bothered any more."

After telling how the artillery was under fire during its movement forward, he continues his narrative.

"Sergt. Stimel dug the artillery in under fire the entire time. He sent for me. I took three or four men from my detail, went over to the left of the sector; some marines came back from the front with two machine guns, the artillery sent over one machine gun and some twenty men. With this bunch we mopped up after the machine guns had shot up what ammunition they had, killed three or four Germans, but the rest got away.

"It was not my men who helped man the artillery guns. It was Benjamin's men who did that. They were distributed throughout the regiment, so that the engineers did not actually man any gun entire."

Principle: *In an advance by the division the combat engineers should accompany the division and assist its units in advancing; they should not be kept in the rear to repair roads which should be repaired by corps and army engineer troops.* This principle was not followed by the 2d Engineers in the Meuse-Argonne for the simple reason that the corps and army engineers could not do their own work and the 2d Engineers had to keep up the roads in the back area in order that the 2d Division could get its supplies. This inability of the 2d Engineers to work in two places at once operated to a certain extent to delay the 2d Division in crossing the Meuse.

Probably the best example of a proper use of combat engineers in an advance is that of the 1st Engineers during the advance of the 1st Division toward Sedan. Briefly, the 1st Division decided that if the roads in its rear were not taken care of by the corps and army engineers the 1st Division would starve, and the 1st Division decided to risk it. Naturally the corps and army engineers would have found it necessary to take care of the 1st Division, or the 1st Division would have been ordered to stop. As the operation was a short one, and as the 1st Division returned in a very short time, the division managed to pull through this brilliant operation without running entirely out of food and ammunition.

The following is quoted from the 1st Division records, showing the kind of work that is done by a division engineer regiment that properly accompanies its division in a pursuit:

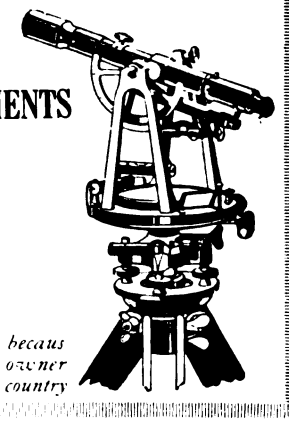
"A and D companies moved forward with the 1st and 2d Infantry Brigade when they attacked from the Beaumont-Stonne road and opened up their communications. Roads and mine craters were repaired and bridges built to facilitate the advance. The remainder of the regiment worked all day on the roads around Commauthe, and then, at night, made a forced march toward Sedan, a distance of 38 kilometers, over roads congested by the movement of a whole division and obstructed by the enemy, who had destroyed every bridge and blown mine craters at every road crossing. A march of 70 kilometers was made in 48 hours. That was a heart-breaking march, because the regiment had been working all day and marching all night for three days and nights. During the march we constructed bridges where the enemy had blown them up.

"At one point near Stonne the division was held by a destroyed bridge, and detachments from F and B companies performed a remarkable feat of rapid military engineering when they constructed a bridge in a single night without any tools. Our wagon transportation and pack mules were far behind us, because we were going so fast, so it was a case of constructing a bridge from a growing forest with the aid of a few axes that were found somewhere. The men were almost exhausted from the long and trying march and loss of sleep, but with unbreakable spirit and determination they went to the task and labored cheerfully all night long, completing the task in a remarkably short time.

"Company A advanced with the 16th Infantry and alone attacked and captured the village of Pont Mangis without artillery assistance and under direct fire of the enemy artillery. The company attacked in face of heavy machine-gun fire and under the fire of an enemy 77 gun, firing point-blank at them as they advanced. They silenced the enemy by rifle fire alone and entered the village, making a house-to-house search and cleaning out the entire village."

• • • "From a purely military standpoint our policy should provide, first, a permanent military establishment large enough to guard against sudden attack; second, a force sufficient to meet our international obligations, particularly on the American continent; third, such force as may be necessary to meet our internal requirements; fourth, a trained citizen reserve organized to meet the emergency of war.—*General Pershing.*

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Military Instruction

No. 2: JULY-AUGUST, 1921

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Military Engineering, Note 1

Foreword

THE problems in military engineering, which it is proposed to publish in these columns, are similar to those given in the subject of field engineering at The Engineer School. This subject, in the curriculum of the school, is covered in two courses of instruction—namely, the basic course and the company officers' course.

Roughly speaking, the problems in field engineering of the basic course are those which normally would confront the lieutenant or captain of engineers serving with a divisional engineer regiment. The company officers' course continues this instruction to include problems which the field officer, serving with divisional or corps engineer troops, would encounter. In the first course the engineer company is the largest unit which is dealt with; in the second course it is the regiment.

The order in which the problems will be published will conform to this division of the subject, the problems in the basic course being given first, to be followed later by the more advanced problems of the company officers' course.

The aim of the basic course of instruction is to teach the junior officer of engineers the technique of his profession and to train him to make a definite plan of operation for carrying on the job assigned to him. He should know the details of the various types of construction with which field engineering is concerned; the number of men, the quantity and kind of tools and materials required in the construction, and where and how they are obtained; the rate of progress that may reasonably be expected on the work and how he can best organize his working force so as to accomplish his mission. The scope of the course is, therefore, limited generally to questions of technique and organization. It is thus limited, because it is believed that theoretically at least the problem confronting the lieutenant or captain is usually a quite definite one. To be sure, he has decisions to make based upon the military situation, but the problem as presented to him is so narrowed down that the unknown quantities usually can be quite definitely determined by the application of the technique of his profession.

In the company officers' course, field engineering problems are taken up in their broader aspects. That is, those questions are presented which should be decided before a more specific task can be allotted to the captain or lieutenant. The military situation has a greater bearing on these questions than in similar problems of the basic course. For example, in the company officers' course the student is confronted with the problem of planning stream crossings for a division on the offensive. Given the military situation and the mission of his division, he is required to decide what method shall be used in crossing the stream and where and when the crossing or crossings shall be made. This having been decided, a problem based upon this decision may be a proper one for the captain or lieutenant. Such a problem, for example, would require the junior officer to construct a bridge at a certain point to take a certain load and to be completed at a certain time. In this problem the student might be given information affecting the supply of tools, materials or personnel. He would then be required to make more or less detailed plans as to what he actually proposes to do. Such plans should be as much in detail as it is possible to make them, the amount of detail depending upon the accuracy of the information which is given him. The military situation is, however, not entirely eliminated from consideration in his problem.

The form of the problems in field engineering, which will be printed in these columns, will follow that in general use in the applicatory method of military instruction. A general situation will be outlined in order to give the student a general picture of the theater of operation and the particular place which he occupies in the general scheme. This will be followed by a special situation in which the part which he is to play is laid down. In this special situation the solutions to larger questions are given him; he is assigned a task and is given information as to the means available for accomplishment of the same. This is followed by the requirements of the problem, in which questions are propounded, the answers to which will indicate the student's ability to estimate the situation and to utilize the knowledge of his profession in making his decision. The questions thus propounded will pertain to one or more of the following factors which enter into the problem:

Types of construction,
Supply of tools and materials,
Personnel and proper organization of the same,
Time.

References to text-books and government publications will be given to be studied with each problem. Map references will usually be to the Camp Humphreys 1:5000 Map and the Mt. Vernon quadrangle, U. S. G. S., which will be furnished upon application to THE MILITARY ENGINEER.

The organizations with which the student will be concerned at present are the platoon and the company of divisional engineer troops and the infantry rifle company. For the benefit of those to whom the new tables of organization are not available, there are presented below organization charts in the forms which are in use at The Engineer School. A thorough understanding of these charts is essential before attempting the solution of any problems.

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Engineer Company (Combat)

War Strength—4 Officers, 106 Enlisted Men

Distribution of Personnel

Road space, 145 yards

Captain (h)

Headquarters
2d Lieut. (h)

Office
First Sergeant
1 Staff Sergeant
1 Supply Sergeant
2 Sergeants
2 Corporals
(1 Clerk)
1 Mail Orderly (pvt.)
2 Motorcyclists (pvts.)

Mess
1 Mess Sergeant
2 Cooks

Stables
1 Stable Sergeant (h)
1 Horseshoer (a)
3 Wagoners (pvts.)
1 Blacksmith (a)
3 Privates (d)

First Platoon
1st Lieut. (h)
1 Staff Sergeant
2 Sergeants
5 Corporals (b)
34 Privates (c)
Including 1 Bugler (Bicylist)
1 Wagoner (a)

Second Platoon
Same as First Platoon

(a) Privates with specialist ratings
(b) One in charge of platoon tool wagon
(c) One assistant to wagoner
(d) One acting saddler
(h) Mounted

Note:—The following specialist ratings are authorized for a company:

3d Class	4th Class	5th Class	6th Class
1 Blacksmith	2 Carpenters, bridge	1 Cook, assistant	1 Carpenter, mine
1 Carpenter, general	1 Cook, first	1 Demolition man	1 Demolition man
		1 Horseshoer	1 Draftsman
			2 Motorcyclists
			2 Wagoners

EQUIPMENT
With Office Detachment
2 Motorcycles, with side car
With Stable Detachment
1 Wagon—ration and baggage
1 Rolling kitchen
1 Water cart
With each Platoon
1 Tool Wagon
1 Bicycle
Arms for Company
21 Pistols
89 Rifles
4 Autorifles

Organization of Infantry Rifle Co. (War strength)

and

Notes on Organization of Machine Gun Co. of Infantry Battalion

Infantry Rifle Company
1 Captain
2 First Lieutenants
2 Second Lieutenants
200 Enlisted—including 8 privates, replacements

Captain in Command

Company Hdqrs. (1-21)
First Lieutenant
First Sergeant
Gas Sergeant
Mess Sergeant
Supply Sergeant
2 Corporals (1 clerk)
(1 agent)
2 Buglers (s)
4 Cooks (s)
2 Mechanics (s)
3 Shopmen (s)
4 Privates (r)

First Platoon (1-57)
Platoon Headquarters
First Lieutenant
1 Sergeant (p)
4 Privates (r)

First Section
1 Sergeant (l)
4 Corporals (g)
21 Privates (q)

Second Section
(same)

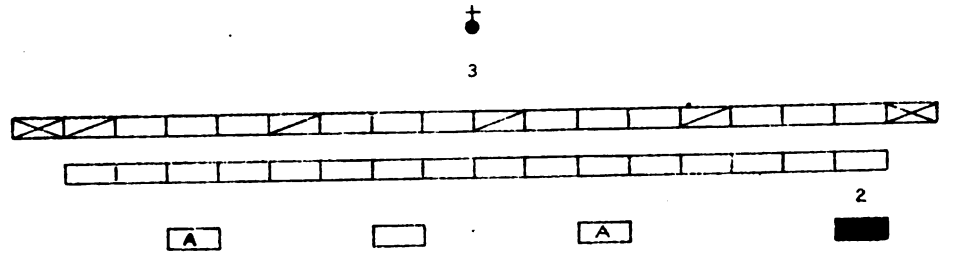
Second Platoon
Same as first, except second lieutenant

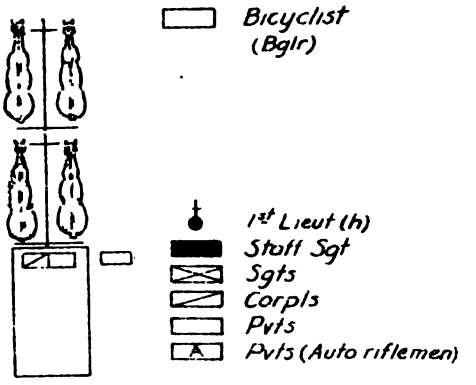
Third Platoon
Same as second

Notes:
(s) Privates and Privates First Class, several with specialists' ratings.
(r) Runners and agents.
(p) Platoon sergeant.
(l) Section leader.
(g) Includes 1 section guide and 3 squad leaders.
(q) Grouped, with 3 corporals, into 3 squads; one private in each squad armed with automatic rifle and one with grenade discharger.

For diagrams of formations of the platoon, see p. 48, Infantry Drill Regulations, 1919.
For formation of the squad, see p. 34, I. D. R.
The M. G. company (5-141) consists of 2 platoons, each of 2 sections. Each section has 2 machine guns, operating as a unit. Each gun is accompanied by a M. G. cart and an ammunition cart.

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EQUIPMENT IN TOOL WAGON

1 Set Carpenter Equipment, Field
1 Set Demolition Equipment, Field
1 Set Pioneer Equipment, Field
1 Sketching Outfit
(See Cir. 445, 1919 Notes 3, 5, 22 and 26)

The following table of engineer equipment is compiled from War Department Circular No. 445, and shows the distribution of the important items of engineer equipment with which the student is concerned in the solution of problems:

Engineer Equipment for Divisional Engineer Regiment

(Extracts from Circular 445 W. D., 1919.)

INDIVIDUAL EQUIPMENT

Compasses, Prismatic, illuminated	1 per Master Sgt., Technical Sgt. and Staff Sgt.
Knives, Clasp	1 per enlisted man.
Pliers, side cutting	1 per Corporal.
Rules, 4 foot, folding	1 per Sgt. and higher enlisted grade.
Tapes, 50 ft. metallic	1 per Master Sgt. and Technical Sgt.

PLATOON EQUIPMENT

(Carried in Platoon Tool Wagon)

CARPENTER

3 Augers, ship, 7-16 inch, 11-16 inch and 1¾ inch
1 Brace and bits
3 Chisels, cold and framing
9 Hammers, claw
6 Hatchets, broad
4 Rules, 2 ft.
6 Saws, hand
3 Squares, steel
3 Tapes, 50 ft.
Miscellaneous small tools and supplies.

DEMOLITION

2 Crimpers, cap
2 Drills, cordeau
1 Pliers
2 Slitters, cordeau
100 Caps, electric
50 Caps, non-electric
40 yds. Cord, detonating
100 lbs. explosive, T.N.T.
100 Fuse lighters
100 ft. fuse, Bickford
100 ft. fuse, instantaneous
6 boxes matches
Insulating tape and twine.

PIONEER

2 Adzes
1 Auger, earth
13 Axes
3 Bars, pinch
3 Blocks, 8 inch
14 ft. chain, ⅜ inch
3 Cutters, wire, ⅜ inch
3 Drills, stone
6 Machetes
3 Mattocks, pick
2 Mauls
17 Picks
9 Pliers
2 Saws, 2-man
31 Shovels
2 Sledges
7 Wrenches
40 Bolts, drift
14 Handles, pick, saw and sledge
5 lbs. Marline
110 lbs. Nails, wire, 60, 30, 10 and 8d
250 ft. rope, 1 inch
6 50-ft. lashings, ¾ inch
25 18-ft. lashings, ½ inch
1500 ft. Tracing tape
Miscellaneous small tools and supplies.
1 SKETCHING OUTFIT

COMPANY RESERVE EQUIPMENT

(Carried in 1½ ton truck with Headquarters and Service Co.)

CARPENTER

4 Augers, ship, 11-16 inch
5 Chisels, framing
16 Files
2 Planes
1 Draw knife
3 Saws, compass, keyhole and nail cutting
9 Handles, hatchet, chisel and hammer
4 Gross screws
Miscellaneous small tools and supplies.

DEMOLITION

2 Detectors, circuit
2 Exploders, magneto
2 Reels, wire, firing
200 Caps, non-electric
200 Caps, electric
160 yards cord, detonating
300 feet Bickford Fuse
2000 feet wire firing

PIONEER

4 Bars, pinch
2 Blocks, double 8 inch
15 Drills, stone
6 Hammers
4 Jacks, screw, 10 ton
4 Peavies
4 Sledges, 8 lb.
2 Wedges, 5 lb.
10 yards canvas
20 Handles, adze, axe, sledge and hammer
2 kegs nails, 60d and 10d
500 ft. rope, 1 inch
MACHINE BLACKSMITH'S TOOLS
DRAFTING
ILLUMINATING
OFFICE
PHOTOGRAPHIC
PIPEFITTING TOOLS
TINSMITH'S TOOLS
SIGN PAINTING

REGIMENTAL EQUIPMENT

(Carried in 1½ ton trucks with Headquarters and Service Co.)

DRAFTING
ELECTRIC LIGHTING SET
FOOT BRIDGE LAMPERT
MAP REPRODUCTION
Blue Print
Cyclostyle
Duplicator
Lithographic
PHOTOGRAPHIC
RECONNAISSANCE
SURVEYING
WATER SUPPLY
ILLUMINATING EQUIPMENT
OFFICE EQUIPMENT
SIGN PAINTING EQUIPMENT
TINSMITH'S EQUIPMENT

INFANTRY INTRENCHING EQUIPMENT

(One set for each infantry battalion in the division; carried in escort wagon with Headquarters and Service Company of Engineer Regiment)

26 Axes
4 Bars, pinch
9 Files
125 Mattocks, pick
1 Maul
26 Saws
250 Shovels
1 Tape, 50 feet
13 Handles, axe and pick
2 kegs nails, 10d and 40d
500 Sandbags
3000 ft. Tape, tracing

Problem No. 1

Military Bridges

Map Reference:

Mount Vernon Quadrangle, U.S.G.S.,
Northwest Section, Camp A. A. Humphreys, 1:5000.

General situation:

Occoquan Creek (Mt. Vernon Quadrangle) is the boundary between hostile states—Blue (south) and Red (north). A Blue army has crossed the boundary, encountering little opposition. The main body of this army has halted on the line of Accotink Creek; its advance guards hold the line, Mt. Vernon-Franconia-Springfield; its advance cavalry is in contact with the Red cavalry along Four Mile Run. The time is early summer; heavy spring rains have passed and the main roads are in good condition.

Special situation:

You command a company of the 1st Engineers, 1st Blue Division. This division has marched on the Occoquan-Pohick road. Your company reached Pohick at 6 P. M.

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At this place your colonel (the Division Engineer) gives you the following oral instructions:

"Tomorrow this division is going to advance along the Telegraph Road.

"The bridge over Accotink Creek on the Telegraph Road has been destroyed. I want you to take your company and build a one-way bridge over Accotink Creek, at the site of the old bridge, to carry 1½ ton trucks. This bridge must be ready for use by 6 P. M. tomorrow.

"Yellow pine timbers of the following sizes are available at Woodbridge: 8×8 inch, 6×8 inch, 6×6 inch, 4×8 inch. 2×8 inch and 2×4 inch, all in lengths up to 24 feet. There are also drift-bolts, spikes and nails in various sizes. If you let me have a requisition by 8 o'clock this evening I can have the material delivered on the Standard Gauge Railroad where it crosses the Telegraph Road at 9 o'clock tomorrow morning."

You direct your senior lieutenant to march the company to the site of the bridge. You go ahead in a side car and make a reconnaissance of the bridge site and the stream in the immediate vicinity. This reconnaissance discloses the following: The stream at this point has a velocity of about 3 feet per second; the stream bed is about 6 inches of sand and clay over-lying gravel; the maximum depth of stream (midstream) is 3 feet, freshets may raise this to 6 feet; the width from shore line to shore line at the bridge site is 35 feet; the abutments of the former bridge are of stone masonry and in good condition; the clear span from abutment to abutment is 45 feet, the height of the abutments is 10 feet above the surface of the water; from the bottom of the abutments the ground slopes uniformly down to the bed of the stream; there is a good ford for animal transportation just east of the bridge site; the wreckage of the former bridge is lying in the stream between abutments; this bridge was a steel truss (Pratt type), it was destroyed by cutting the lower chords with explosives; there is very little timber suitable for bridging in the vicinity.

Required:

(1) Your decision as to the type of bridge you will build.

(2) Dimensioned sketches showing side elevation and cross-section of bridge.

(3) The organization of your company into working parties.

(4) A working schedule showing the estimated time of completion.

(5) A list of tools and materials required, showing where you propose to obtain the same.

(6) Measures adopted for security.

Note.—In the preparation of this problem the following texts are given for study and reference:

Engineer Field Notes, A.E.F., Nos. 4, 7, 8, 10, 48 and 52.
Engineer Field Manual, Part II.

Map Reading

As the ability to properly read a map is essential to the solution of many problems in military art and military engineering, there is given below a map reading exercise. This subject is a highly important one in the training of an officer, so that a study of the questions presented below cannot be too strongly urged. The questions given refer to the Taneytown sheet of the Gettysburg map which is one of the sheets which the reader will require for the problem in Minor Tactics which appears in this issue. The answers to these questions will appear in the next issue of THE MILITARY ENGINEER.

1. (a) What is the scale of the Taneytown sheet expressed in inches to the mile?

(b) What do the various divisions mean on the scale underneath the letters "M. D." at the bottom of that sheet?

2. (a) What is the true azimuth and distance of Centennial School House from cross-roads 533 at Koon?

(b) What is the magnetic azimuth of this line?

(c) What is the magnetic bearing of this line?

3. (a) In marching along the main road from Taneytown through Bridgeport to the extreme western boundary of the sheet, what is the highest elevation encountered.

(b) What is the lowest elevation?

(c) What is the steepest ascending grade encountered expressed in degrees? Where does this occur?

(d) What and where is the steepest descending grade?

4. A sketcher is sent out to map the country to the east of Bridgeport on a scale of 1:10,000. In making his sketch he uses a scale of strides based upon the assumption that the length of one of his strides is 70 inches. On the map which he makes the distance from cross roads 472 at Alexander to crossroads 476, about 650 yards east of Boyd, measures 10 inches. What length of stride did he actually use? What is the true R. F. of his map?

5. A mounted sketcher made a road sketch of the country in the vicinity of Bridgeport on a scale of 1:20,000. The rate of his horse was supposed to be six miles per hour and on this supposition his working scale was constructed to show minutes and half-minutes of travel. On the map which he makes, the distance from cross roads 472 at Alexander to cross-roads 476 about 650 yards east of Boyd measures 6 inches. What was the rate of his horse? What is the true R. F. of his map?

6. An observer is lying down on hill 547 about 850 yards west of Koon. An enemy patrol has reached the point where Allaway Creek crosses the road running eastward from Koon and is continuing its advance westward along this road. At what point will the head of this patrol be visible to the observer? Disregard obstructions to the line of sight by trees and houses.

7. Will an observer lying down on hill 452 about one-half mile south of Clear Ridge Farm be able to observe the ford over the Monocacy at Pinehill Mill. Disregard obstructions as in question 6.

8. (a) A machine gun occupies a position at the farm house of Mountain View Farm. Will it be able to employ direct fire on the bridge over the Monocacy at Bridgeport?

(b) Can it cover the cross-roads at 472 at Alexander by direct fire?

(c) If this gun is ordered to cover the bridge over the Monocacy northwest of Mountain View Farm, by direct fire, will it be necessary to move the gun? If so, at what point east of the Monocacy would you locate it? Assume maximum effective range of gun to be 1500 yards.

General Subjects, Note 2

An Approved Solution of Test on Military Administration

(See Page 4, Military Instruction, Vol. XIII, No. 69)

By Maj. C. C. Gee, C. E.

(References are to U. S. Army Regulations 1913)

Question number	Reference paragraph	Answer
1	271 (C.A.R.72)	(a) By regimental commander upon the recommendation of the company commander.

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Question number	Reference paragraph	Answer
		(b) By the unit commander with the approval of the next higher tactical commander.
2	276	(1) By sentence of a court-martial.
		(2) On recommendation of company commander, by the order of the commander having final authority to appoint such non-commissioned officer.
3	317	(a) All officers present for duty with company.
	316	(b) To audit the company fund; to ascertain and examine the sources from which and methods by which the fund has accrued; and to recommend expenditures from the fund.
4	355	A roster is a list of officers or men for duty, with a record of the duty performed by each.
5	387	(a) Return his salute.
		(b) Call company to attention and salute.
		(c) Call company to attention and return the lieutenant's salute.
6	922	(a) An officer is placed in arrest by his commanding officer in person or through another officer, by a verbal or written order or communication, advising him that he is placed in arrest, or will consider himself in arrest, or words to that effect.
	923	(b) He should repair at once to his tent or quarters, and there remain until more extended limits have been granted by his commanding officer.
	933	(c) The gravity of the offense charged, and the known character of the accused, indicating the probability of an attempt to escape.
7	1493	The duties of the Corps of Engineers comprise reconnoitering and surveying for military purposes, including the laying out of camps; the preparation of military maps of the United States and its possessions, including co-operation with other Government and private mapping agencies, and in field operations, of maps of the theater of operations; selection of sites and formation of plans and estimates for military defenses; construction and repair of fortifications and their accessories; the supervision of the location of all buildings in or within one mile of any fortification; the installation of electric power plants and electric power cable connected with seacoast batteries, and furnishing the necessary electrical supplies connected therewith; planning and superintending of defensive or offensive works of troops in the field; examination of routes of communications for supplies and for military movements; construction and repair of military roads, railroads and bridges; military demolitions; execution of river and harbor improvements; construction and repair of military roads, railroads and bridges; military demolitions; execution of river and harbor improvements assigned to it; and such other duties as the President or Congress may order. It collects, arranges and preserves all correspondence, reports, memoirs, estimates, plans, drawings, such deeds and titles as relate to the Washington Aqueduct and public buildings and grounds in the District of Columbia, and models which concern or relate in any wise to the several duties above enumerated. In time of actual or threatened hostilities, within the theater of operations, it has charge of the location, design, and construction of wharves, piers, landings, storehouses, hospitals, and other structures of general interest; and of the construction, maintenance and repair of roads, ferries, bridges and incidental structures; and of the construction, maintenance and operation of railroads under military control, including the construction and operation of armored trains.

An Approved Solution of Test on Military Law

(See Page 4, Military Instruction, Vol. XIII, No. 69)

By Maj. P. C. Bullard, C. E.

(References are to "A Manual for Courts-Martial, 1921")

Question number	Reference paragraph	Answer
1	2	1. Military government.
		2. Martial law at home.
		3. Military law.
2	7	(a) Not less than 5
		(b) Not less than 3
		(c) One.
3	44	(a) Not over 1 month
		(b) Not over 3 months
		(c) and (d) Not over two-thirds of one month's pay.
4	63	Any person subject to military law.
5	71	No
6	78	When the officer exercising General Court-Martial jurisdiction so or-

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Question number	Reference paragraph	Answer
		ders (limitations as to punishments and persons triable not being affected).
7	89, 89a	Challenges for cause, Findings, Sentence: By the closed court only Admissibility of evidence: By the law member only. All other questions: By the law member subject to objection by member of the court. In case of objection by the closed court.
8	90a	(a) Two-thirds (b) All (c) Two-thirds (Note: conviction, not sentence) (d) Two-thirds (e) Three-fourths
9	120, 120a	A peremptory challenge is one which causes the removal of a member of the court without cause stated.
10	145	1. Plea to the jurisdiction 2. Plea in abatement 3. Plea in bar of trial 4. Plea to the general issue.
11	159	Trial judge advocate.
12	168 and App. 20	A warrant of attachment is an order to a proper official to bring to court a witness who has refused to obey a subpœna.
13	158c	When the prosecution rests.

Questions on Infantry Drill Regulations

(Reference—Infantry Drill Regulations, 1919, pars. 101-296)

No.	Wt.	Question.
1	12	How are the members of a squad armed? How are they arranged?
2	10	Show by diagram how the squad is arranged when deployed alone. When deployed as part of a larger unit?
3	4	What is the normal interval between skirmishers?
4	12	The squad being in line, by what commands does it turn on a fixed pivot? Describe in detail the execution of the movement.
5	12	The platoon being in column of squads, by what commands does it form line of sections to the front? Describe the movement.
6	15	The platoon being in column of squads, by what commands does it deploy as skirmishers? Describe in detail the movement.
7	5	Where are the platoon runners when the platoon is deployed when acting alone?
8	12	The platoon being in line of sections, by what commands does it change direction? Describe the movement.
9	10	What is a section column? What is its interior arrangement?
10	8	The company being in column of platoons, by what commands does it form line of platoons to the right?

Questions on Military Law

(Chapters XI-XVI, Manual for Courts-Martial, 1921)

No.	Wt.	Question.
1	6	Where are the rules found which are binding on Courts-Martial as to admissibility of evidence?
2	8	In each of the following cases, state whether the witness should be disqualified from testifying, on the grounds given: a. Witness owes money to accused. b. Witness has been convicted of embezzlement by a civil court. c. Witness is father of accused. d. Witness called by defense in case of desertion is wife of accused.
3	8	In the trial of Private A for desertion, testimony was given as follows. State in each case whether the testimony should be admitted: a. Capt. B testifies that Pvt. A has been previously convicted of disrespect to a non-commissioned officer. b. Sgt. C testified, "Capt. B told me he saw Pvt. A in Washington." c. Pvt. D testifies that Pvt. A told him, just before he (Pvt. A) left the company, that he was going to see his sick mother and would come back when she was well. d. Sgt. E testifies that Cpl. F (now deceased) told him that he (Cpl. F) saw Pvt. A in Baltimore in civilian clothes during the alleged desertion.
4	6	What two facts must the prosecution prove as to the identity of accused?
5	8	Name three cases in which leading questions can be asked when questioning a witness.
6	4	During a trial, the Trial Judge Advocate states to the court: "I wish to offer in evidence an affidavit executed by the accused in my presence after I had warned him that anything he might say might be used against him." Should this affidavit be admitted in evidence?
7	9	When is a copy admissible in evidence instead of the original document?
8	8	Name the ways in which the accused can get before the court his personal account of the actions for which he is being tried.
9	5	What is meant by judicial notice?
10	6	It is proven in a trial for murder that the accused was drunk at the time he committed the crime. How may this affect the findings of the court?
11	7	A soldier having five previous convictions is to be tried for violation of A.W. 63 (maximum punishment under Executive order, 6 months' confinement at hard labor and forfeiture of two-thirds pay for 6 months). By what court should he be tried, and what is the maximum punishment that can be adjudged on conviction?
12	5	How does the Trial Judge Advocate dispose of the original record of a trial by a general court?
13	8	Describe the method of voting by members of the court on the findings.
14	6	What action may the reviewing authority take on a sentence which is in excess of the legal limit, there being no other errors in the trial?
15	6	On what date does a sentence of confinement begin?

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Military Art, Note 2

MAP PROBLEM NO. 1. A Solution.

The following is a solution of Map Problem No. 1, which was published in the May-June issue of THE MILITARY ENGINEER, page 303.

First Requirement:

Mission.

Captain A's mission is to march his company to Taneytown on the 4th instant, arriving at the school house not later than 11 A. M.

Enemy.

The Red infantry battalion at Gettysburg is too far from Captain A's line of march to affect his mission. The same is true of the troop at Emmitsburg, so long as it remains there. The reports of the Red patrols at Bridgeport and Harney would seem to indicate that this troop is sending small detachments to reconnoiter; there are probably other patrols on the road, which have not been reported to the Blues. It is possible that Captain A may encounter one of them to-morrow, but he believes that it can hardly be of sufficient strength to interfere seriously with his march.

Our Own Forces.

The Blue forces at Littlestown and Taneytown are, roughly speaking, between Captain A and the enemy. In the improbable event that the Red troop at Emmitsburg, or what is left of it after deducting the patrols, should advance on Taneytown, Major M's command will be between Captain A and the enemy. Otherwise his supporting troops do not affect Captain A's mission.

Plans of Action.

In view of the definite orders which he has received, Captain A's plans of action are reduced to selecting his route of march, the time of leaving camp and his march formation.

Captain A has no choice of routes until he reaches the road-fork one-half mile west of the Green Valley school house (elevation 496). From there he may go by a northern route, starting northwest and approaching Taneytown by the Taneytown-Kingsdale road; or he may go by a southern route, starting southwest and approaching Taneytown by the Taneytown-Stumptown road. Both routes must at some time cross the range of hills running northeast from Stumptown. A closer examination of the map, however, shows that the southern route, which follows Silver Run and Big Pipe Creek to Stumptown and crosses those streams or other tributaries five times, has appreciably more up and down grades than the northern route. In view of the state of the weather, considerably more mud is likewise liable to be encountered. The northern route (496-625-626-546-545-509-469-Taneytown) is only eight miles long, against 9 miles for the southern route (496-Big Pipe Creek Mill-466-467-488-Zimmerman Mill-Stumptown-Taneytown). From the standpoint of ease of marching the northern route is to be preferred.

On the other hand, for the last mile and a half, the northern route lies close to the possible theater of operations of the Red patrols. Captain A, however, does not believe these patrols can interfere with his march seriously and, since he feels sure of defeating them with ease, he would not much object to meeting one, because a successful brush with the enemy at the outset would tend to raise the morale of his troops. He therefore selects the northern route.

Captain A has 8 miles to march—

2½ miles	50 minutes
(Halt)	15
2½ miles	50
(Halt)	10
2½ miles	50
(Halt)	10
½ mile	10
8 miles	195 or 3 hours, 15 minutes

If he starts the march at 7:00 A. M. he should reach Taneytown at 10:15 A. M., thus allowing a margin of safety of 45 minutes, or more than 25 per cent of his actual marching time, which he considers ample. Since reveille is now set for 5:30 A. M., a start at 7:00 A. M. will give an hour and a half in which to get ready for the march, without changing the hour of reveille. Captain A therefore decides to begin the march at 7:00 A. M.

Captain A considers that a section would probably be sufficient for his advance guard, but in order to avoid splitting tactical units and to provide flank march outposts at points on the road where the line of march makes sharp changes of direction, he decides to use a platoon.

Decision.

To march by the Green Valley SH-496-626-626-546-545-509-469-Taneytown road; to place one platoon in the advance guard and to take up the march at 7:00 A. M.

Second Requirement: Captain A's orders.

(NOTE.—Since Captain A's company has been in its present location for three days it is reasonable to assume that he has previously considered the possible routes to Taneytown.)

(a) At 10:40 P. M., to the orderly who brought in the motorcycle messenger: "Tell Lt. B. (the Officer of the Day) that I should like to see him here at once."

(b) At 10:45 P. M., to Lt. B., "The Reds declared war late this afternoon. This company will march to Taneytown to-morrow, starting about an hour after reveille. I want all the company officers to assemble in my tent with their maps at breakfast call tomorrow morning. Please inform the other lieutenants."

(c) See 3rd Requirement.

(d) At 5:45 A. M. on the 4th, the officers having assembled in his tent, Captain A spreads out his map on his folding table and dictates the following verbal order:

"The Reds declared war late yesterday afternoon. According to our secret service, they have one battalion of infantry at Gettysburg and about one hundred cavalry at Emmitsburg (points out these towns). Civilians say that Red mounted patrols, of ten to fifteen men, were at Bridgeport and Harney yesterday afternoon. (Points out these towns.)

"Our troops at Littlestown and Taneytown are ordered to remain in their present localities.

"This company will march to Taneytown this morning; it will form at 6:45 A. M., in the normal formation and at the usual place.

"Lt. C., your platoon (the 3rd) will form the advance guard and will precede the main body by 200 yards. Follow this route. (Indicates on map the route stated in Decision, above.)

"The main body will march in the order: First Sergeant and Company Runners, 2nd platoon, 1st platoon.

"The Company wagons, escorted by the Company Head-

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quarters Section (less First Sergeant and Runners), will follow the main body without distance.

"I shall ride at the head of the main body."

(e) The Company having formed as ordered; at 6:50 A. M. Captain A says to Lt. C:

"Take up your advance guard formation on the road and signal me when you are ready to start."

To Lt. E (commanding Co. Hdqrs.): "Make your dispositions for escorting the train and take up your formation as we move out."

Upon receiving Lt. C's signal, Captain A signals to the Company, "Forward, *March.*"

He waits for the entire company to march past him and then rides forward to his place at the head of the main body.

Third Requirement: Captain A's message.

SILVER RUN, 3rd June, ——, 10:50 P. M.
C. O. 1st Bn. 1st Inf.,
TANEYTOWN.

Reference your message of 9:45 P. M. this date; I expect to reach TANEYTOWN about 10:30 A. M., tomorrow the 4th, arriving by the KINGSDALE-TANEYTOWN road.

A,
Capt. 1st Inf."

The above message is sent by the motorcyclist who brought Major M's message.

MAP PROBLEM No. 2. Patrolling.

Maps—
Gettysburg General Map
Gettysburg 3-inch Map, Gettysburg, Taneytown and Emmitsburg sheets.

General Situation:

This problem is a continuation of Map Problem No. 1, which was published in THE MILITARY ENGINEER, Vol. XIII, No. 69, May-June, 1921, pages 302, 303.

Special Situation:

Same as Special Situation for Map Problem No. 1, with following additions:

At 10:00 P. M., June 3rd, Major M, commanding 1st Bn. 1st Blue Infantry at Taneytown, receives the following telephone message from his regimental commander at Littlestown:

"The Reds appear to be prompt with their reconnaissance. It is rumored here that an infantry detachment, about a platoon in strength, left Gettysburg this afternoon, marching by the Baltimore Pike. My outpost, at the southwestern exit of Littlestown, drove off a Red mounted patrol at 8:00 P. M. today.

"I am sending patrols to my front tomorrow. The most southern one, containing six mounted men, is ordered to go to Koon's place, about two miles northeast of Harney.

"Tomorrow, the 4th, I want you to send out the necessary forces to keep the general area Koon's-Harney-Bridgeport-Stull house (on the Monocacy, about two miles southwest of Bridgeport)-Taneytown-Longville-Koon's under observation. Withdraw all your detachments to Taneytown by dark.

"Inform me promptly of the definite presence of the enemy in this area."

Major M has secured eight saddle horses, with the necessary riding equipment and has improvised a mounted detachment under command of 1st Lieut. L. Major M has also obtained three motorcycles, with sidecars.

The battalion is camped in the square northwest of the school house. (The exact location of the outpost line is not needed for the solution of this problem.)

Required:

(1) What forces does Major M send out to comply with his Colonel's orders? Give brief reasons for decision.

(2) Give Major M's orders for the commanders of his patrols and detachments, if any. Indicate the time and method of issue, and use Major M's exact words.

References:

The following references, in addition to those listed at the end of Map Problem No. 1 (see MILITARY ENGINEER for May-June, 1921, page 303) should be studied in connection with the above problem:

Technique of Modern Tactics, Chapter III.
Field Service Regulations, Pars. 9-36, inc.

"God grants liberty only to those who love it, and are always ready to guard and defend it."—*Daniel Webster*

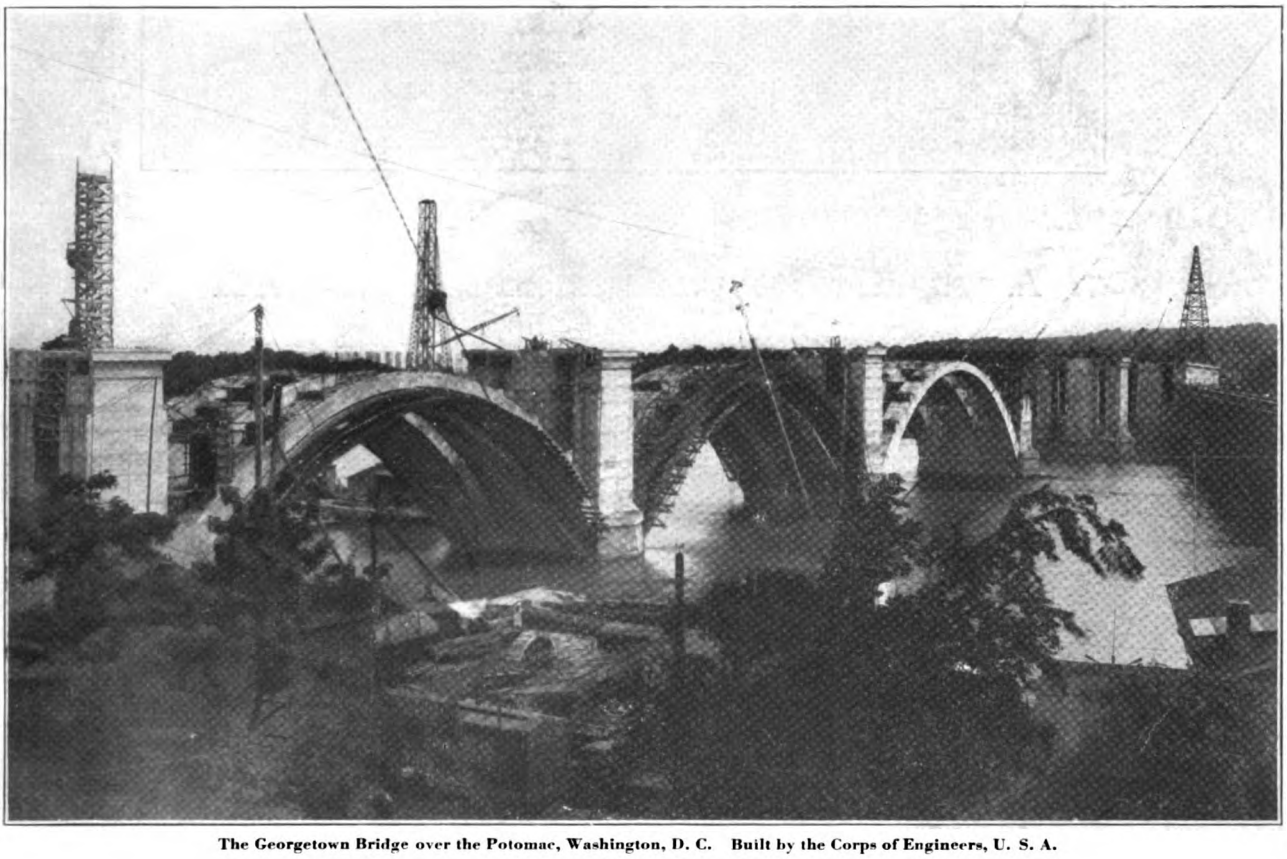
"We may well pause for a few minutes over the history of our own country. Its lessons, unfortunately, are little understood. Every generation has been called upon to fight, every generation has neglected preliminary training, and the fact that all our wars have been ultimately won often obscures the real lessons of our past conflicts and renders it imperative that they be taught and understood."—*Sidney Ballou.*

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The Military Engineer



The Georgetown Bridge over the Potomac, Washington, D. C. Built by the Corps of Engineers, U. S. A.

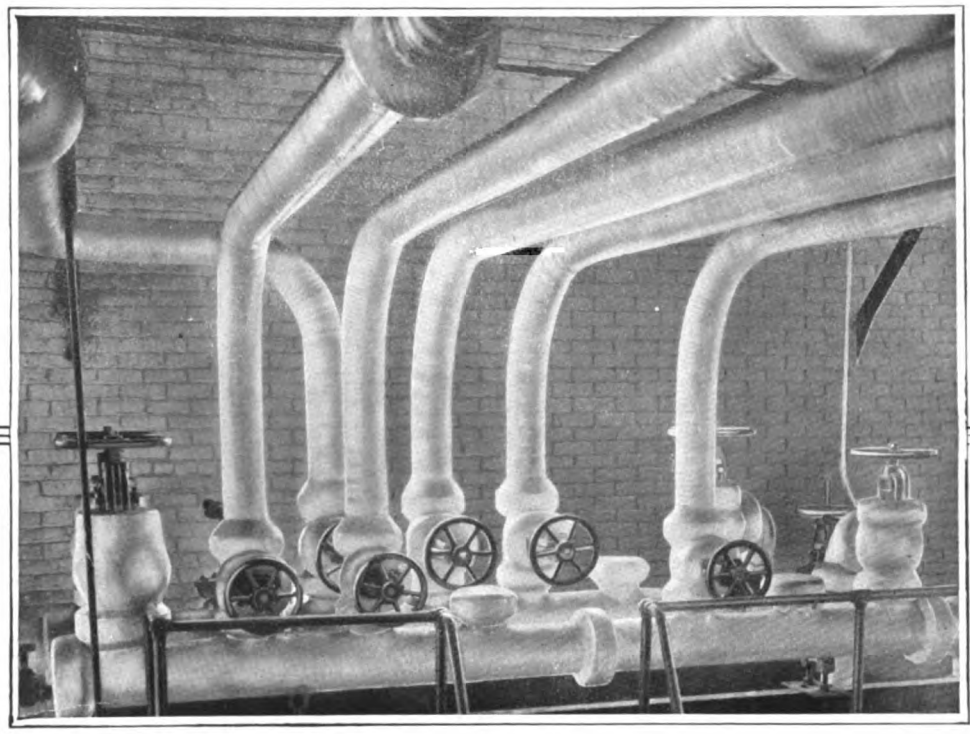
Training An Engineer Regiment

Chicago's Harbor Problem

The Battle of Cantigny

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The Battle of Cantigny

As seen by one who was there

By

Boleslaw Suchocki

Formerly Sergeant, 1st Engineers, First Division, A. E. F.

[*Note.* Intimate accounts of their personal experiences by those who participated in the World War are not only of great interest at the present time, but unless they are recorded now they will be lost to future generations. It is for this reason that the editor has made repeated appeals for such experiences.

The following account was furnished by a former officer of the First Engineers. It was written by Sergeant Suchocki within a few days after the capture of Cantigny, which was the first offensive operation of any importance in which American troops participated. Coming at a time when the great German offensives of 1918 were at their height, Cantigny on May 28, 1918, was the one bright spot on three hundred miles of Allied front. It gave promise of the great power of the new army which was so soon to turn the tide of battle. The little town was captured by the 28th Infantry; Company D, 1st Engineers, of which Sergeant Suchocki was a member, took part in the attack as infantry. May 28, 1918, was a red-letter day in American history.

The author of this article, a Pole, and a cabinet-maker by trade, was neither an experienced soldier nor an experienced writer. Yet as a soldier he fought for his adopted country with a courage and skill that stamp him as a natural leader of men, and as a writer he has given us a graphic account, a "close-up," of battle that no war correspondent could hope to equal unless he had himself gone over the top with the first wave of the assault.

The account is reproduced as Sergeant Suchocki wrote it. Efforts to improve it would be futile.—Ed.]

Cantigny, May 28th, 1918.

The First Part

The Night Before the Battle of Cantigny.

THAT afternoon Lieutenant Jones assemble all non-commissioned officers of his command for the necessary instructions, which were a very useful for the operations of Cantigny for the next morning.

First he announced to the boys, after they all gather together at the woods were we camp, southeast of Tartigny. "Company D, 1st Regiment Engineers is elected to go 'Over the Top' to-morrow morning," he said, "and I want you boys to understand fully the part of our work which got to be done in Cantigny. Here is a map and I will explain to you the location of our position. We will go with Doughboys in the front line. There won't be a very far for us to go, only about 350 yards beyond the cemetarium, where a single house of some kind is standing, and from the leading road to the cemetarium the First Section will dig a trench to the house for the infantry, with connecting some shell holes for strong points, than when we complet the trench the infantry will drop back, take the position in, and we will probable be send to the back to the rear. but remamber these few points men, if I get bumpt off or any of us, so the rest will know where they are and what they ought to do."

The afternoon passed by very busy, the boys have been telling stories, singing and joking, also prapaire themselves for the unknown future.

The country around Cantigny we practicly knew very well, first our work was barb wire entanglements for two weeks, for four weeks trenches and dugouts and for last two weeks it was night work in the vicinity of Cantigny, though we work there at night but it was a plane view of the village and the death Vally (as generally was called) the leading Valley to the village, was also well knowen to us.

The evening was slowly approaching, the bright golden sun was sinking beyond the far dimmy hills, the men have been anxiously waiting for the wonderful night.

Supper time came, right after the supper evrybody was ready to go, but still it was to light for the expedition, the Company Commander, Captain Smith, ordered to wait until complet dark.

The Company was formed at the edge of the woods waiting for the convinient time and signal to go.

The evening was remarkable, the silvery moon rose up in horizon with a full smiling face, the night was very quite, could hear a fly buzing in the air, only now and then a heavy roar of a cannon bruke out the silence.

During the waiting time the boys start to bit good bye to each another, and jokes of all kinds broke out, they-ve been joking and laughing until the order came out to go.

Here we are! A single file strachet out about mile long across the field, there was a grave silence amongs the men, just in full step going ahead through well known trail to us, the camp was left far behind, there was no whisper of any kind, just now and then some of the men turned their heads towards the camp, look just like they left it for ever.

We slowly approach to the death Vally and enter it, without of any disturbans came to the quarry that was the place where we intend to wait until the next morning.

The quarry was large enough for about two companies, the southern wall gave us a good protection from enemy artillery shells, it was about 30 feet high and steep bank of solid rock containing a temporery first aid station, also two dugouts, it was quite save shalter for the men to take rest before the time to go over the top.

Nobody there expected any ceriouse danger that night in the quarry, but Ales! appear different shortly after.

The boys took their packs off and equipment, lay it besides them where they seat or lay, some lite cigaretts and smoke, some went to sleep. I capt my pack on and rifle in my hand seating down about in the center of the quarry, the time seemes to me was very long, I felt tired from seating down, get up and cemmencet to walk in the empty spays of the quarry, thought what will come next?

While I was walking, 1st Sgt. Hastings stoped me and said, "Suchocki, why don't you take your pack off, and make yourself easy while you have the time for, there is a big job for us to do to-morrow so take rest all you can to-night."

Sgt. Haistings was quite right so I di'nt wait for repeat. I stop right at the entrance on the leading road to the quarry.

The right side of the road as you go in to the quarry was a high bank about three or four feet high, where three officers been sitting, and on the left side of the road there was of some kind dugout and big chunks of rocks been piled about six or seven feet high, so I thought that will be the best for me to lay my pack and equipment on the lower of

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the right side of the road, just simply to keep it seperat from the rest in case of mixed up.

I took my pack off, lay it on the bank, rifle and carteladge belt lay on top of it, stood there for a while leasten to the officers which were right in front of me carry on very interesting conversation. There was Lieut. Jones, Crawfford and several other officers, about four feet away from where I've had my pack layd.

Then I look a round there was very quite. German shells never fell near the quarry from the time we've came there, only airoplane turned my attention which was sailing around the quarry over our heads for about half an hour, then I saw some the boys seating near the high wall smoking cigarettes, well I've said to myself, I di'nt smoke tonight yet, so about the time for me to have it, I took a cigarettes out of my pocket, walk to the first man and light it from his cigarette, sead down besides him and start to talk about the time that is so long.

At that time we've hear a shell was coming from the German side, we were of course accostumed to such and sound and di'nt pay much attention to it, but there was worst than we expected, the shell of a heavy caliber land a bout fifteen feet from quarry on the road, and burst with a thunderous roar, the fragments of the bursting projectile been carry away up in the air, with bozzing sound as a sworm of beas.

The boys that seat jumpet up to their feet and those that slept been a waiked. I've raised from my seating position, also there become a slight tumult, I walk to my pack and put it on, before some one else will take it, I told the boys that it is no use to run a round because we don't know where the next shell will fall, will be much better to remain where we are, so they quite down for a moment.

I've stood at the same place fixing my pack, my rifle was still laing on the bank where I've had my pack laid. Some the officers walk away from their previous locations, but Lieut. Jones, Crawford and enother Lieut. remain at their former places. I've also had mind to go look for safer position but it was to late.

At that time enother shell (or three of them together) have been coming down, there was no time to thing very long about, but I laid down flat on the road right where I been standing, every body else have doen the same thing.

At once! a tremendeuse explosion shooked the air, the quarry was filled with thick dust, blood and terrible sight. some the men been toren in to pieces.

The shells fell direct in the quarry struke solid rock di'nt buried themselves in the soft ground as usely was. but exploded on top the rock, and cause awfell damedge to the men that were in the quarry.

I get up and look around all the stars I saw while laing down disappeared, but my neck and right side of my face was numb. What was happened? I've asked myself, I've placed hand on the neck and felt it, it was hot as fire and little bliding. Oh! that i'st so bad I wisper to myself.

First I've cast my sight where the officers been sitting. Ales; what I saw; there was a small howle in the rock and a round it nothing but a mass of human bodies. I've ran to the first aid station but there was crowded impossible to come near to the place where the streachers been piled at that time several voices holled for the streachers finely one of them was passed to us, the boys ran with haist, first was picked Lieut. Crawford, they brought him near to the first aid station and laid on the rocks. Lieut. Jones was brought afterwards, and the third Lieut. I don't know his name had one of his legs cut and face.

I've come to Lieut. Crawford again to put him back on the streachers I call for help but in the excitement nobody hear me, so a fellow was standing right behind me, I hollerd at him (without of recognize who he was) why do'nt you help me to put Lieut. Crawford on the streacher. "I ca'nt." he answered, "I'm wounded myself, am waiting for the first aid." I raised my head and saw Corporal Gordon. His neck was covered with blood, I tolled him to wait a moment I will give you the first aid, as soon as I lay Lieut. Crawford on the streachers.

I try to put him on the streachers alone, but as soon I put my arms under his shoulder there was no bowns at all, it was soft as a pillow, so in the meantime LaMagdelaine came, and we both laide him on the streacher again, when I was bend low over his body, I jest hear a deep sigh, that was the last signe of his life. LaMagdelaine and another man carry him to the first aid station, but Lieut. Crawford di'nt need a doctor any more, his quiet soul was between the body and the future.

I turned to Copl. Gordon perceived that he still was waiting for the first aid, I've asked him if he's got first aid package he answer me that he hasn't, "I don't know where any parts of my equipment are, use your own package." I thought to myself, I might need it for my owne use soon, so I took off of some another field-belt first aid package, wrapped his neck and the head as well as I could.

I was also slightly wounded too, but it was nothing to compare with the others, there were about 23 men when to the Hospital besides thoes that died right at the quarry, two Lieuts and a few inlisted men. McDougall, Patterson and also some Frenchmen was torn in to pieces and several others.

What ever we've doen there, it was doen in a hurry, one of them Officers hollerd to the men "Get out from this place before a nother sheel will burst here." We started to look for better and safer place, every one of us suite himself, and all the boys mooved out from quarry no time, the safest place was on the steep hill side of the death Val'y, we located ourselves right there temporarily because the day brake jest started.

In the dimmy light early in the morning we could see each other moch better, and also the visinity of our station, though the German artillery fire was very heavy, G. I. Cans and shrapnels been falling insecently all a lone the vally, in spite of the grave danger that was a round us, we start to talk and jocking again.

Sgt. 1st Class Thoete, the section leader said, "why do'nt they let us go over the top instead waiting so long. I am wounded but I can stand it, for today yet, and am ready to go." So the medical man came, he asked him "Say can you paint my back with iodine," "yes," the first aid man replied. He rubbed his back well with iodine, there was several bad cuts on his back and in some parts of his back been sunked chunkes of the shell.

After then he finished operate on Thoete I asked the Doctor if he will paint my neck also, "sortainly" the Doctor said. He looked at my neck and said, your neck and the ear are very bad bruised, so Thoete said "Suchocki, you better go to Hospital," "why don't you go," I said, "you are worse woundede than I am and you refuse to go when 1st Sgt. Hastings called you to go to Hospital." "Oh! no, I am ready to go over the top today and I will stay here as long as they gone keep me."

The Second Part

The Barrage.

The American artillery of the 1st Division with some French help, open up the fire stronger and stronger, there was many different sounds penetrating the air from different sizes of guns, the echoes was almost continental and became more louder than ever, and from the enemy side also have been puring hundreds of shells on the heights of Cantigny and into the death Vally, where the

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most convenient passage was only for the transportation of our troops and supplies.

Wounded soldiers have been carried one after another to the first aid station, we laid right at the steep slope of the hill, no shell fell amongst us that time, but at the base of the hill the earth was turned from its natural bed over and over.

Copl. Gordon become very ill from his wounds and another man fainted from gas faction we had to carry them to first aid station, that was also interesting.

The time was coming near, the barrage of the 1st Division was in full live, also trench mottors open its fire, with more like theatrical play, it was similar jest as a famious jugler was jugling a dozen balls with one hand, but each of thoes balls fall, cause death and distruction for the enemy.

The air was full of whistling, roaring, and exploding echoes, jest like a pitty tempest was passing through the peacefull forrest, with its open mouth devouring everything that dare to stand against it.

It's time, for Capt. Smith assemble all his men, and instructed section leaders for the necessary action, also announced with deep sorrow of his heart, "we lost and lost heavy, some our losses never can be replaced."

Sgt. Thoete was not there at that time so Sgt. Kelly took his place, he received an order to send two men with the doughboys to laid out a line for trenches, the plan was changed, we had to do all different now. Sgt. Kelly called me, "Corpl Suchocki and Nickolas you both will go with Lieut. and stay with him until you get the order to come back." "Yes sir," I said. I and Nickolas we took two spools of tape with us and some hooks to pin it to the ground, and start off with Lieut. We walk to the very top of the hill the Lieut. went in to a small dugout, I asked him if there is room enough for two more men, "No" he said, of course the small dugout was full all ready.

We've had fifteen more minuts to wait before to go over the top, we laid down in the lowest spot that we could find aroun the dugout, and wait. German shells been falling very heavy but the bushes protected us from fragments and injories.

The tanks been comming with some kind groumbling noise, one tank was hurt with shell and stop right on the spot, the others passed him around and went by. Time was ripe and everything was ready for Lieut. came out the dugout told us, "Let us go."

Part Three

"Over the Top."

The great theatrical play start on the wide planes of Cantigny, thoes men that were in the reserve trenches been already in skirmish line approaching the fearful village of Cantigny, but these men from the vally been coming by squads in a single file, as soon as they reach the plane field they deploy themselves in to a skirmish line too, and formed as one waiving onbrokable chain with heads up and smiles on their faces, approaching the first and biggest battle that the 1st Division ever pulled off.

A little ways behind there was another waive coming, and another behind the second all the men were jest like a single onbended rod of one spirit, were going forward, nothing could stop them.

We cross the field under the curtain of our barrage, reach the left side of Cantigny there was no German in sight yet, but a wild boar came in to view and turned our attention, the boys start to chase him but soon it disappear.

The happy village of Cantigny remain nothing but ruines, where the houses were standing if there was not a shell hole so pile of debris.

We passed the ruines and on the other side we find many orcherts and also there was barbwire fance with four strings of wire about ten inches a part, it was hard to cross it, so I came to the post, knock the wire down with the bot of my rifle, low enough to step over for me and the others that were behind me. I jest moved on one side the post and a bullet struck the post and penetrated through, that was a nother my good luck.

We cross the fance and start up again I notice that the boys bee falling down very often, there a shell burst about ten feet on front of me and exploded, I almost was in tance rising dirt, lump of dirt or chunk of rock stroke me square in the chest knock me down on my back, become very dusty and smoky from the bursting shells, I could not see farther than 100 feet a round me, I rose start up again, I hear somebody holled "lay down," I kneeled on one knee and was waiting what will.

The barrage moved moch farther, and the command was "forward" I perceived that there was Lieut Conel third man on my left side, leading the wave. I asked a doughboy, "who is that man?" He taled me that the man is Lieut Conel Maxey.

Colnel Maxey was a tall man smooth shave and red cheeks, with a revolver in right hand and streaching arms lead the 1st Division into victory.

At that time we approach near to a hedge of Crategus Coccinea, the hedge was thick and high it was impossible to see what was behind it, there stop us of some kind unknown power, many boys fell on both sides of me as I look about a 100 feet on my left and right side, there only six of us left, the rest killed or wounded were left behind.

Colonel Maxey gaive order for the tank to go ahead, and order us to lay down, most the time we were ahead the tanks, tanks crowled and open up machine gun fire at that direction and discharged the 75 gun several times and advance closer to the hedge.

Hail of bullets that was puring upon us from behind the hedge stopped, while I was laing I noticed low stumps of the hedge that there behind an apple tree some one was standing it was about forty yards away, I took good aim right through bushes, fired, and saw that something fell to the ground.

The command was given forward again, but we di'nt walk that time we ran as fast as we could to the hedge. There was only three of us in a grupe, myself and two doughboys, one of the doughboys had Automatic rifle what I never saw before, I shoot as fest I could but he shoot much faster, I asked him what kind rifle it was he toled me that it is an Automatic rifle, my partner Nickolas went closer to the tanks and I ve lost him for ever.

Three of us crossed the hedge, there was full of small dugouts all alone the hedge and a regular firing trench a bout two hundred yards long in the orchert.

First the doughboy with Automatic rifle was hurt in right arm I and the other fellow we ran to the trench, I saw that a Dutchman stick his head out over the parapet I shot at him and he rolled in, into the trench.

The doughboy was chasing a nother Dutchman but he di'nt shoot at him only was trying to staob him, the Dutchman grasp the doughboys bayonet with one hand and pust it a side, bend the bayonet pretty bad right at the handle I look at the struggle it was about ten feet away from me, so I holled "shoot him" but the Dutchman throw his hands up and holled in German "do'nt shoot me I will tell you something," I said to the doughboy "halt on," but it was to late, the shot fired and the Dutchman tumble down.

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Now he start one way and I start other alone the trench, the traverses of the trench have been covered with plates and about two or three inches of dirt over it, and caumflage with grass on both sides the entrance was covered with buarlap like a cortaine.

I saw that the cortain was moving I holled few times "Come rouse" but no one was coming out, so I open fire right at the hole, fired five rounds, then I hear of some kind squiling in the hole. I steped closer to the trench and pull the top off, there was four men convolsively twisting in the trench.

I turned a round and saw the doughboy was fighting with two men so I fired at one and he stabbed the other, but the Dutchman that were in the small holes saw it and start to come out by bunches three bullets penetrate my close, two below the waist and one in the right hand sleeve.

We laid down and start to shoot but that was only our good luck that the second wave reach the place and become boutchering.

We were about 150 yards to far ahead so the Lieut came to me asked if got the tape, of course I had the spool on my arm with me all the time, "Where is the other fellow?" he asked me, "I don't know Sir," I answered, last I saw him that he was on the other side of the hedge, he was behind the tanks, after that I didn't see him at all. Shall I look for him, I've asked the Lieut. "No," he said its no use, "but how we will start the trench line?" he asked me again, "I don't know Sir; Lieut Jones instruct us that the trench duged about 300 yards beyond the cemetarium from this road to the house that was standing on our right, (but instead of house there was pile of debris only) "wait a minut" he said "I'll soon find out" he stepped just across the hedge where the narrow road was and Colnel Maxey was there, he talk with him a while and came right out, I was gaizing at the bunch German prisoners which been waiting for transportation.

"We are to far" the Lieut said me, he moution his hand to the doughboys which all ready start to dig themselves in, and walk about 100 yards to the rear I fastened the end of the tape to the ground and follow the Lieut he was directing the way.

I streached the tape as far as it reached, it was on the spool about 300 meters, but one spool wasn't enough so the rest of the part we lined up by the green grain that was growing there. "Now you are throew with me, you can go to your company," the Lieut said to me. "Yes Sir;" I said, "Lieut do you know where the Engineers are working?" I asked the officer. "No, I don't know very well but I think that some Engineers are working in the woods on the right side of Cantigny," and he poited out with his hand in that direction. All right Lieut I said Goodbye. Goodbye he repeat and we parted.

I walked a cross the ploughed by shells field to the woods I found that bunch fellows been digging a trench I've asked them where the Engineers are working, some of them working right here a fellow told me and showed me the direction, I came into a large shell hole there was Copl Bragg, Ruh and Lieut Cox, I've asked Copl Bragg where the first section is working, on the other side of the woods, but you better stay here and help us to dig this trench, because is danger to travele through this woods today.

I accepted the invitation. I seat down in the shell hole took little rest I toled them all the stories what I saw and doen, then took shovel and start to dig. We finished the trench and some strong poins by one o'clock afternoon and start up back to the Death Vally agin.

We passed the woods and came on sloping field down the Vally, when Infantry open up maching gun barrage fire on moving Germans across the Vally, the bullets of our guns were high up over our heads but the Germans observed us and they open up their machine gun barrage too, the bullets been falling down like hail amongs us, but by good luck nobody got hurt.

Lieut Cox said that we are in both barrages the enemy and our own too, we all laid down for a moment then start up double time again down the hill, at the end we ran as fast as we could to reach the bushes, then when the trees cover us up Lieut Cox asked of any body was lost no, there was every body present.

The machine gun barrage stopt right after but the Germans send few shells after us and they exploded about two hundred yards away from the path that we been on.

We returned to the same place that we left in the morning, all the boys take the same places under the steep slope of the hill.

Later the report come out that we will wait here till dark, and after dark will go back to the camp, but six o'clock that afternoon the Company was formed and march up to the first line trenches to reinforce Infantry.

On our way to the position we went through Cantigny. A house was standing right at the edge of the steep hill looking in to the death Vally, that was the Germans observation point, from where they could observe every single movement of the American troops in the death Vally.

The house was caved in, and several dead Germans bodies laid out side the house and few in side, hanging over the beames pined down by the falling roof.

The German artillery was in action all the time, we came again to the first line trenches by ducking, the trench was not duged a cross the road so we had to clime over the bank to get in to the trench when I clime it over there was big shell hole, the shell hole was full of men I stood for while, but a fellow toled me "you better get down," soon I laid down, I saw that Sgt. Thoete was right behind me on the ground, dead. Pvt Loftis, Miller and Riordan was shot in the legg, he was laing on top the ground Lieut Cox was in the same shell hole too, so he toled him "why don't you run farther up here is no room for all the men," "I can't Sir; I am shot in the legg." "Roll in, into the shell hole, don't lay on top," I said, but here is no room to do it.

I start to holled, we got to get out from this hole, and give chance for the fellows behind to get into this shell hole, so Lieut Cox told me all right show the way.

I get up and ran, Le Magdelaine and Laube follow me, I ran to the very top. I stop at a strong point and ask the boys occupying the trench if there is enough room in the trench for me to get in, "don't ask for room but get in before you get your wing cut off," the doughboy said.

The trench was very narrow and shellow also full of men, but I got in and start to dig the trench wider and deeper and they all been digging too.

We stay here for all night, and all next day, been relieved next morning two o'clock we came back and took position in the first line reserve trenches, we eat cooked meal at eleven o'clock that day that was the first meal we've had in three days.

The evening we been complitly relieved and for the camp, the boys in the camp received us a very warmly and with open heart.

Many happening is left out in the last part, just an account that probably the story would be too long and dissedisfied the readers.

The battle of Cantigny was for a long time transfered from leaps to leaps. I thank God for my safety and sank the passed in the dept of my heart for ever.

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Chicago's Harbor Problem

The need of present planning for future growth

By

W. V. Judson

Colonel, Corps of Engineers
District Engineer, Chicago District
Division Engineer of the Northwestern Division

[The Esch-Cummins law places upon the War Department the duty of studying local harbor conditions and advising with localities as to wharf developments suited to meet the demands of commerce. An expert branch of the shipping Board, devoted to the study and planning of wharf facilities, has been transferred to the Board of Engineers for Rivers and Harbors, which is under the War Department.

The District Engineer of the War Department stationed in Chicago has been studying the wharf requirements of this region for many years, and he believes that the Lake Michigan shore near Wolf Lake, including Wolf Lake itself, offers the greatest opportunity in all this region for the creation of wharf facilities of a character, magnitude and location suited to meet the demands of the future. He has drawn general plans for these harbor facilities, and they have been approved by the War Department agencies in Washington.

The port facilities which the Board of Engineers is advising the City of Chicago and the States of Illinois and Indiana to contemplate at this time are especially for transfer purposes, and in such transfers there would probably be involved ocean vessels, lake vessels, barges, lighters, railway cars, trucks and warehouses. By no means is there any thought that all of the harbor facilities of the Chicago industrial and commercial district will be concentrated in the proposed location, but only the major transfer port facilities.

Since this article was written, the States of Indiana and Illinois have passed legislation for the creation of an inter-state harbor commission along the lines recommended by Colonel Judson, and it is hoped that this vast project, which means much to the entire Mississippi Valley, will soon find itself on the way toward realization.—ED.]

Chicago's Future

CHICAGO is the greatest railway center in the world. In less than 10 years Chicago will be the northern terminus of an 8-foot barge channel connecting the Great Lakes and the railways centering at Chicago with the coal mines of Illinois, the cotton belt of the southern States and the ocean port of New Orleans.

It seems reasonable to assert that within less than 15 years Chicago will be connected with the great ports and sea routes of the world by a channel from 22 to 25 feet deep, following the Great Lakes and the St. Lawrence River.

Never before did it seem as fair to point out in prophecy a region where there must inevitably, and soon, be established the world's greatest port facilities to take care of the vast warehousing and transfer operations which will be required when and where there will be a common meeting place of so many agencies of transportation.

The locus of this great prospective center of commerce is the Chicago district.

Possibilities and Limitations of Harbor Development

Where in a great stream of commodities undergoing transportation there is a breaking of bulk, it is customary to find an industrial and commercial city, where many of the commodities passing through are changed in character by manufacture, or warehoused and resold by local merchants.

Within the Chicago industrial and commercial district, extending say from the Evanston line to Gary along the lake shore and far landward thereof, we find nature's most marvelous preparation of land and water to serve the ends of man in the requirements of the future.

The lands are low-lying and flat, without bluffs where land and water meet, such as occur to the north, and without sand-dunes such as lie to the east. Bluffs and sand-dunes are picturesque, but they add vastly to the cost of adapting shore lands to purposes of commerce and industry.



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The foreshore of Lake Michigan fronting the Chicago district slopes very gently lakeward, so that the 7-fathom contour is 4 miles off-shore, instead of ¾ of a mile, as is the case east of Gary. This means that in submerged lands, or foreshore, all publicly owned, the Chicago district possesses nearly a hundred square miles, any part of which it is within the power of man to raise into land to serve one great purpose or another. This is an asset of almost incalculable value.

Back of the lake shore there is, in the Chicago River and its branches, the main and Sag Drainage Canals, the Calumet River and its branches, and the Indiana Harbor Canal, some 92 miles of channel available within the urban area for barges and lighters, and in some parts still promising long continued useful navigation for lake vessels.

Possessed of these marvelous assets, and confronted with vast expansions of commerce in the immediate future, Chicago is indeed no less in the presence of opportunity than of demand upon every resource to plan and exercise foresight.

Where, for example, shall be planned and built the wharves with the warehouses, the railway yards for car storage convenient to the wharves, the breakwaters and the channels of approach?

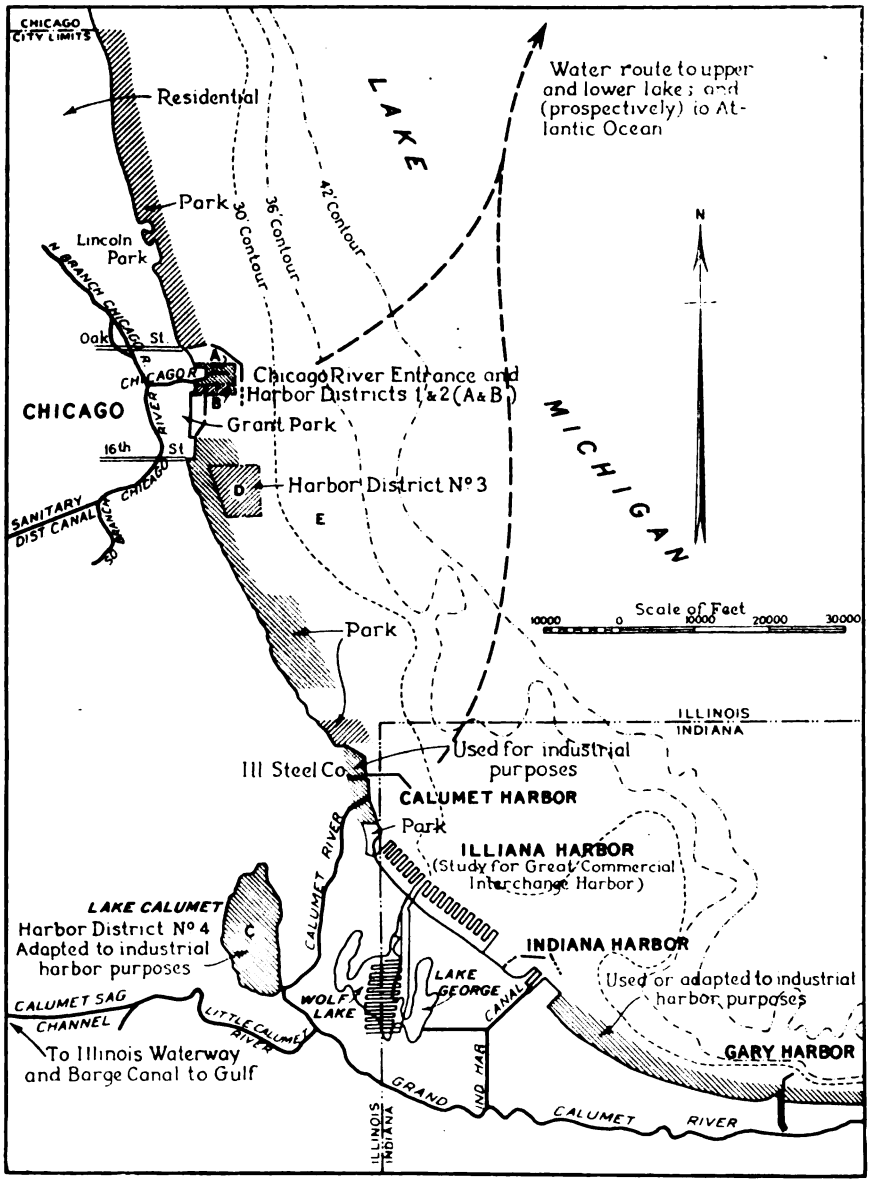
The lake shore from Oak Street to Evanston is devoted to high-class residential purposes and to parks.

In Lake Michigan, north and south of the mouth of Chicago River, lie two small harbor districts. Their limited extent and other circumstances, especially relating to convenient and general accessibility by rail, preclude all thought that they go far to solve the wharfage problem.

The Chicago River, in response to inexorable urban requirements, has become unfit for navigation by large vessels. Its commerce now is but little more than one-fifth what it was many years ago, and what lake commerce now utilizes the river places indirect costs upon this community for bridge operation and interruptions to land traffic, which would not longer be endured if they were fairly envisaged.

Grant Park, the Field Museum, Jackson Park and other park projects occupy the lake shore from Randolph Street southward to the Illinois Steel Company's great industrial plant at South Chicago, although lakeward of some of these park lands, south of Sixteenth Street, and embracing a part of them if necessary, wharves may be built.

The banks of Calumet River and of the Indiana Harbor Canal serve excellently as sites for great industrial plants requiring water transportation of coal and other raw materials. Lake Calumet may be developed into similar industrial sites, but will not serve as a locus for a great transfer harbor by reason of the number of bends and bridges interposing between it and Lake Michigan.



From the Illinois Steel Company to Gary, both inclusive, the Lake Michigan shore is largely taken up by industrial plants, including the Iroquois Iron Works, Whiting, the Marks plant, Inland Steel and Universal Portland.

Fortunately, the shallow lakes known as Wolf and George, with their marshy margins, lying close to Lake Michigan upon the Illinois-Indiana state line, have preserved from industrial or urban development about 3½ miles of Lake Michigan frontage and some 6 square miles of submerged and marshy lands lying immediately shoreward thereof, and it is to this locality that Chicago must look for her future transfer port.

Ample Room Available

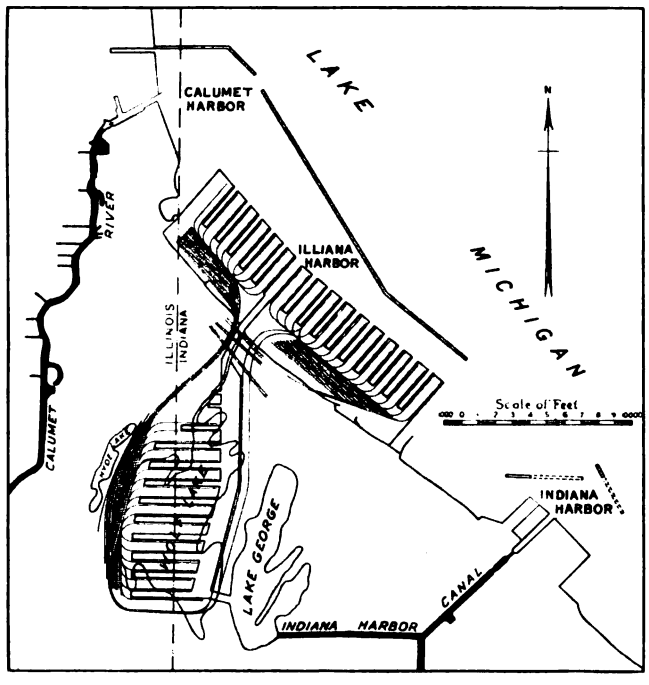
No man can now predict what portion of the development shown on the general plan will be required within the next ten, fifty or one hundred years. The vast amount of wharf frontage shown, when compared with the corresponding available frontage of the great ocean ports of the world, indicates that here there will be room for any business, however large, that the future may bring. The general plan shows 16 piers on the Lake Michigan shore, each 3,000 feet long and 750 feet wide, affording simultaneous accommodation for 232 vessels of an average length of 500 feet. In rear of the wharves, upon the lake front, there is shown, for railway yards, 15.-

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840,000 square feet, sufficient for the storage and movement of 16,000 freight cars. Inside the shore line, in Wolf Lake, are indicated 9 piers, each 750 feet wide and averaging 4,100 feet long, together with 14,200 additional linear feet of quay or wharf front, affording accommodation for 212 vessels, averaging 500 feet in length. In rear of the Wolf Lake piers are indicated yards occupying 7,240,000 square feet, sufficient for the movement and storage of 8,400 freight cars. Thus the total wharf frontage indicated both within and outside the shore line aggregates 222,840 linear feet, sufficient for 444 vessels averaging 500 feet long. More than 24,400 cars may be moved and stored within the yards. The warehouses on the piers, if but one story high, aggregate in floorage 164,900 feet in length and 225 feet in width, or 37,102,500 square feet. Allowing 15 square feet of warehouse for the storage of each ton, the warehouses shown on the piers alone would accommodate 2,473,500 tons of freight.

Cost of the Project

Inasmuch as no man can now say how much of this development should occur in any stated period of time, an estimate of cost of the entire development would be of little practical importance. Approximate unit costs may be stated, however, and with these before him anyone may easily compute the cost of such portion of the system as he may see fit. Thus the cost of wharf front or revetment, per linear foot, would average about $120. The cost of excavation of basin and slips in Wolf Lake, including disposition of material in piers, wharves and yards would average about $0.18 per cubic yard; railway yards, for trackage, would cost on an average about $40,000 per mile; warehouses on piers would cost on an average say $6.00 per square foot; necessary excavation in Wolf Lake, 25,000,000 cubic yards, would supply all fill required in the Wolf Lake portion of the development and furnish in addition 9,000,000 cubic yards toward the Lake Michigan frontage development, and such additional fill as may be required for the latter would cost say $0.40 per cubic yard.



Types of Piers

The piers shown on the general drawing are of the quay system. That is to say, they are of such width as permit of the storing of incoming and outgoing cargoes in warehouses on the piers themselves. Piers of this type may be of far greater length than those of the narrow bridge type, such as we see in New York for example, and each pier bears several railway tracks, and would be equipped with cranes of various types, conveyors, etc., so as to be adapted to the handling of different kinds of freight. Doubtless, it would be found economical and convenient to provide some of the warehouses with more than one floor and some piers with no warehouses at all. Upon the general drawing are indicated, immediately inside the shore line, on the one side, a certain length of wharf front adapted to the fueling of vessels, whether with oil or coal; and on the opposite side repair facilities, including dry docks, machine shops, foundry and the like. Certain portions of the wharf front are indicated as devoted to grain elevators, coal storage and transfer, and the handling of ore, in the latter case for furnaces in the nearby industrial district, which have no wharf facilities of their own. Needless to remark, the arrangement of the wharves shown on the general plan and above described is only in the broadest sense suggestive. When the development is begun, and constantly as it progresses, there should be study of the details of lay-out and equipment.

Breakwaters and Bridges

It is fair to assume that Congress would give consideration to building with Federal funds the breakwater and the entrance to Wolf Lake. The breakwater is shown on the plans as extending some 20,000 feet in a southeasterly direction from a point opposite the end of the existing Calumet breakwater and sufficiently distant (say 600 feet) therefrom to provide an entrance. This breakwater would protect the lake shore development and the entrance to Wolf Lake from wave action. Barges from the Illinois and Mississippi Rivers would reach the wharves via the Sag Channel and the Little Calumet and Calumet Rivers, either passing out of the mouth of the latter into the breakwatered area or being admitted to Wolf Lake by a canal connecting the south end of the latter with the Calumet. Lake and ocean vessels might, with but slight deviation from their courses, stop at wharves near the mouth of Chicago River to put on and off passengers and certain express and local freight. Stops of this character are common at Hamburg, for example, and might prove both economical and convenient. As Wolf Lake and the entrance to it are legally navigable waters of the United States, the building of proper draw-bridges could be exacted of those now crossing the channel of exit near the Lake Michigan shore line. It is probable that a detour could be arranged for the many fast passenger trains which now cross here, and the same detour might save these trains delays at present experienced at Indiana Harbor and Calumet River bridges.

Administration of the Port

In Great Britain it is common practice to develop and administer ports and port facilities through the agency of so-called "Harbor Trusts." Such a trust is composed of unpaid gentlemen of the highest character and ability, willing to devote themselves to the public service for the satisfaction that such service brings. To create the port facilities herein advocated, it would seem advisable that the states of Indiana and Illinois should by concurrent legislation establish an inter-state harbor commission, half the personnel to be appointed by the governor of each state. To this

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commission should be granted title to the lands under water in Wolf Lake and along the margin of Lake Michigan where the piers are to be built, which lands are now the property of one state or the other. The commission should be empowered and directed to issue bonds, to acquire certain marginal lands, to settle riparian controversies, to build wharves and related port facilities *pari passu* with the increase of need for them, and to exact dues for their use. The submerged lands conveyed to the commission would possess a value of many millions of dollars. The power to collect port dues would eventually produce a revenue ample to meet all interest, sinking fund and other current charges Whether or not the commission would require any direct appropriations by the two states at the beginning of its work, or whether it would be better if the bonds were simply guaranteed by the states, is a question, of course, for study and determination. There are understood to be no constitutional objections to the course herein outlined, and such management and control would probably be on a higher plane in some respects than if a single state or municipality were to exercise them.

Forethought and Co-operation Necessary

It will require much careful study and effort on the part of many public-spirited men in this country before the two states may be expected to enact the necessary legislation. In the meantime there is always danger that private individuals or corporations may seek to take action which would destroy or mar the opportunity that now exists, perhaps through industrial developments unfortunately located, or perhaps through purchases of land to be held at high prices until the public requires it. It is hoped that the publicity necessarily given to this subject at this time will operate as a warning against rather than as a suggestion of activities contrary to the public interest.

Principles Governing the Use of Combat Engineers

A Correction, By

D. D. Guilfoil

Major, E. O. R. C.; formerly Major, 108th Engineers

[*Note.*—The author and the editors regret that through inadvertence the crossing at Consenvoye was credited to the 110th Engineers of the 35th Division, instead of the 108th Engineers of the 33rd Division, and are glad of this opportunity to make the correction.—Ed.]

I WANT to call your attention to an error in the July-August issue of THE MILITARY ENGINEER. In Major Mitchell's article on "Principles Governing the Use of Combat Engineers," it is stated, in the last column on page 329, that the 110th Engineers of the 35th Division constructed the foot bridge and heavy wagon bridge across the Meuse at Consenvoye. In the editor's note preceding the article on page 353 this is again referred to.

The bridge work in question was accomplished by the 108th Engineers of the 33rd Division. On October 8, 1918, the writer, then a captain in the 108th Engineers, was in charge of Companies B and C of that regiment and acting on orders which had been received the previous day, constructed an infantry foot-bridge across the Meuse River at a point about 600 yards up stream from the ruins of the wagon bridge crossing into the town of Consenvoye. On the following day, this ruined wagon bridge was reconstructed by Company B of the 108th Engineers under the command of Captain L. J. Hughes.

As our division held this front from the early part of September until the latter part of October and as the front was considerably north of Consenvoye at the time they left this sector, it is hard to figure out how this work was credited to the 110th Engineers.

Major Mitchell might also be interested in knowing that while this river crossing was anticipated as he states, the engineers had been unsuccessful in securing any of the necessary materials through the regular source of supply.

Companies A and E of the 108th Engineers also constructed an infantry foot bridge across the Meuse at the town Brabant earlier on the same day. The materials for both of these foot bridges were obtained by tearing up an old German plank road which ran through a portion of the swamp lying west of the town Forges.

The orders for this bridge work were received about noon October 7 and carpenter details were immediately sent to the plank road and constructed bents from the bridge balks and tore up the chess for use as planking on the bridges. That night the bents, planking and what rope could be secured, together with the carpenters' tools spikes, etc., were taken into the town of Forges by horse transfer. On October 8 this material was carried to the bridge sites by the companies mentioned above. This entailed carrying a distance of nearly two miles.

The depth of the river was an uncertain matter and as a consequence the heights of the bents were more or less guess work. Very few of the bents could be used at the bridge sites without a certain amount of splicing as the river was found to be deeper than anticipated.

The bridge at Consenvoye was 156 feet long, and the deepest water encountered was 16 feet.

The work was started with the enemy entrenched on the opposite bank of the river, but due to the effective work of the infantry covering party consisting of one platoon, the rifle and machine gun fire of the enemy did not in any way hinder our operations. When the bridge was constructed to about the half way point, the advance of our troops on the opposite side of the river caused a complete let-up in the rifle and machine gun fire on us. Of course the enemy's artillery was on us constantly from start to finish.

Another principle brought out by Major Mitchell and emphasized in this bridge operation is the ability of engineer troops to produce the necessary material for the work in hand. The bents, planking, etc., mentioned above were not sufficient to construct over two-thirds of the bridge required but the carrying parties produced the balance of the needed material and in no instance were they asked for anything needed by the bridge builders but what it was supplied or a very satisfactory substitute was furnished.

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Engineer Supply in War

By

T. H. Jackson

Colonel, Corps of Engineers; and Engineer Purchasing Officer
Formerly Engineer, Advance Section, Service of Supply, A. E. F.

[*Note.*—The fundamental economic principles which should find application in the conduct of war are of such importance and so vitally necessary to success that we have given freely of space in this journal to the statements of successful practical men as to the manner in which they have applied these principles. We believe that there is no other item in the preparation of the engineer for service in war which is comparable in importance with the inculcation of these sound ideas on the application of a just sense of proportion or common sense in the conduct of the engineer's part in warfare.

The many engineer officers and former officers who came in contact with the energetic, resourceful and clear-thinking officer who contributes this article, during his very active service in the A. E. F., will be interested to learn the basic understanding of economic principles which enabled him to steer a straight course through the difficulties which he, in common with us all, had to encounter. They will also be interested to note that Colonel Jackson's ideas of the importance of simplicity, the value of time, etc., are in general accord with the ideas of other successful practical men, heretofore presented.—ED.]

ENGINEERS have in war two great problems to solve—personnel and supply. Much has been written since the war regarding the former and covering both its combat and non-combat aspects. Little, however, has been written bearing on the supply, and that little has been as a side issue to the personnel problem.

Why is this? Is it because the supply problem is not known, or because its importance is not appreciated? There is a tendency to exaggerate the use of personnel, particularly the combat, and to overlook the supply service. There are several reasons for this, of which the following are the most important. Officers, both temporary and regular, have, in general, a lack of field experience, without which one cannot know how to use supplies economically either in peace or war. The greater portion of our regular officers enter war with little experience except with troops. Add to the above the fact that all officers realize that the greatest opportunities for distinction and reward come with troop duty, and it is easy to see why officers, irrespective of their qualifications for troop duty, seek it, and particularly that with combat troops.

My experience from August, 1917, to February, 1920, was with supply and construction. It involved contact with the supply problem from all sides—purchase, storage, issue, and use in field. I had the good fortune to come into close contact with the engineers who did the most for engineer supplies in France, and I believe that most of the opinions advanced in this discussion coincide closely with those of these men. I have always held that we learn through mistakes more than through successes, and when I try to point out the mistakes that were made I am not doing so with a view of drawing attention to individuals or their shortcoming. Yet, one cannot write a useful article on a subject like this without stepping on someone's toes, however much one may wish not to do so.

The Supply Section of the engineers was, I believe, more efficient than that of any other service. But it should have been. It was not as efficient as our construction or combat sections, though it should have been and could have been had we realized its importance. As a body we know something about combat and construction, and realize fully their importance in war. As a body we had little knowledge of supply. This is why our supply was so far behind the combat and construction. A good service, however, should not have such a weak link in its chain as we had.

As illustrating the lack of appreciation of the supply problem within a service, I desire to invite attention to two very interesting discussions on the use and merits of the narrow-gauge railroads in the war, which have appeared in recent engineering literature. In neither has any mention been made of the relation of the supply of this facility to the general supply of the service. Now, a discussion of a war utility is not complete unless this relation is thoroughly discussed. Furthermore, before you can prove the desirability of the utility in war you must prove beyond a doubt that its usefulness more than compensates for its complication of the supply problem. Personally, I am convinced that in the case of narrow-gauge railways this complication completely eliminates it as a means of war supply for our army.

In this article the term field and construction engineer will be used repeatedly to distinguish men trained in the handling of labor and materials on construction from those who have had little or no such training. The former are the desirable type in war.

The war operations of engineers are more like the first stages of the work on a construction job than any other engineering work in peace. War has little of no place for the inside man, men who design, inspect, administer, instruct, etc. I never knew a field man to fail, while I have known dozens of the inside type to do so. Their failure may be attributed in most cases to timidity, which was the result of their lack of training. When called upon to do field work they had only theory to draw on, and theory does not go far in war. The oft repeated statement that in war there is a place for every man, is almost too foolish to discuss. It certainly does not apply to engineers for engineer work. The organization in war is entirely different from that in peace, and it calls for very few inside men. For example, a section engineer working 15,000 men on various construction jobs will have at the most two or three officers whose duties are inside. Their duties will be such that field men are preferable, too. In time of peace, with an equal field force, he would probably have in his office from 30 to 50 men of the inside type, and they would be giving full return.

Probably no one thing caused so much trouble in our supply section as the foolish statement constantly appearing in print at the beginning of the war that it was a war of experts and specialists. In consequence, every possible effort was made to get special troops, and the expert proceeded to try, at least, to load our supply section with supplies that were not necessary in war. I suppose the same condition existed in other services to an extent even greater than in ours. Now, in war the engineers have no use for experts, and very little for specialists. They want the field type construction man, for war work is throughout the simplest kind of engineering.

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During the first stages of the war, and frequently throughout its duration, the supply problem is more important than personnel. By important I mean it is the one that must be developed the more rapidly and efficiently in order that the progress of the operations as a whole may be promoted. There is no use in supplying men for combat or construction when there are supplies available to employ efficiently only 60 to 80 per cent of them. My experience in France showed that so far as engineers were concerned, the critical element were always in the following order: transportation, supplies, men.

Transportation has always been, and probably always will be, in war, the critical element of the general supply problem. The Transportation Service should therefore be the most efficient in the army. It is probable that it has always been the least efficient. This may seem peculiar, but it is the logical result of our organization. For a service to be efficient in war it must have had a free existence in peace, and have had the best possible facilities to build up its personnel, esprit, and organization. Our transportation has always been a side issue in a big supply service that has had little recruitment of men trained in transportation or the handling of men.

In the past war a step was made in the right direction and an effort was made to place transportation—motor and railroad—in the hands of men trained in its use. However, a war-created service always labors under a heavy handicap as compared with one that has functioned in peace. The efficiency of a service in the first year or so of war varies directly with the number of regular officers of ability with the service. After that, the high-grade temporary officers will have learned enough of the war to take up and carry the load they should bear. But you cannot create a new service in war and have in it any considerable number of regular officers of ability, for good men hold to their own service at that time.

Though the engineers are vitally concerned with transportation itself, our control over it will be limited to that obtained by the use of our personnel in the operation of motor and animal-drawn vehicles. The operation of the railroads in the theater of operations by the engineers is dependent on the decision of the Commanding General, hence cannot be depended upon to have any important bearing on the supply problem. It is probable that it will be the unusual rather than the usual thing when we operate for any considerable time railroads back of the most advanced depots. Supply within the Transportation Service is the important transportation problem and over it we have little or no control.

Such being the case, we must always expect a shortage of transportation—animal-drawn, motor, and rail—and must do all in our power to function with that available for use. This requires that we reduce our needs to absolute essentials. It is here that the great distinction between regular and emergency officers (the trained and untrained officer) is noticeable. The regular officer may not know how to exercise economy in supply, but he is usually willing to cooperate to gain that end, even if his functioning is impaired. Emergency officers for a long time, however, are generally prone to insist on their pound of flesh. We expect this from men not trained as engineers, but it is inexcusable for engineer officers to fail to see or to meet the supply situation with an open mind. I have heard high ranking emergency officers state repeatedly the inability of their service to meet demands on it for supplies, yet insist that every other service should give to their particular service its full demands. They could not see that all services were in the same condition as to supplies—short.

It is very difficult to exercise control over engineer supplies used by troops in combat operations other than in the number of items. Furthermore, this is not very necessary, since nothing but the absolute essentials are usually available. Control in the S. O. S., including rest areas back of the lines, is possible to almost any extent. It is therefore with the use of supplies in the S. O. S. area that we are principally concerned. Moreover, the great bulk of the engineer work is behind the line. In France, probably 90 per cent of our effort was there. What applies there, however, so far as the providing of unnecessary items, applies equally to the armies. There should never be furnished to the armies items that they cannot or should not use.

In considering the problem from a general standpoint, it must be remembered:

That the engineer service furnishes engineer supplies to all other services;

That the engineer service performs all construction in the theater of operations;

That the engineer service, being a combat service as well as a supply service, must supply its own troops whether combat or construction.

In the solution of the problem, therefore, the needs of the various services, including our own, must be considered and co-ordinated. This co-ordination is a function of the General Staff. The General Staff, in acting, settles definitely certain previously determined factors. With these known, the engineer service can consider the factors affecting its own service, and having settled them can proceed to a solution, which, if correctly made, will give efficient results. I will try to consider in turn the factors referred to above.

The General Staff determines such factors as the number of troops for which quarters will be provided and for which supplies will be furnished and stored; the sites at which the depots for these stores will be constructed; the floor space that must be provided in barracks for personnel, commissioned, enlisted, and sick; certain details regarding the construction of buildings, such as no floors in barracks, storehouses, etc. These and similar questions will be settled by the issue of general orders, G. O. No. 46, A. E. F., specifying no floors in barracks, and the floor space for all personnel, meant more to the engineers than any other order issued in France.

The General Staff also approves the projects for all installations. The procedure should be as follows: A service desiring an installation, camp, hospital, depot, etc., at a certain point, presents its needs in the form of a project, which, in general, is not detailed. This project is considered by the engineers, and an effort made to secure an agreement satisfactory to the service concerned and the engineers. If an agreement cannot be reached, the project is sent up with such comments as both sides may desire. The General Staff officer concerned then makes a decision and directs what is to be done. It was not until about September, 1918, that the above procedure became the policy in France. Previously, the engineers were rarely consulted, and many poorly designed installations were approved. That they were not always constructed as approved was due to the refusal of the engineers to use supplies on non-essential work which were needed on necessary authorized work. It is not fair to a service, however, to make it carry a load of this kind; furthermore, it creates an antagonism between services that should be avoided.

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The General Staff did not appreciate the fact that a stroke of the pen cannot provide men or supplies except at some time in the future. In war, we cannot deal beyond the immediate future.

Within the service the demands of the combat troops and those of the construction section must be met. As indicated before, those of the latter are the greater, and such that they can be better controlled to increase efficiency.

The supply problem within the service is simplified in two principal ways:

By reducing the total tonnage required;
By reducing the number of items to be furnished.

Reduction of items increases the efficiency of the supply section faster than reduction of tonnage. I would rather provide in depot, 1,000,000 tons on a basis of 10,000 items than 500,000 on a basis of 30,000 items. (The inventory made following the armistice showed that we had in depots in France a total of approximately 500,000 tons of engineer supplies and about 30,000 items.) That this is not appreciated even after our war experience is obvious from a knowledge of what was being done by the General Staff and the various services in 1919-20. A great effort was being made then (it may be in progress still, since a scheme like that is apt to run on indefinitely) to improve the purchase side of the supply services. The services were all being worked on detailed specifications for the various items in their category. In peace this may be all right for services that have officers with no technical training, but for war it is wrong. It simply handicaps the buyer when he goes into the market for items in large quantities. For example, there was never a time in the A. E. F. when we were not short of the commonly used supplies—tools, pipe fittings, etc.—and they may say the shortage extended to the United States. Why complicate a shortage like this by an action that will obviously increase the shortage? Any commercial type of material, tool, fitting, etc., will answer in war, and any action that will handicap the purchasing officers in buying such articles should be avoided. Instead, we see a definite plan to perpetuate this handicap. It is different when items of plant are under consideration, since the fewest possible types should be permitted to avoid multiplicity of spare parts.

What should have been done by the General Staff at that time was to determine the supplies each service should furnish in war on a basis of predominant use. This was the A. E. F. policy, and it proved a success. Instead, we have a system untried in war which places in the category of the Quartermaster Corps all supplies common to two services. If the engineers and artillery use shovels, then the Quartermaster supplies them. Such a system does not even sound right. It may be all right in peace, but in war it will last just long enough to cause a general tie up of all supplies. It is the result of the failure of the General Staff to perform its co-ordinating function during the war. In France, where the Staff co-ordinated the supply services, we had no trouble.

Having determined the categories of each service, the Staff should have called for detailed lists of war items, insisting that these lists should carry not over one-half as many items as they did during the war. If the services wanted more, they should have been made to show the need. If specifications were desired for peace purposes, no harm could have followed the preparation of same. So, in short, what we wanted was categories on a basis of predominant use, and lists of war supplies cut to the bone. Instead, we get a lot of paper useful only in peace, and because technical supplies are to be purchased by a service that lacks officers with the technical knowledge that is necessary to purchase such supplies.

In the general problem, however, reduction in tonnage is the more important, since transportation (rail and motor) always controls supplies, and transportation takes little account of anything except tonnage. This is effected by:

Having a few simple standard designs. This applies not only to buildings, but to installations.
Eliminating all construction on a building, and installation, to that necessary to permit its functioning.

In France we had three standard types of buildings, one for troops, one for sick, one for stores. These have been described in other articles, and are familiar to all. The barrack building was of about the same class as is found on a construction work for housing labor. The important feature was that it had no floor. Similarly the storehouses, except in the Advance Depot at Is-Sur-Tille, had no floors except for perishables like salt, sugar, and flour, or where the construction officers failed to exercise proper economy. The design in each case had a very low factor of safety. Many of the hospital buildings furnished under contract had to be strengthened. This was not objectionable for it proved our design was on the right side of the allowable factor of safety, *i. e.*, the low side. I wish to quote here a remark of one of our best construction officers. He had reduced the strength of the storehouse design repeatedly. One day one of them blew down before it was finished. He said, "Now we have a good factor of safety, we know what will just stand and that is all we want." Such officers are invaluable in war. I have repeatedly remarked, "Anyone can construct anything if you give him all the men, materials and time he wants. Do not cite, as qualifying yourself for war, the simple fact that you have done such and such work of magnitude." In war I would rather have a man who can build an outhouse economically than one who can build a skyscraper slowly or uneconomically.

To be able to eliminate all construction not needed for functioning should be the highest aim of the engineer in charge of the construction of an installation in war. To illustrate, a building must have roof and sides to house men but it does not need a floor. The same applies to storehouses. The man who puts floors in storehouses except for certain perishables like flour, salt and sugar, or who puts in raised floors, except under positive orders overruling his protests, is failing in his duty, yet there was a constant fight to prevent this from being done; a fight with the service for whom we were building, and a fight with many of our assistants who had not learned war construction. This fight ended very abruptly, however, in the case of floors, when General Pershing gave orders in person that there should be no floors except for perishables. It was wonderful how quickly many people saw light after that. What applies to individual buildings applies also to installations. Designs came to me with forty-foot roadways and the same facilities duplicated from one to ten times.

The greatest difficulty in installation design came when we had to deal with the specialist, the man whose aim in peace is to provide what will give the greatest efficiency in operation or who was accustomed to such facilities. Such a man has no place in war if he cannot accommodate his designs or his needs to war conditions. The Railroad Transportation Service was a particularly great offender in this respect. We had heard so much of railroad efficiency in time of peace that much was expected of its individual engineers. That service showed the least ap-

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preciation of the need of simplicity and economy in war. It was fully a year before it seemed to realize that we were at war and that we were constructing with time, simplicity, and just sufficiency of construction to permit operation as the essential elements in the railroad problem as well as all problems. As was to be expected, the worst offenders were the inside men. The Water Supply Section of our service was equally noted for its failure to see the real object of our efforts. Some of us succeeded locally in getting good results from that section, which had excellent personnel in general, by eliminating the men who lacked field training.

Our efforts resulted eventually in pretty complete standardization of installations and on a basis of minimum needs to function. It was really simply a case of education. As stated before it was a constant struggle, not only with other services, but with one's own assistants. It is remarkable how trained men will insist on doing in war what they would not do in peace. Those who were leading in simplifying our work finally took steps to train all of their construction officers before giving them independent charge. They were detached from their organizations and tried out on jobs where we had tried and proven men. If they showed, under such supervision, that they had possibilities as economists of men and materials, they were given independent jobs; if not, they remained always as assistants or were "canned," depending on their ability to conform. Many officers failed to make good in this struggle simply because they had lost or had never had ability to fight—to resist the demands made upon them by others. This is why I have always insisted that for war construction we want no majors over forty. I would give thirty to thirty-five as the desirable age for that grade, adding about five years for each grade above. The older men cannot go back to the lessons they learned or should have learned in the construction camps when they were young.

It will be seen from the above that in the settlement of the factors that the service can settle, the engineers in the combat and construction sections must strive in every way possible to reduce their needs in tonnage and number of items to a minimum. To secure this, every engineer officer must be educated to realize that the exercise of economy in the expenditure of supplies is his most important duty.

We finally come to the supply section of the engineers. This section must bear the blame if supplies are not forthcoming. It would seem that not much is left for it to do but buy, store and issue. Well, that in itself is a big problem and it may be all it may be able to do. But it should not be. It should never be content to accept requisitions blindly and try to fill them. In the early stages of the war, and before the construction and combat sections have learned the game, it must keep its blue pencil sharp and apply it vigorously. Many object to this blue-penciling of requisitions, but when one stops to think that in the early days of the war, hundreds of incompetent and inexperienced officers are requisitioning and that these requisitions get little or no examination prior to receipt by the supply office, it will be realized that much elimination is necessary. An examination of the first thousand requisitions for supplies, either in France or the United States, would be most interesting. I am satisfied that, outside of the company equipment, which was definite, at least 50 per cent of the items and the tonnage were not war supplies. When road troops requisition asphalt concrete plants to take into the field, almost anything may be expected.

As the other sections learn their war duties, and what supplies are war supplies, then the bluepenciling will decrease and the effort of the supply section to keep requisitions limited to essentials will be directed at the heads controlling requisitions on it. But the time should never come when it should furnish supplies simply because they are requisitioned. It must fight to prevent the recurrence of unnecessary requests, carrying its protests to the highest authority. There is nothing that will breed unnecessary demands like acquiescence to similar ones. The supply service must be a fighting service if not a combat one. The fact that we had 30,000 items in stock at the armistice showed that something was wrong with our supply service, that it had not fought for simplicity. It is my estimate that 25 to 40 per cent of the items were not war supplies. In no individual case was this more true than in the water supply. The number of items for its stock was abnormal. In war this service is one adapted to the greatest simplicity.

The efficiency of a supply service increases more rapidly with decrease in number of items than with decrease in tonnage. This, even the most ignorant must admit; yet it is a queer fact that the people who preached this principle and did the most to secure it, were not supply, but construction officers. They were not many in numbers either, probably half a dozen. The curse of the supply office was its acquiescence to the demands made upon it. There were a number of section engineers in France who were first, last and always for simplicity of construction. They showed the supply section what was possible, yet it went on merrily trying to meet the demands of the most inefficient. To illustrate the lack of fight in the supply service in France, I need but cite the fact that the lumbering operations were taken from the supply section and put under the construction section, though the production of timber products was a phase of supply and not of construction. It was a most direct indication of the lack of confidence in the supply section, and fully justified by later results.

Any discussion of simplicity of design to gain reduction in items and tonnage must sound like kindergarten work to the field engineer. It should be part and parcel of such engineer in peace time, and of every officer in time of war, yet in my peace and war experience I have heard less than five people preach it and I know of but two or three who do so naturally and constantly.

The trouble with our supply service in the United States during the war was due to:

Poor organization in the office of the Chief of Engineers;

Lack of sufficient experienced personnel in the supply section.

The supply problem was the most important problem in the office of the Chief of Engineers in the beginning, and was the one that required the most attention. There had been no preparatory work worth mentioning, which made the problem very difficult. The organization of the supply section of the office of the Chief of Engineers indicates that the supply problem was considered to be of less importance than either enlisted or commissioned personnel, while as a matter of fact it was more important. The regular officers assigned to the supply section were excellent, but they were too few in number. There were just sufficient to handle the administration. There should have been at least three times as many. The answer that there were not officers available is not sound. An experienced officer on such duty was worth five times as much

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as with a combat or any other regiment in the United States. It was the placing of troop duty above supply, combined with the foolish idea that men of less than fifteen years commissioned service were not qualified to command combat engineer regiments, that caused this apparent shortage of officers in the early stages. Now ten to fifteen years is the ideal length of service for commanding officers of combat troops. It is much better than twenty to twenty-five and infinitely superior to thirty to thirty-five. You may at first not admit this, but you will realize it is true if you stop to think or if you know what combat duty demands physically. The officer of our service who went farthest with combat troops, puts thirty-five years as the limiting age of a commanding officer of a combat regiment in war. I would not increase it to over forty years.

In France there was the shortage of personnel, but the great trouble was the changes. There were about eight changes in the Chief of the Supply Section in a period of about fourteen months. You can get nowhere with a big job under such conditions. No one wanted the supply job, but the trouble lay in the lack of appreciation by the higher authorities of its importance. What was needed was to place supply, both in the United States and in France, on a par with personnel, combat and construction. The combat and construction sections succeeded because they were recognized as important, and given a reasonable number of qualified officers. The supply failed to make an equal record because this was not done. There was no *fight* in the supply section, and, as I have stated before, that is an essential quality for success in war. War is no place for the timid; they should stay at home or be sent home. I do not mean that courage necessarily gains one rewards in war, but it prevents failure. It also makes a man able to look his fellow man in the face and say that he did not shirk his duty because it was disagreeable, or because he could not see a reward. Courage, energy, physical vigor and common sense are the essentials in war. If a man has these he cannot fail.

To illustrate how necessary it is to have construction men in the supply section, I could give a hundred illustrations. The cement sub-section in France produced 5,000 tons of hydraulic lime, none of which was used, or would ever have been used, since it was not a war material. This was done because the man in charge of the sub-section was not a construction engineer and did not know field construction. Bath tubs were accumulated by the hundreds though the construction section announced the policy in 1917, that no tubs would be installed, even in hospitals. The same reason applies. Some eight asphalt concrete mixing plants were sent to France though there never was any intention on the part of the construction section to use such plants. The amount of work done on the roads was large and it showed conclusively that road work in war is of the simplest nature. Our best officers knew this and preached it.

Our mistakes in war are the direct result of our lack of training in peace. You cannot expect officers to strive for simplicity and economy in war, if they do not hear of those things in peace. There is no excuse for the regular officer not knowing such things. Every war has been the same old story so far as construction and supply are concerned, and our older officers should know it and teach it. But they do not. I had but one regular officer teach me any of the principles of simplicity of construction and economy of materials in either peace or war. It is somewhat different with temporary officers. Unless they are field men they think of economy and efficiency in terms of dollars saved in the first cost or in operation. Now in war there is no thought of money, it becomes zero in the equation. In war, *time* is the element that counts. It counts in peace construction, too, though most engineers do not realize it fully.

To facilitate operations at the beginning of a war it is necessary that we have schedules showing the items and the quantities of these items that should be furnished without further information than that giving the number of divisions that are to be supplied. Also lists that show the standard equipment for all engineer troops. These lists, no matter how crude, will be of the greatest assistance. The most essential thing is that the number of items be low. The lower the better, for no matter how low it will contain unnecessary items and many more will soon be added. Remember that it is easy to add, but almost impossible to subtract. No officer not qualified as a construction man should be allowed to meddle with this preparatory work. As an example of what the other type may do remember our limber and caisson wagon experience. Another shining example is our present army water cart. It would be a task to conceive of more unserviceable pieces of war equipment than these two devices.

The importance of the supply section should be clearly understood. Provision should be made for adequate and competent personnel, particularly in the depot sub-section. By competent personnel, I mean men with construction experience. No others should be considered, for a man who does not know construction work cannot succeed in this sub-section. The purchasing sub-section should do nothing but purchase under orders from the depot section, hence what it wants principally is active, intelligent, experienced buyers. However, if the depot sub-section is inefficient then the purchasing unit must handle many of its duties and should be controlled by experienced construction men. When competent officers are secured they should not be changed until the policy as to items is definitely settled and the service functioning smoothly.

In conclusion it is believed that in training and preparing for war the following points should be emphasized to all officers, and dwelt upon constantly in instruction:

Construction in war is seldom equal in quality to that on a contractor's camp, and on the installation of his construction plant.

Efficiency in war rests in the standardization of buildings and installations; these to be of the simplest and fewest possible types.

No construction should be done beyond the point that will just permit of functioning.

Efficiency in the supply section increases with the decrease in the number of items it must supply.

What is most needed, therefore, for the successful solution of the engineer supply problem in war is:

Realization by the General Staff that its power to bring about co-ordination of the ideas of each service, with those of the engineers, must be promptly, vigorously, and wisely exercised.

Realization by the office of the Chief of Engineers that its most important problem is that of supply.

Realization by all engineer officers of the importance of the principle that bare necessities only govern all phases of construction and supply.

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The Rise and Fall of Traffic on the Willamette River

Above Portland, Oregon

By

E. Burslem Thomson

U. S. Assistant Engineer

THE Willamette River rises in the Cascade Range in southwestern Oregon, flows northerly and empties into the Columbia River about a hundred miles from the ocean. The city of Portland, incorporated January, 1851, is 13 miles above the mouth of the Willamette River. For the purposes of this article the river may be conveniently divided into two parts, viz, from Portland to Oregon City (13 miles), and from Oregon City up to Eugene (159 miles). At Oregon City there is a horseshoe-shaped rocky reef, causing a drop in the river known as Willamette Falls. The difference between the upper and lower pools averages 41 feet, which, since 1873, has been taken care of by a series of four locks on the west side of the river. The City of Eugene (172 miles by river from Portland) is the highest point that has been reached by steamboat service.

In the year 1850 transportation on the Willamette River above Willamette Falls was in the hands of two pioneers, Capt. George Pease and Capt. Jas. D. Miller. Captain Miller owned a flatboat 65 feet in length, motive power for which was furnished by four Indians, each of whom received $16.00 a trip for their services. Captain Pease had a larger flatboat of 6-Indian power. The two boats did a lively and prosperous business between Canemah (just above Willamette Falls) and the towns of Dayton and Lafayette. Dayton is 5 miles and Lafayette 8 miles above the mouth of the Yamhill River, which enters the Willamette River about 42 miles above Portland. They carried from three to four hundred bushels of wheat to a downstream load at a rate of 50 cents a bushel. Upstream charges were $35 per ton.

The first commercial steamboat operated on the Willamette River between Portland and Oregon City was the *Columbia,* a side-wheel vessel 90 feet long with a carrying capacity of about 20 passengers and 75 tons of freight. The *Columbia* made her first trip at noon on July 3, 1850, starting from Astoria near the mouth of the Columbia River, where she was built. The boat arrived safely in Portland the following afternoon. The trip is now made in from six to seven hours, the distance being 100 miles. The *Columbia* reached the foot of the rapids below Oregon City at 8 p. m. the same day.

The following is copied from the "Portland Weekly Oregonian," dated December 4, 1850, Volume I, Number 1:

Regular Steam Packet
Twice a Week
Between Astoria and Willamette
At the Foot of Clackamas Rapids
THE STEAMER COLUMBIA
Captain J. Frost

Will run regular twice each week, leaving Willamette on Wednesday and Saturday, returning will leave Astoria on Monday and Friday, touching at Milwaukie, Portland, Vancouver and St. Helens.

For freight or passage apply to A. P. Dennison, Agent, Portland, or to the Captain on board.

The passenger rate between Astoria and Portland was $25 each person, and the charge for freight between the same points was $25 per ton. The trip regularly occupied 24 hours.

The enterprise of the citizens of Astoria stirred the ambition of the town of Milwaukie, about 6 miles above Portland, and they responded by building the side-wheel steamer *Lot Whitcomb,* which was launched December 26, 1850, and started on a run between Oregon City and Pacific City, the latter then a small town near Ilwaco, Wash. The rates on this, the second steamboat to navigate the river above Portland, were:

For passengers, Astoria to Oregon City, without board	$22
For freight, per ton	25

A lower scale of rates was adopted March 10, 1851, the passenger fare being reduced to $15, with board, and the freight to $15 per ton, or 40 cents per cubic foot.

In May, 1851, the *Lot Whitcomb* made the first trip up the rapids at the mouth of the Clackamas River, one mile below Oregon City, to Oregon City, where a company was organized to purchase and operate the boat. About this time a small steamboat, the *Hoosier,* was purchased by some enterprising citizens of Oregon City and operated on the run between Portland and Oregon City. This boat was a side-wheeler made out of a ship's longboat, and a pile-driver engine. The *Hoosier* was shortly after taken above the falls at Oregon City, achieving the distinction of being the first steamer to run on the upper river.

The first boat to run between Canemah (just above the Willamette Falls) and Corvallis (105 miles above) was the *Multnomah,* a side-wheel steamer about 100 feet long. Corvallis was at that time, October, 1851, known as Marysville, the name being changed by the legislature to Corvallis January 1, 1854. Following this, various boats—*Canemah, Washington,* and others—took part in the upper river transportation, the southern limit at this time being Corvallis. In 1854 the competition on the run between Oregon City and Portland increased to an extent which makes it questionable whether there was enough business to go around. At this time the steamers *Gazelle,* running between Oregon City and Corvallis, and the *Oregon,* running between Oregon City and Lafayette, on the Yamhill River, were monopolizing the transportation business on the river above Willamette Falls. Passenger rates from Portland were $3.00 to Lafayette and $5.00 to Corvallis, and freight charges $15.00 per ton to Lafayette, and $20.00 per ton to Corvallis. The steamer *Belle* carried all upper-river freight from Portland to Oregon City, whence it was transferred by portage at Oregon City to the steamers above the falls.

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In March, 1856, the steamer *Canemah,* running between Oregon City and Corvallis, announced the following freight rates per ton from Oregon City: Salem, $16.00; Albany, $22.00, and Corvallis, $24.00. Tonnage rates from Portland on the upper river were reduced in May, 1867, as follows: $8.00 to Salem, $10.00 to Albany, and $11.00 to Corvallis. The Peoples Transportation Company were then running a boat as far south as Eugene, to which place the rate was $16.00 per ton. Special rates were made for flour, oats, apples, separators, and reapers. Hampered by the cost and delay of portage over the falls at Oregon City, the Peoples Transportation Company, in July, 1869, began the work of constructing a canal and locks on the east side of the river. By September of the same year they had excavated three sections and the work was then discontinued.

In 1870 the Willamette Falls Canal and Locks Company secured, by an act of the State Legislature, October 21, 1870, assistance to the extent of $200,000 in 10-year 7 per cent State bonds for the construction of a canal and locks on the west side of the river. An agreement was made that the company should limit their charges for toll to 50 cents per ton of freight and 10 cents per passenger. An unsuccessful effort was made about the same time by the Peoples Transportation Company to interest the Legislature in the completion of the canal and locks upon which they had already commenced work on the east side of the river. In accordance with an agreement made with the State to complete the work of constructing the locks on the west side of the river by the end of 1872, the Willamette Falls Canal and Lock Company formally opened the locks to traffic January 1, 1873. From that time to date the locks have been in continuous operation. The locks were operated with toll by various companies until April, 1915, when they were purchased by the United States. Since then they have been operated by the Government without toll.

Until the locks were opened, the bulk of the traffic was handled by the Peoples Transportation Company, who at one time operated seven steamboats above the falls at Oregon City and two below. Transfer was made on a mule-track railroad from Oregon City to Canemah, a distance of about one mile.

Prior to 1872 there was no organized plan for maintaining the channel of the river, but the steamboat *Success,* owned by the Canemah Transportation Company, was engaged by the Peoples Transportation Company from time to time to remove obstructions in the upper river.

Improvement of the river by the general Government was first undertaken in 1871, with an appropriation of $16,000, under the river and harbor act of March 3, 1871. The work consisted of removing snags and scraping bars.

About this time the Peoples Transportation Company, who for ten years had practically controlled the upper river traffic, sold their interests to Ben Holladay, who organized the Oregon Steamship Company to carry on the business.

At the formal opening of the newly constructed locks at Oregon City, January 1, 1873, the first vessel to pass through the locks was a small stern-wheel steamboat, the *Maria Wilkins.* From this date there was keen rivalry for the business on the upper river, various local companies vieing with each other, and with independent steamboats, for the privilege of carrying the rich crops of the valley to the markets.

In 1874 Capt. U. B. Scott designed and built the *Ohio,* a light-draft stern-wheel steamboat. The *Ohio* made her first trip December 12, 1874, proceeding up the river to Eugene on a draft of 8 inches light. The return trip was made to Portland with a load of 70 tons of wheat. As no other boat then on the river could come within 40 miles of the upper Willamette River points the *Ohio* could reach, the venture was a financial success. Strenuous rivalry existed for several years, until in 1881 the Oregon Railway and Navigation Company secured and held the bulk of the upper river traffic.

In 1894 the Oregon City Transportation Company started a boat on the run from Portland to Independence, 83 miles, making the ninth steamer plying on the upper river. Competition became still more acute, until in 1904 an agreement was reached to turn the business over to the Oregon City Transportation Company, the railway company agreeing to withdraw their boats from the upper river. The Oregon City Transportation Company held a practical monopoly of the upper river traffic until May, 1918, when their boats were withdrawn, owing to lack of business. Since then two attempts have been made to renew regular traffic, but in each case the effort resulted in financial disaster.

Investigation as to the reason of the failure of the Oregon City Transportation Company to successfully maintain their boats on the river developed the following contributary causes.

(1) An aggressive and successful campaign by the Southern Pacific and Oregon Electric Railroad Companies in 1913 to secure the bulk of the local traffic for their respective lines.
(2) Failure of the boat company to maintain a business front in opposition to the railroad competition.
(3) Lack of determined effort on the part of the boat company to afford satisfactory accommodation to the public.
(4) Irregular and unsatisfactory boat schedules.
(5) Increase in cost of materials and labor.
(6) Insufficient differential in rates which was found to be but 4 per cent in favor of water traffic. (See note below.)

Note.—The 1912 final report of the National Waterways Commission (Senate Document No. 469, 62d Congress, 2d Session) states on page 556, under the head of "Comparative rail and water rates," as follows: "The amount of difference between rail and water rates necessary to give the waterways a fair share of the traffic varies in each case according to the circumstances. Ordinarily a difference of at least 20 per cent is necessary. In some cases on the Mississippi, hull and cargo insurance alone would require a difference of 33-1/3 per cent. There are instances, however, both in the United States and abroad, where the waterways secure a large traffic at rates as high or even higher than those charged by the competing railway."

From 1871, when, as above stated, the United States first appropriated funds for the improvement of the Willamette River above Portland, to 1920, there had been expended by the Government for this purpose a total of $1,013,880, of which $498,078 was for new work and $515,802 for maintenance. As a result of this expenditure, the river is in good navigable condition, has a depth of 6 feet at low water between Portland and Oregon City and 2½ feet between Oregon City and Corvallis. Above Corvallis there is but little traffic, and that only at the higher stages of the river. The distance by water from Portland to Corvallis is 119 miles.

There is at present no public service transportation on the river above Oregon City, and it is worth while to consider why this river traffic has within a decade dropped from a remunerative business to practical extinction.

The decline began in 1913, when the Southern Pacific and Oregon Electric Railway Companies succeeded in persuading the valley merchants and farmers that they could supply more satisfactory transportation than the boat service. It is probable that if the water traffic interests had met this inroad into their business with increased facilities and more regular and reliable schedules the boats might yet be running. However, no such effort was made, and since October 17, 1920, when the steamer *Northwestern* was taken off the upper river by her owners, the Portland Transportation Company, there have been no regular boats running above the falls at Oregon City. The company stated that their venture was not a financial success.

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It is possible that to the causes contributing to the failure of the water traffic companies may be added the competition of the auto trucks operating on the highways. At the present time there is no doubt that this highway auto traffic is a real menace to the water-borne commerce of Oregon, and perhaps to the water-borne traffic of the United States. It is not within the scope of this article to discuss the larger aspects of the subject, but the local situation as affecting the present trafficless condition of a formerly busy section of the Willamette River is worth investigation.

Prior to 1918, when comparatively few auto trucks were operating, truck competition was not materially felt on the river. Since then there has been a rapid growth of this business, until even the railroads are considering whether it may not be necessary to absorb this traffic to co-operate with their own systems of transportation.

In March, 1918, a line of trucks was started between Portland and Eugene, 127 miles. The service is controlled by the Willamette Valley Transportation Company. Following are their present freight rates per hundred-weight compared with the railroads:

	Portland to Salem		Portland to Eugene
Class	Auto	Railroad	Auto and rail rates are equal
1st	30 cents	37½ cents	72 cents
2nd	26½ cents	33 cents	61½ cents
3rd	22½ cents	28 cents	50 cents
4th	20 cents	25 cents	44 cents

It is to be noted that Salem is easily accessible by river and Eugene is not.

The business of the Willamette Valley Transportation Company has developed since 1918, until to-day they are operating a 24-hour service with 16 auto trucks. The average day's load is 50 tons, with a maximum capacity of 100 tons. The concern is run on a co-operative plan, each man owning his truck and working on a commission basis. The average operating cost per day per truck is $16.00.

The auto truck is here to stay, and it is not unlikely that its advent will put some of the smaller rivers of the country out of business so far as the transportation of freight is concerned. With rates by auto truck closely similar, and with the added advantages for the truck of more rapid delivery, combined with a warehouse to warehouse service, it seems hardly possible that the small river traffic can survive.

Discussion

By

Charles Keller
Colonel, Corps of Engineers

The preceding article by Assistant Engineer Thomson might, with minor modifications, be adopted as a fair discussion of the state of navigation upon many of our small inland rivers, on which the general rule is that traffic at the present time amounts to little or nothing.

The question arises, Whether the day of the minor waterway has definitely gone or whether, on the other hand, it may be restored to its former position of usefulness as part of a properly planned transportation system? To this question it is impossible to give a reply applicable to all. Probably some of them are in a state of permanent decline and will never again really be useful. Others appear merely to require that they be made to give service in accordance with modern developments to be once more the scene of a remunerative traffic.

It is axiomatic that what the customer desires is the best service obtainable for the least money. Speaking in terms of transportation, what he expects of the Willamette River or any other waterway is that he shall be able to move his commodities upon it at least as conveniently and satisfactorily as he can have them moved by rail, by electric trolley car or by motor truck. To fulfill this demand on the part of the public, vessel interests must therefore furnish, at reasonable rates, a dependable, regularly scheduled service, equivalent to the most convenient service that can be given by any other agency. To do this, they should have capital sufficient to enable them to procure plant of the most economical and efficient kind. They must accept responsibility for the safe and proper handling of goods committed to their care, and probably, in the majority of cases, they must be prepared to make store-door delivery. The Willamette Valley is apparently a prosperous, well-settled farming community. The freight to be handled is high grade, and if there was enough of it to keep quite a number of river boats busily occupied prior to 1913, it seems quite clear that the loss of the business to the river since that time must have been due to the fact that the Southern Pacific and the Oregon Electric Railway Companies were able to prove that they could be relied upon for better service.

Taking the average of the motor-truck rates between Portland and Salem, listed herein, it will be seen that the charge for a haul of approximately 60 miles is $5.00 a ton, or say 8 cents a ton mile. A properly organized vessel line, capably managed, ought to be able to build up a profitable business on rates much less than this and to absorb the cost of store-door delivery at both ends of the haul. Everything, however, depends upon the quantity of traffic available in the territory under consideration and the daily rate at which it moves. If the business to and from Salem is as much as 50 tons a day, apparently it ought to be possible to organize a motorboat service or an economical steamboat service to handle this business on regular schedules. In the final analysis, however, what is needed is to find out just what the business is and then to ascertain what must be the equipment and service to handle it to the customer's best satisfaction. Undoubtedly there seems, on the evidence, opportunity for modern equipment and progressive management to establish on the Willamette River a common carrier service which should also exchange business on through-bills of lading with rail lines and other common carriers.

Mechanical-Chemical Protection of Piles

In THE MILITARY ENGINEER for May-June, 1920, we published a short article on methods of providing mechanical protection for piles. The article discussed several schemes of completely armoring the piles by jackets made of concrete, vitrified pipe or sheet metal. It also mentioned the fact that the Romans had made use of nails—studding the exposed surfaces as a protection against the ravages of the Teredo—and stated that this method was still used in European waters. Apparently the nails used had large square heads and were so driven that the edges of the nailheads touched, thus forming a complete metal casing for the surface of the pile.

A variation of this method has been tried in the harbor at Charleston, S. C., using nails about one inch long with round heads one-fourth inch in diameter, spaced on three-fourths inch centers. This leaves by far the greater portion of the surface exposed. The resulting protection is chemical rather than mechanical for the reason that in the salt water the nails at once begin to rust and the products of the corrosion impregnate the interior of the pile to the depth of the nails. This impregnation has proved an effective protection against the activities of both the ship worm (*Teredo Navalis*) and the gribble (*Limnoria Terebrans*). Piles so protected have been in use for three years and disclose no indications of either the Teredo or the Limnoria, while other untreated piles of the same species, driven at the same time, have long since ceased to be of any value.—*C. A. Y.*

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A Science of Infantry Tactics*

By

Capt. B. H. Liddell Hart, K.O.Y.L.I.

Reprinted from *The Royal Engineers Journal.*
[Concluded.]

The Expanding Torrent System of Attack Against Defence Distributed in Depth

We have dealt so far with the principles of attack on any one body or center of resistance of the enemy.

In modern war, however, armies are distributed in great depth, and the attackers are faced with the problem of breaking through a series of positions extending back in layers to a depth of several miles.

To this problem, an effective and scientific solution has yet to be found. Moreover, every defending infantry unit also is itself distributed in depth in successive posts. We need to invent a system which will ensure—as far as is humanly possible—that our attack sweeps through and overwhelms the successive layers of the defence with an unslackening momentum combined with a minimum loss of men.

We have learnt by bitter experience, that it is sheer waste of force, when we come against an enemy position, to press our attack equally at all points.

We must feel and test the position everywhere, and endeavour to push in the weight of our reserves where a weak spot is found or made. This principle has been definitely established and the problem yet to be solved is our tactics when an initial breach has been made at any point in the first layer of the defence.

On the one hand, if we press forward at full speed beyond the gap without attempting to widen it simultaneously, it is risky. We lose the *weight* of our blow because we cannot push adequate reserves through a bottle neck. We lose *time* because the passage through a narrow gap causes delay and confusion. We *endanger our security* because we leave the enemy on our flanks untouched, and so able to cut off the head of our advance.

On the other hand, if we halt our advance while we widen the breach, we lose *time,* the advantage of *surprise* and the *opportunity* of exploiting our initial success, thus allowing the enemy time to organize strong resistance in rear, and await us. Hence we must create a scientific system of attack which will reconcile and combine *speed with security.*

The breach must be *widened in proportion as the penetration is deepened,* by automatically progressive steps beginning with the platoon and working up to the brigade.

Such a system I have endeavoured to deduce by examining and analysing Nature's method of attack.

If we watch a torrent bearing down on each successive bank or earthen dam in its path, we see that it first beats against the obstacle feeling and testing it at all points.

Eventually it finds a small crack at some point. Through this crack pour the first driblets of water and rush straight on.

The pent up water on each side is drawn towards the breach. It swirls through and around the flanks of the breach, wearing away the earth on each side and so widening the gap.

Simultaneously the water behind pours straight through the breach, between the side eddies which are wearing away the flanks.

Directly it has passed through, it expands to widen once more the onrush of the torrent. Thus as the water pours through in ever increasing volume the onrush of the torrent swells to its original proportions, leaving in turn each crumbling obstacle behind it.

Thus Nature's forces carry out the ideal attack, automatically maintaining the speed, the breadth, and the continuity of the attack. Moreover the torrent achieves economy of force by progressively exploiting the soft spots of the defence.

By applying this natural system to battle I deduce these principles for the attack against defence in depth:

i. The forward sub-unit which finds or makes a breach in any of the enemy's positions should go through and push straight ahead so long as it is backed up by the manœuvre body of the unit.

ii. The forward units on its flanks who are held up should send their manœuvre bodies towards and through the breach. These will attack the enemy in flank, destroy his resistance and so widen the gap.

iii. Meanwhile, the units in rear press through the gap and deploy (expand) to take over the frontage and lead the advance in place of the temporarily held up units.

iv. The held up units, as soon as they have accounted for the enemy opposing them, follow on as manœuvre units to support the new forward units.

(N. B. If the forward units are able to clear away the enemy opposing them before the rear units have passed through the gap they will naturally continue to lead the advance.)

Thus an automatic and interchangeable system of attack will be achieved. This system is applicable to all units and formations from the platoon upwards.

Taking for example the infantry attack: the left forward platoon of a company might find or make a gap whilst the right platoon was held up (see Plate I). It would press straight ahead, whilst the company commander moves towards the gap with his manœuvre platoons (see Plate II). The held up platoon is still engaged with the enemy resistance, when the company commander has passed through the gap. He will therefore send one of his manœuvre platoons forward and to the right to take over the frontage of the held up platoon and carry on the advance in its place (see Plate III).

If the company commander judges that the held up platoon can destroy the enemy resistance by its own resources, he will press on at once with his remaining manœuvre platoon, to back up the forward platoons.

If not, he helps the held up platoon by a flank attack before following on.

In any case, directly the enemy has been destroyed the checked platoon would follow on as a new manœuvre platoon.

The company commander would be ready to repeat this method against each successive position of the enemy, thus

*A lecture delivered at the S.M.E. on 6th Jan., 1921, by the author.

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ensuring the relentless momentum of the torrent. (See Plate IV.)

Likewise the battalion commander may infiltrate his manœuvre company through the gap made by an advancing forward company to expand the front and replace another forward company whose advance is checked or delayed.

Thus any gap in the defensive system will be progressively enlarged and deepened on the initiative of each successively higher commander.

The battle tactics of infantry will become automatic and depend less and less on fresh orders from superiors in rear. Moreover artificial geographical objectives will be restored to their right position as mere stepping stones in the advance. We shall fulfil the principle of economy of force by concentrating our efforts on the only true objective—the enemy.

Thus we see that the respective phases of *Reconnaissance, Fixing* and *Decisive Manoeuvre* will be carried out against each successive resistance, whilst the "expanding torrent" will ensure that the momentum of the attack is not lost by the delay caused by the clearing of these enemy defence posts.

Maxim i. No forward unit must however press on even if it finds a gap, unless it has cleared, or made arrangements to clear, all enemy resistance within its frontage.

Maxim ii. To ensure good team work in the confusion of battle, every unit commander, separated from his own superior, who finds another similar unit in front of him engaged in fixing the enemy, must be ready to act as a manœuvre body to the unit in front. To this end he should get in touch with the unit in front and find out if the latter requires him to aid it by a decisive manœuvre.

Maxim iii. In the case of the platoon, its commander must remember that his sections are not tactical units. This means that they are not composed of interdependent fighting parts and so capable of fixing and manœuvring simultaneously. They possess no manœuvre body of their own, and therefore the platoon commander must use his own manœuvre sections to help any of his forward sections which are held up, before continuing his advance.

Maxim iv. The forward section therefore which finds or makes a gap should only make a bound as far as the nearest tactical point from which it can cover and hold open the breach. It will not move on until it sees the rest of the platoon coming on to back it up.

Maxim v. In the attack against a large force distributed in depth, the expanding torrent system will abolish the need for battalion pursuit. Hence the battalion commander may use his reserve company, also, for replacing forward companies.

Three outstanding advantages of this system are firstly that an automatic continuity of the pressure of the advance is ensured, secondly, that the expanding of the front of the advance rests with the immediately superior commander, thus ensuring that tactical unity is preserved instead of an unorganized dog fight to get forward, with each unit playing for its own hand; thirdly, that the units which lead the advance will automatically be those which have encountered the least opposition. This will mean that the leading infantry are those which are freshest and have the most ammunition. It will be far easier to supply extra ammunition to those who have fallen behind than to those who are leading the advance.

Infantry in Defence

The defence is simply the attack halted. *Any unit which halts its advance is capable on account of its open and self-contained formation of offering an immediate resistance to any hostile attack or counter-attack.*

Thus it resembles our simile of the human tank, possessing both the power of offence and defence. It only remains for it to consolidate the ground within its area so as to gain the most cover and best field of fire.

Once we have grasped this obvious truth the whole problem of tactics in general, and defence in particular, will be vastly simplified. Our previous method of creating a complex system of watertight compartments for each tactical action appears truly unscientific.

From this realization that defence is the attack halted, we deduce the truth that the five battle principles of protective formation, reconnaissance, fixing, decisive manœuvre and exploitation are equally applicable to the defence as to the attack.

A.—PREPARATION.

I.—Formation.

This will be generally similar to that of the attack. The company and platoon will be distributed into a forward body and manœuvre body. The battalion or higher formation into a forward body, manœuvre body, and reserve. The reserve will consolidate a final position of resistance for the battalion, or brigade.

Maxim i. Each unit in defence should be allotted an area to hold, and not a definite point. Thus if the enemy takes a defence post at a disadvantage, by crushing shell fire, smoke or manœuvre, the commander should use his initiative to quit the post and take up a fresh position on the flanks of the post so that he can out-manœuvre the attacking infantry.

Maxim ii. One difference in regard to the formation in defence will be that the manœuvre bodies can be previously placed in readiness on a rear flank of the forward body. They should be placed to cover with enfilade fire the flank on which it is most likely that the enemy might break through. They should take up a position from which they can best sweep the breadth of their area with fire.

Maxim iii. The actual distribution in defence will depend mainly on the frontage and the field of fire. Two sub-units forward and two for manœuvre will be normal, but if the field of fire is restricted it will be best to place three sub-units forward and one for manœuvre. The essential need is to cover the whole area with intersecting rays of fire from the posts of the sub-units. A diamond formation, modified according to the ground, is very suitable for the forward platoons in defence.

Maxim iv. It will be advisable for all forward, or stationary defence, platoons to consolidate in section posts in order to cover more ground with fire.

Maxim v. In the case of manœuvre platoons it will normally be advisable for them to consolidate in platoon posts so that they may be kept more concentrated ready for manœuvre.

The "Contracting Funnel" in Defence

Just as manœuvre is far superior to frontal attack, so manœuvre fire which enfilades the enemy from a flank is the most damaging both in material effect and to the attackers' morale. It represents the main sub-principle of economy of force, which is surprise. Thus the defence should be so disposed as to develop their greatest fire effect to the flank. To this end it should be our aim so to dispose infantry for defence, that the attacking enemy is encouraged to penetrate into channels in which he can be raked by flanking fire.

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One step towards this is to site our Lewis and machine gun posts to mutually support each other with fire, rather than to fire direct to the front.

Another is the placing of manœuvre bodies so that they fire mainly to a flank.

A third way is to *echelon* backwards the posts of the manœuvre platoons and companies along the natural channels of approach to form a gradually contracting funnel raked by fire. Thus the further the attacker penetrates the more resistance he encounters and the more confined becomes the space in which he can manœuvre.

A diagram of a battalion disposed for defence may make the idea clear.

If we study such a disposition, it becomes apparent that the only effective counter to such defence is the "continually expanding torrent" system of attack.

II.—Reconnaissance.

1. Preparatory reconnaissance will be carried out on similar lines to that for attack. Each commander both before taking up a definite position and during its occupation should study all available information, personally survey the ground and the possible ways of manœuvre, and send out company scouts on special missions.

2. Battle reconnaissance will be carried out mainly by patrols.

Maxim i. If not yet in contact with the enemy they should be sent out to keep watch on all likely lines of approach.

Maxim ii. When in contact with the enemy as in position warfare, they will be sent out at night, in fog, or in dense country by day to keep his forward defences under observation, discover his dispositions, and give warning of a likely attack.

Maxim iii. They should usually be supplied by manœuvre or reserve bodies.

Maxim iv. In darkness or fog, patrolling is the best means of protection from surprise, and not the massing of more infantry in the forward positions.

Maxim v. Patrols and observation posts should be used by manœuvre and reserve bodies during an enemy attack to obtain information as to the situation in front and flank, and so enable instant and correct action to be taken.

III.—Fixing.

Defence in itself is one method of fixing the enemy. It is incapable of beating him, and therefore a defensive attitude will only be assumed in order to fix and weaken the enemy so that another force may be able to attack the enemy decisively elsewhere, or that you may yourself attack later when his vigour is spent.

In the actual infantry defence the phase of fixing is carried out by the forward bodies. If the forward and manœuvre companies of a battalion fail to fix and break up the enemy's attack, it will be the duty of the reserve to fix him in order to allow higher formations to decisively manœuvre against him.

Maxim i. Forward bodies holding positions should defend to the last man and the last round the area allotted to them.

Maxim ii. To instil this idea that troops who have consolidated should not withdraw, fighting patrols should be detailed from the reserve if it is desired to harass the enemy's attack before the main positions of resistance are reached. Moreover troops who have consolidated are more likely to hold on too long, and so if allowed to withdraw would mask the fire of the posts in rear when they fall back.

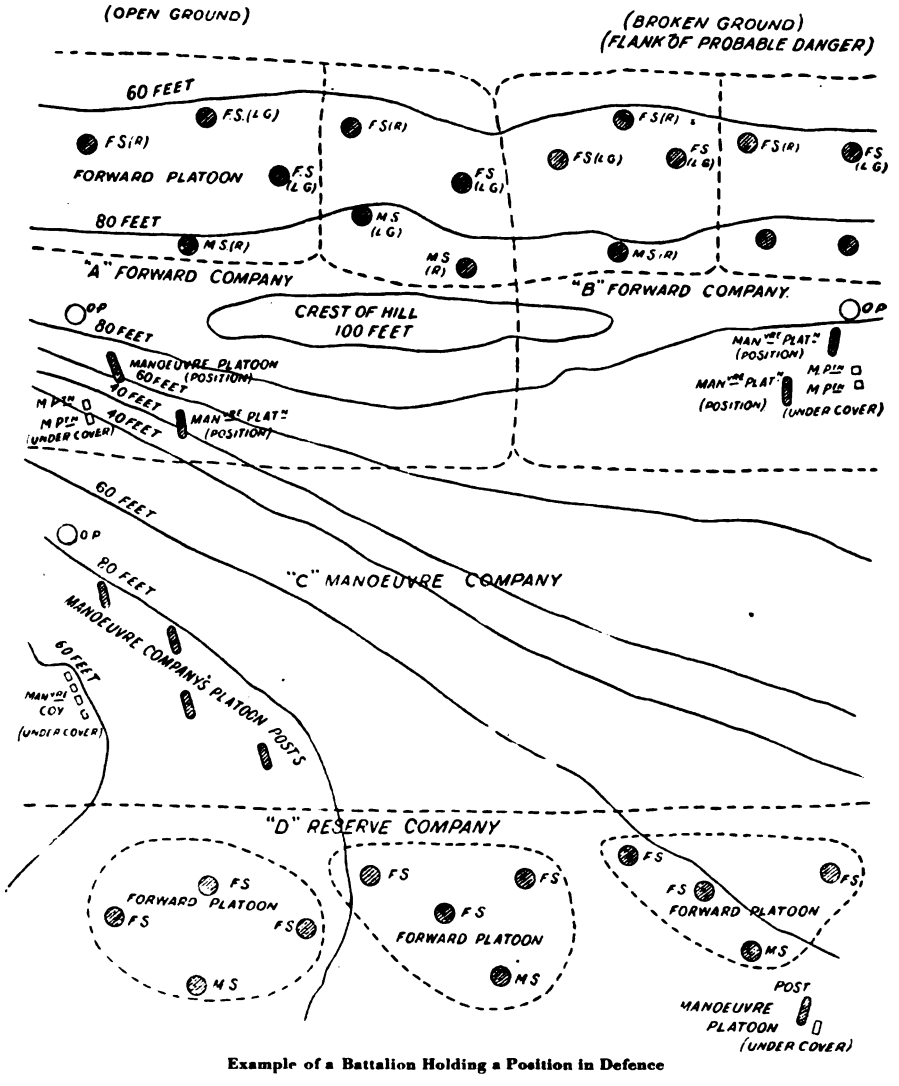
Maxim iii. The *role* of forward bodies is stationary defence by fire.

Maxim iv. The commander of any forward section must however be ready to quit the post and take up a position on its flank, if the enemy take it at a disadvantage by shells, smoke or manœuvre.

B. (IV).—DECISIVE MANOEUVRE.

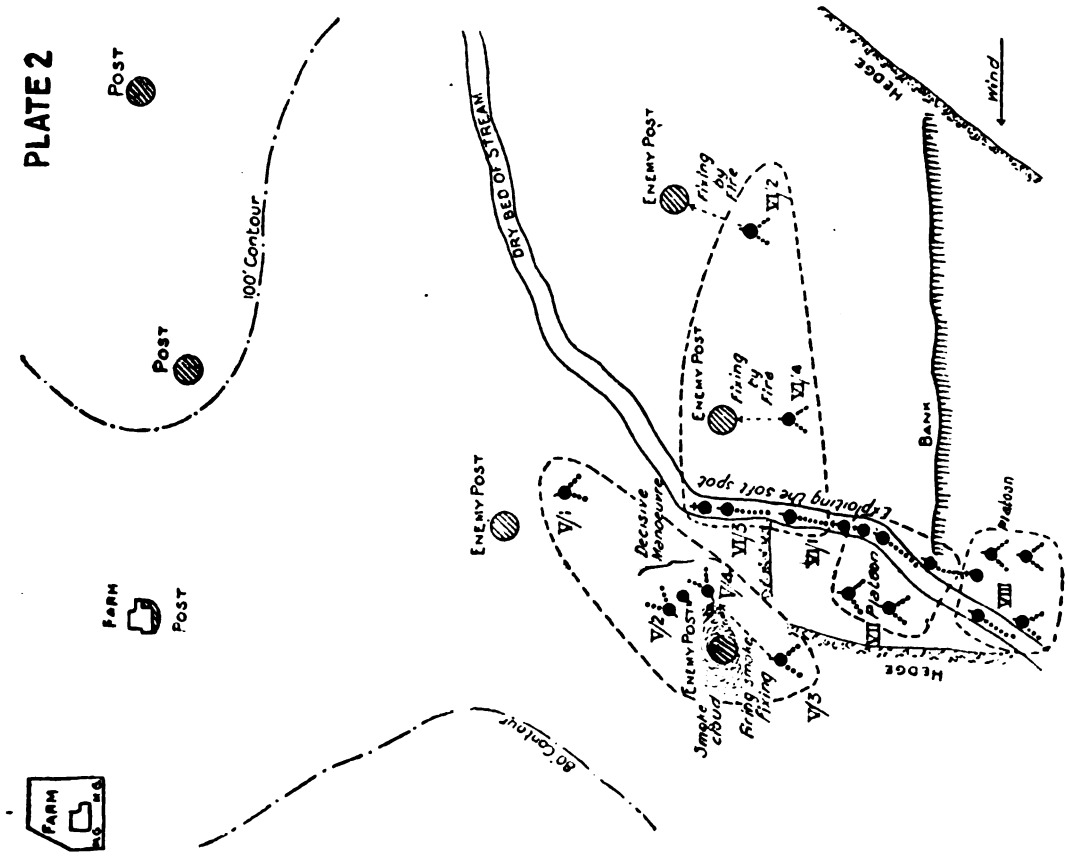
The manœuvre bodies carry out the decisive manœuvre in defence as in attack.

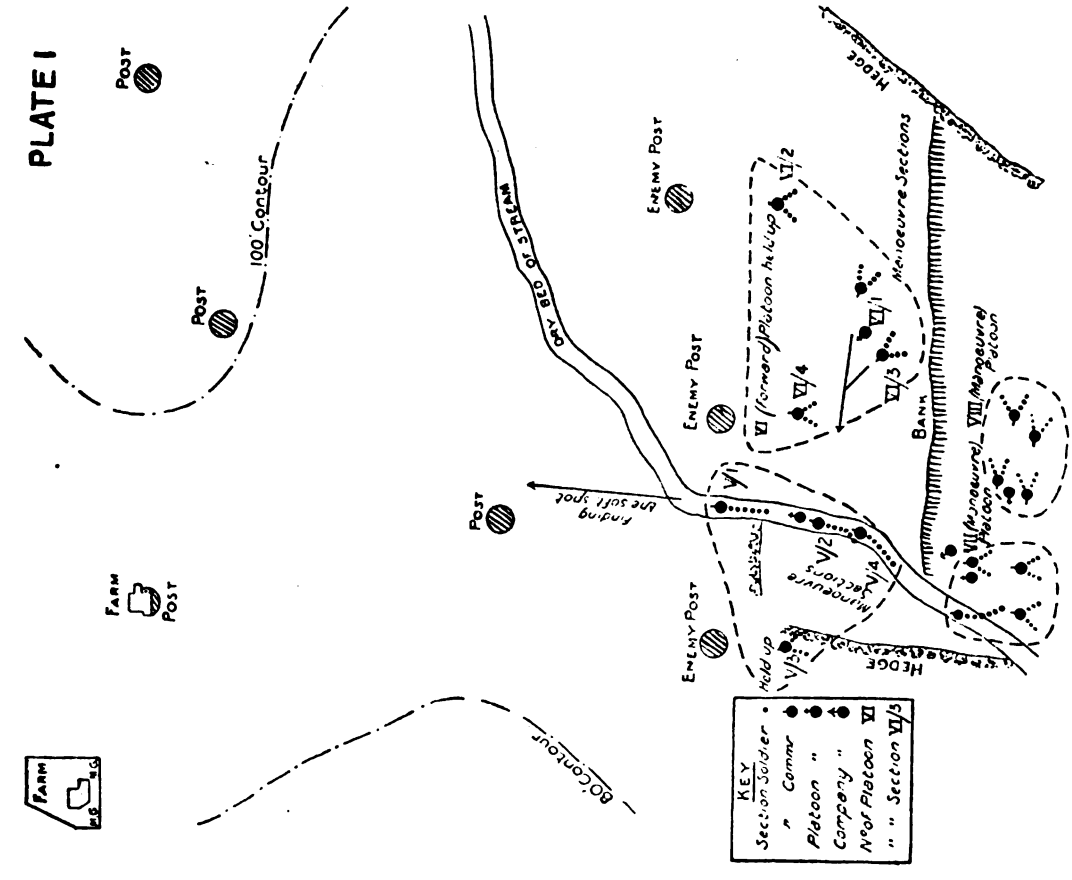
If the enemy makes a gap or effects a lodgement in the positions of the forward body, the manœuvre body will make an immediate counter-attack to throw him back, or manœuvre by fire to close the breach and destroy him in a contracting funnel.



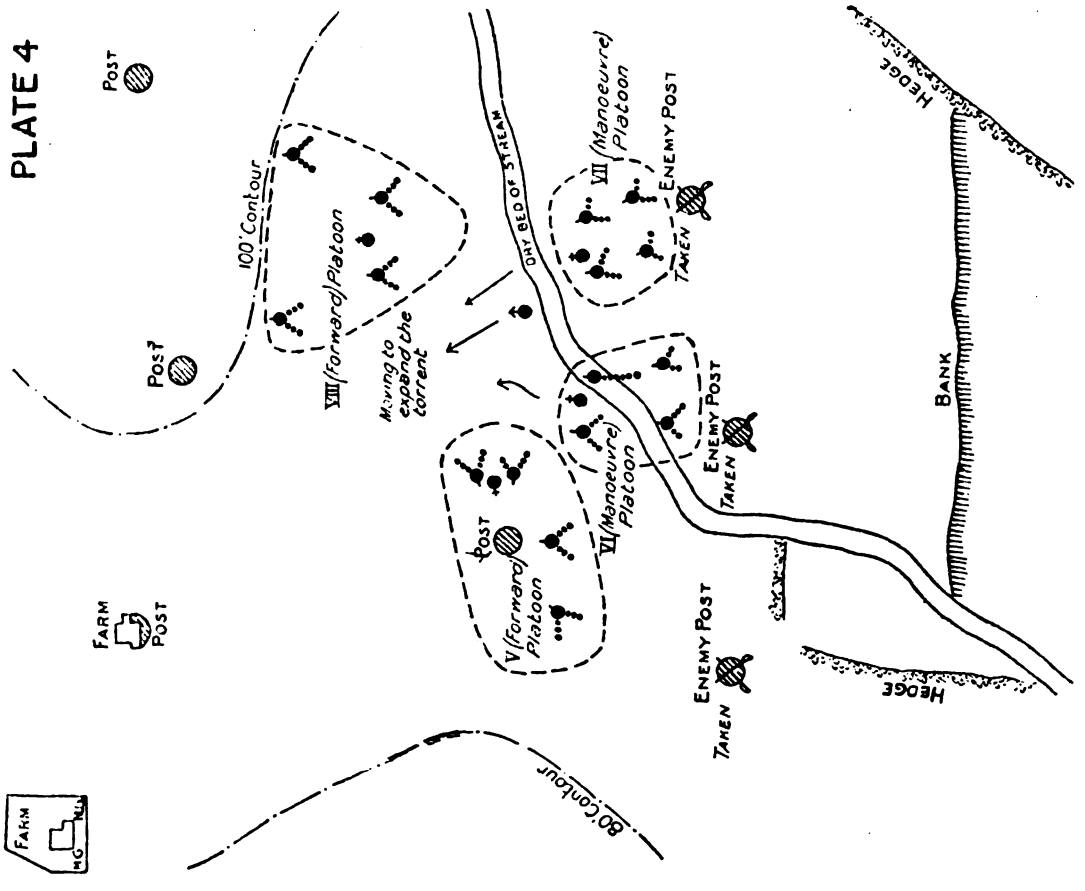
Example of a Battalion Holding a Position in Defence

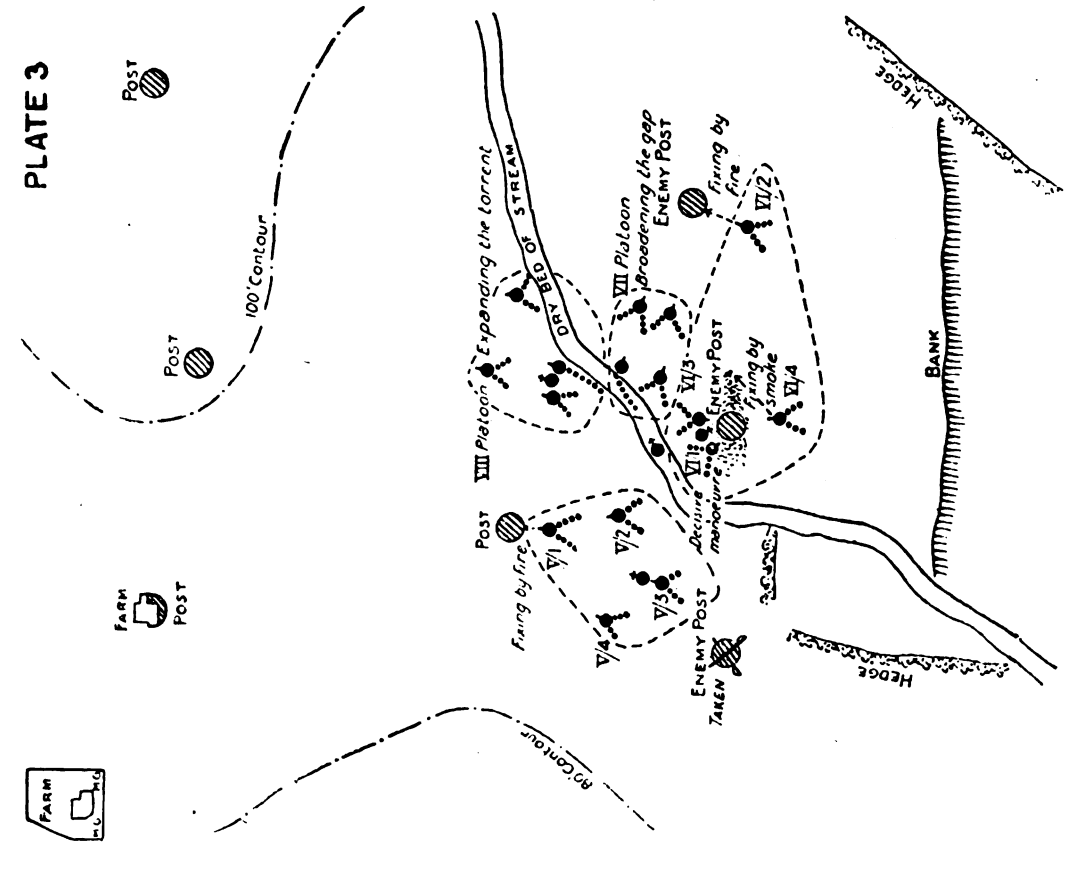
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The function of its commander is manœuvre, which does not necessarily imply assault.

The commander of a manœuvre company or platoon has a choice of two main alternatives:

1. If the enemy break through the forward positions quickly and on a broad front, it will be best for him to man his prepared positions to take enemy in flank by fire.

2. Otherwise he should manœuvre to assault or fire.

Maxim i. A counter-assault which fails is a sheer waste of force. Hence it should not be launched unless the enemy is engaged with other defending units.

Maxim ii. Lewis gun sections of a manœuvre platoon may be used to surprise and fix the enemy with fire while the rifle sections assault.

Maxim iii. If the company commander decides to manœuvre to fire he should move to suitable positions on the flanks of the enemy's breach from which he can enfilade.

Maxim iv. Above all he must remember that whether he uses fire or assault, or both, it will be most effective if delivered against the flanks of the enemy's wedge of attack. In this way the flanks of the breach will be strengthened and his advance cut off.

Maxim v. A counter-attack will be carried out according to the same principles as for the attack, but a definite objective should be fixed for it, and it should never be pressed beyond the forward positions of the defence.

Maxim vi. The one great advantage which the defence possesses is that every move can be thought out and rehearsed beforehand. Every possible line of enemy advance should be reconnoitred and plans worked out for countering them. The possible routes of manœuvre and fire positions on them for each manœuvre company and platoon should also be reconnoitred and marked.

Maxim vii. A counter-attack by any unit smaller than a platoon is rarely effective. Hence fire and not counter assault is the best course for manœuvre sections to adopt.

C (v).—EXPLOITATION.

Exploitation is the counter-offensive when the enemy's attack has failed, and is therefore not true defence.

Outposts.

It should be clear from our analogy of the human tank that outposts *are* simply a temporary form of defence.

Maxim i. When contact with the enemy is unlikely the main consideration is to rest as many troops as possible. Hence units should usually be disposed with only *one* subunit forward and three for manœuvre.

Maxim ii. It will suffice, particularly at night, if the main channels of approach are covered by forward bodies.

Maxim iii. With this reservation the disposition and routine duties of outposts will be similar to those for defence. Only the first stage of consolidation—disposition over the ground for observation and resistance, will be needed.

Maxim iii. With this reservation the disposition and routine duties of outposts will be similar to those for defence. Only the first stage of consolidation—disposition over the ground for observation and resistance—will be needed.

Retirements.

These are simply a mobile defence.

Maxim i. Hence security is the first consideration.

Maxim ii. Retirements should be carried out therefore by a series of leapfrog bounds, the forward body retiring behind it, from which, in turn, it can cover the retirement covered by the fire of the manœuvre body to a position of the manœuvre body. Thus the strain of holding off the enemy will be evenly distributed between forward and manœuvre bodies.

Maxim iii. In flat country zig-zag bounds should be used to avoid the risk that the fire of the covering body may be masked by the retiring body.

Maxim iv. If the enemy presses the retiring body too hard, a sudden counter-attack should be made by the manœuvre body to relieve the pressure.

Summary

Thus we see that by working out our principles of tactics upwards from the elementary, instead of downwards from the complexities of large operations, we can simplify infantry tactics to a flexible framework of clear principles which are applicable to all forms of action. This frame work provides us with a sound base upon which to build up our practical knowledge of ground and weapons. It has been the hope and aim of the author to create the foundations of a true science of infantry tactics.

Good Roads

The growth of "The Good Roads Movement" in the United States and Canada since its organized inception in 1880, and with the great stimulus it received in the periods immediately following the advent of the automobile and the appearance of the motor truck has been so rapid, so extensive and so effective that highway construction to-day constitutes one of the greatest, if not the greatest, problems in American economic life.

There are now 1,702 organized agencies actively and directly pleading the cause of good roads. The agitation, to date, has brought about the construction of 310,000 miles of surfaced highways—raising the highway mileage of the United States to 2,478,552 and that of Canada to 255,000.

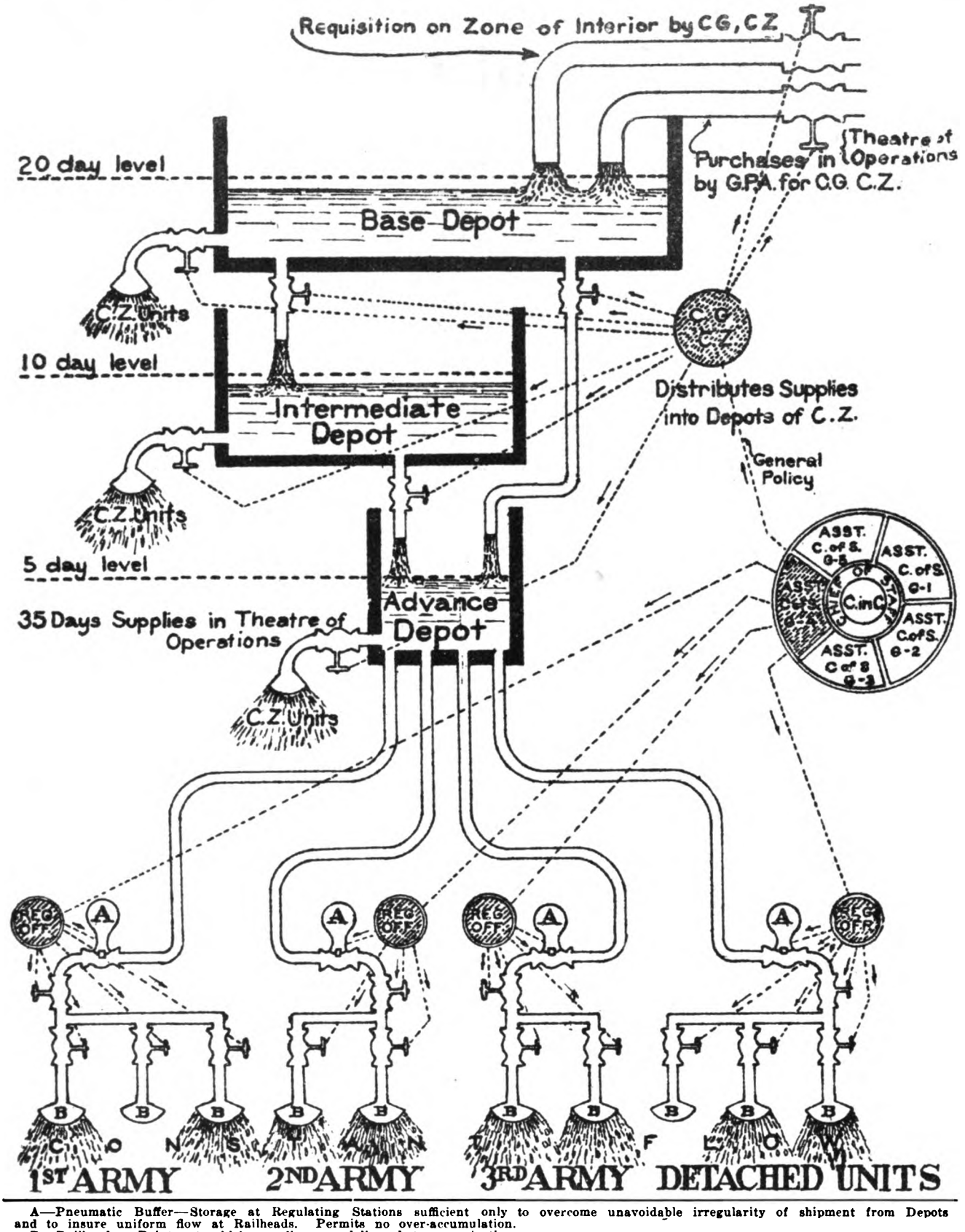
The automotive industry, fourth largest in the country, with 368 manufacturing plants capitalized at $1,204,378,642 and employing 325,000 workmen; having an annual output of 2,205,197 passenger cars and trucks valued at $3,594,814,620, and supplemented, as it is, by 1,900 firms producing auto parts valued at $300,000,000 a year, together with 1,000 firms manufacturing annually 35,000,000 tires valued at $1,000,00,000, is absolutely dependent upon highway improvement for its stability and upon increased road mileage for greater expansion. In addition, 33,000 distributors of automobiles are involved as well as 45,800 dealers in automobile accessories and 35,000 dealers in tires. So great, too, has the road-building industry become, in consequence of the demand for improved roads, that there are now 7,500 contracting firms engaged in actual construction work. The roads are now traversed by 9,211,295 licensed cars and trucks, of which 3,000 are used on the farms. These cars consumed 3,200,000,000 gallons of gasoline.

Prior to 1880, when Amos G. Batchelder, late Chairman of the Executive Board, American Automobile Association at Washington, with H. S. Earle, of Detroit, and other pioneer advocates, organized the League of American Wheelmen and began a systematic campaign, a good roads enthusiast was looked upon with undisguised curiosity or amusement as something of "a nut"—a loquacious, but, no doubt, well-meaning person who might be seen but not heard. Usually he was "sat upon" by the taxpayer.

Opposition gradually melted away, however, as the campaign became more fully organized and extended. Since 1880 more than $3,000,000,000 has been spent for highway improvement in the United States and Canada. More than $1,300,000,000 is now available, and $1,500,000,000 additional will be necessary to carry out projects under contemplation. And yet, with all this, only a beginning has been made. Billions more must be expended before the country has anything like a highway system adequate to the traffic needs.—*Highways Information Service, N. Y.*

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Graphic Representation of System of Supply in the Theatre of Operations



A—Pneumatic Buffer—Storage at Regulating Stations sufficient only to overcome unavoidable irregularity of shipment from Depots and to insure uniform flow at Railheads. Permits no over-accumulation.
B—Railheads. Points at which supplies are delivered to organizations.

The accompanying chart is self-explanatory. It was originated in the 4th Division, General Army, A. E. F., a short time prior to the armistice. It was reproduced in its present form by the General Staff School, Fort Leavenworth.

The abbreviations are as follows—

C. G., C. Z.—Commanding General, Communication Zone. (Note—In future the abbreviation "Cn.Z." will be used instead of "C. Z."
G. P. A.—General Purchasing Agent.
C. in C.—Commander-in-Chief.
Asst. C. of S.—Assistant Chief of Staff. The five assistant chiefs of staff handle the following departments: G-1, Administration; G-2, Intelligence; G-3, Operations; G-4, Supply; G-5, Training.
Reg. Off.—Regulating Officer.

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Morale and Leadership

By

J. A. Woodruff

Colonel, Corps of Engineers
Assistant Commandant, The Engineer School

[The following, substantially as here printed, was originally delivered as a lecture to the officers detailed to take the basic course at The Engineer School.—ED.]

Morale

THROUGHOUT the military service we hear constantly of morale—that it is the most important possession of troops and that with morale ten men can beat a hundred. Its value is universally recognized and yet many leaders assume that their men will be endowed with it by nature. They take no means to inspire it—even worse, their conduct of office is often such as positively to injure and even destroy the previously existing morale of their subordinates. It is almost criminal to allow such alleged leaders to be responsible for training men for battle. They are quite as dangerous in training for battle as in leading in the actual battle itself.

The morale of the fighting line has been defined as "that instinctive feeling of strength and superiority which at the very outset gives a feeling of confidence and an assurance of victory through our own irresistible ability." "Having the morale," means that no matter what obstacle or enemy we face, we meet it absolutely confident of our ability to overcome it. *Confidence*—a justified confidence, is, therefore, the real foundation of morale. It is seated in man's loftiest sentiments—patriotism, pride of race, faith in the cause, abhorrence of the enemy's crimes against humanity, determination to overwhelm him, devotion to duty, regards for comrades, loyalty to leader, and in the glory of individual self-respect, skill, vigorous health and general fitness as a superior human being. It is developed by personal example and through intimate talks by the leader with his men on all appropriate subjects, in which he arouses these feelings, always pointing the way to ultimate victory and instilling cheerfulness, pride and determination. But even more, it is developed by the proper training and in the daily handling of the men, in so handling the individual as to develop his self respect and confidence in the excellence of his instruction and in his personal fitness, in so training the team in precise drills and successfully conducted minor tactical exercises that each member is made confident of the skill, team-work and co-operation of his fellows; and above all in the leader's so conducting himself as to inspire the men's confidence in his ability, physical stamina, self-control, judgment and courage.

To develop morale on the drill or manœuvre field requires that the leader be sure and accurate, cheerful, self-controlled, vigorous and undismayed no matter what the discouragement. He must note good performance and commend it, and by encouragement and praise increase his men's endeavor, and confidence in their own ability.

The subject of Morale is intimately connected with that of Leadership. In the discussion of the principles of leadership we find their constant application in how they affect morale.

Leadership

Your first consideration, if you wish to succeed in the military service, is to fit yourself to be the team-captain of your group. To be a good team-captain requires first that you be a good disciplinarian, next that you acquire and use those qualities that characterize natural leaders of men. In all dealings with your men you must have their respect, unhesitating obedience, and if you are man enough to win it, their enthusiastic loyalty.

To attain the confidence and respect of your men, the first requisite is *superior knowledge.* That will give you the self-confidence to appear as a leader, and will justify your men in following you. Therefore, never appear before them unprepared to play your part in the game. You are a sorry object pretending to lead when there are men in ranks who know your part better than you do.

There are many circumstances in which a leader may advise with his subordinates, but it must be clear in the end that the judgment is his own. It is possible, too, for the best men to make mistakes. These should always be frankly acknowledged as such, and no attempt made to bluff them through. Apologies for and explanations of failure are only harmful. The men appreciate manliness; you can not fool them long, and once unmasked as a bluffer, your leadership is hopeless.

It is proper that you should aspire to genuine popularity, to be beloved by your men, to be one of those leaders of whom it is boasted that their men will follow them anywhere. But do not be deluded into thinking that this popularity is attained by easy-going methods, by favoritism, by winking at delinquencies and by overlooking failures in strict performance of duty. Such popularity is false and fades when the real test comes; it changes to disrespect, insubordination and contempt, when real men are at the fore, leading through hardships and dangers. Build your popularity on the firmer qualities of justice and fairness to all; inflexibility in demanding obedience and faithful performance of duty and constant vigilance for the welfare and interests of your men; and above all, by forethought and preparation. In a word, found your position on such qualities and on such conduct of your office as will inspire respect and even admiration for your ability as a leader. Imagine yourself in the other fellow's place and then "do as you would be done by," while not forgetting your own responsibilities as the leader.

It is psychologically true that every group of men, working together for any purpose, soon comes to have a soul of its own. It is true of a company, it is true of a squad. The good leader learns to know that soul, and deal intelligently with it—knows its aspirations, its limits of endurance, how to inspire it to increased endeavor, how to inspirit it when discouraged in fatigue or hardship, how to arouse its interest in the work at hand. There are many means of appeal to this spirit; you must learn and use them.

It is spirit that makes the soldier endure and dare. Especially among volunteers spirit will carry through when

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cold-blooded training alone must fail. Watch the good troop leader; on the march, in camp, at drill, in the class room, by word and even more by thoughtful conduct of the work in hand, he is always fostering spirit. His men know that what he requires is reasonable, they feel that he is regarding their welfare in every move, making their work as interesting as possible and conducive to future success.

Every man delights in work well done, in actually doing well what he puts his hand to. Remember this when you direct the drill or work of your men. They enjoy being "snappy," being efficient, doing the right thing at the right time, avoiding wasted time or energy, and they are disgusted with the reverse of these.

The state of discipline, a mental status, is attained more by a system of rewards than of punishments, yet both are necessary and potent factors. And do not imagine that there is a class to be controlled by punishment alone.

In the system of rewards the leader finds the most powerful ally in building up that discipline which leads to esprit and morale. He must be on the lookout for opportunities to use it. A word or even a look of approbation is often sufficient. In every group will be found natural leaders, men who, when hardships bear down the spirits of the majority, are found doing more than their share, and not only by example, but often by cheerful word or joke, are unconsciously inspiring the whole to better endurance. The leader must find every opportunity to show public recognition of the merit of these men, thus strengthening their influence with their fellows. Give them the important missions; if favor must be shown, be sure it goes to such a man. Again, there are always found would-be leaders of the opposite temperament, chronic pessimists and critics, who by example, and frequently by grumblings and veiled complaint, lower the average of endurance and performance. It is equally important that the leader undermine the influence of these men, quietly giving them the disagreeable details that often must be performed, and never making the vital mistake of appearing to approve by selecting such a man for a conspicuous detail.

In such cases avoid more sedulously still any injustice, either apparent or real, and all appearance of discriminatory action, for this places you in a position of grave disadvantage.

How absolutely important then that a leader truly know the personalities of his men. Not only must he pick the man best qualified for the task at hand, but he must consider the effects of his selection on the morale of his group, and this demands constant observation of his men at their work. He must learn from the very first to know them by name and then study their individual characteristics.

Punishments can not be administered in accordance with any inflexible rule. Every offense involves the elements of the personal equation of the offender, the attending circumstances, the motive, and always the effect on the discipline of the group. Your decision must be the voice of calm impartial justice.

The authority in you to reward and punish the acts of individual men is a great force for good or for evil, not alone to the individual, but through your treatment of his case, to the whole group. Cultivate patience and justice, a knowledge of human nature and of cause and effect. It is also of the greatest value to be able to see from the soldier's viewpoint, as well as from your own.

Since both punishments and rewards are given for their effect on the discipline and morale of the whole group, they should always follow the delinquency as closely as possible, thus giving full effect.

Be calm in emergency; unruffled, even sardonic (if you have it in you) in the face of hardships; unperturbed and even casual in the face of danger. If you are a real leader your men will take their mental attitude from what yours appears to be. In time of unavoidable hardship you must avoid showing annoyance or impatience. In emergency you must show perfect self-control. Remember that your conduct will determine that of your men. If you are excited, they will be more so. With calm self-assured demeanor give your directions as becomes a real leader. Directions so given are a great comfort to the men and assure steady intelligent execution. This is one of the most characteristic failures in inexperienced troop leadership. Try to train yourself so that you will be one of the exceptions by acquiring the habit in any given situation, of being first sure of yourself, and then calmly giving directions to your men.

It is of the genius of war to seize the fleeting opportunity. Train yourself to quick decisions, carried out with calm self-confidence. It is in general not so important what you do, as that you do something and do it quickly. Do not waste time in searching for the idéal method of procedure. Make a quick decision and then calmly carry it out. Do not change to another plan that may look better an instant later. Vacillation destroys all confidence in a leader. Do not fear to assume responsibility for anything appropriate to your office. Take a simple plan, a bold one, and then unhesitatingly bend every energy to its accomplishment. You may train yourself for this in peace time.

One of the surest means of attaining company spirit is to train your unit to excel in something; it may be in shooting, in close order drill, or in having the best mess. The men begin to take pride in their organization for excellence and they are more excellent, and their personnel is easily maintained from the best men. A good company is always popular and men seek to join it by transfer or re-enlistment from other units.

A good leader is as one with his men; he speaks their language, he shares their comforts and their hardships, he is jealous of their name, he defends their sensibilities and their rights in the larger organization; in fact, he is the recognized guardian of their welfare, physical and mental, as individuals and as a group. He becomes their hero and is affectionately nicknamed. He strives at all times to promote their best interests and thus make them feel that he is concerned with their welfare rather than with his own selfish comfort. It is incidentally true that when hardships come he will be more than repaid by their devotion to him and care for his comfort.

The ability to give orders properly is most important. Disobedience is almost always the fault primarily, either of the order or of the way in which it is given. Make your orders fit the intelligence of the men. It takes time for a man of low intelligence to comprehend an order.

It is a safe rule that your men originally intend to do right. Assume that first, then be sure that your order is right and that it is something that should be done. It is demoralizing to discipline to give an order, and then have to change it. And above all, be sure that there is no suspicion of a question in your own mind but that the order will be obeyed.

Give your orders in a quiet, decorous tone. Too often those placed in authority mistreat their subordinates. By word, tone or manner, they wantonly insult their manliness and thus sacrifice loyalty and cheerful subordination. Remember that military courtesy is a reciprocal relation; it is due as much from the superior to the inferior as from

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the inferior to the superior. You want to command a team of men, not of curs, and you will never get discipline from men by outraging their sensibilities.

He who can make his men jump with a low firm tone of voice has an enviable force of character. The man who has to raise his voice, scream and roar and curse in order to get action is pathetic. He will be an even sorrier figure when trying to lead in an emergency. He has probably missed the first essential, self-control, and is too likely conscious of his own inherent weakness or inability.

Avoid giving too many orders, or indefinite half-hearted orders. Your order must be so expressed as to leave no question whatever as to your intentions and above all take time and care to see that every order is carried out.

The leader is held responsible for the appearance, conduct and performance of duty of his men. He accomplishes this first by being an example in neatness of dress, care of arms and equipment, punctuality at formations, cheerfulness in performance of all duties, unvarying observance of regulations, military courtesy, etc., and then follow up the delinquents, to see that they also conform.

You expect loyalty, so show it yourself to your superiors. If you are not loyal to your superiors, your men will not be loyal to you. If you receive an order for your command to perform a disagreeable duty, go to its execution loyally; do not try to purchase cheap popularity with your men by saying "so and so has ordered this and we've got to do it."

Try to arouse the men's interest in the work at hand. The men should know at least what they are about and why it is necessary and so be allowed to participate with you in the pleasure and credit of doing it well.

Most tasks require special forethought and planning on the part of the leader. You have got to sit down and study it ahead of time, foresee every detail and plan to meet it with system and the least friction and lost motion for the men. Then only will you be able to conduct the work as a real **leader.**

Any man of innate character may fit himself to lead successfully. Hundreds of thousands of civilians thus fitted themselves in the late war to lead as officers and N. C. O.'s. Many had had no experience of command to guide them, had never given a direction even to a servant. Yet by application they rapidly learned how to handle themselves as leaders and their men as loyal followers, and carried through with a success that varied with the degree of proficiency they attained in the art. No one expects perfection. It is impracticable to follow rules or to assume personal qualities that are not natural. The thing to do is to realize that leadership may be developed, to absorb its fundamentals into your system, and to study yourself as applying them to the problems of your profession.

Jet Anchor in Use by the U. S. Suction Dredge "H. S. Taber"

By

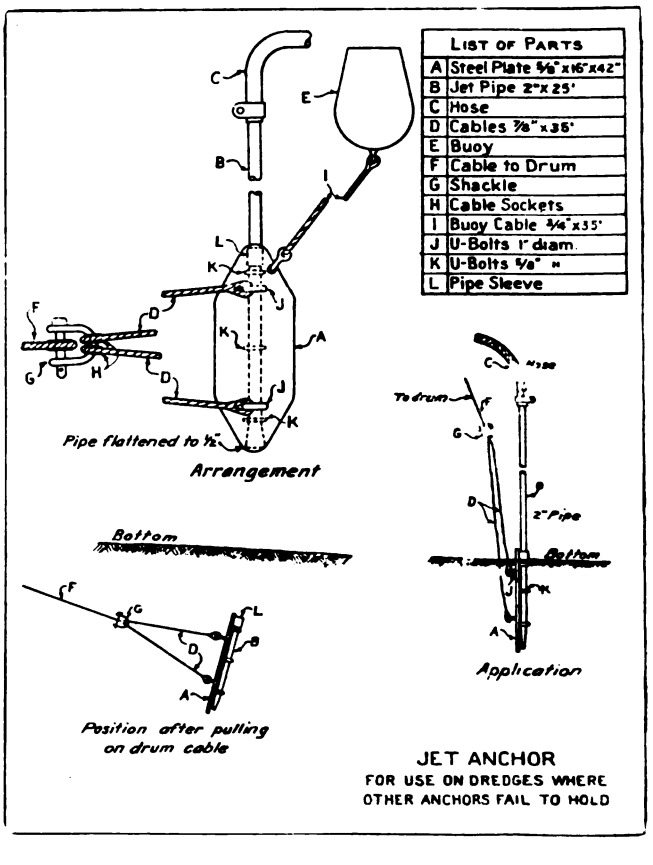
John C. Oakes

Colonel, Corps of Engineers

The U. S. dredge *H. S. Taber* was built for the Little Rock, Arkansas, district, and is a pipe-line suction dredge with no cutter head but with shovel suction, using water jets to stir the material. The dredge is moved forward by means of lines fastened to piles or anchors placed ahead of the dredge. This dredge was transferred from the Arkansas District to the Norfolk District to work in Croatan Sound on the inland waterway, and on arrival at the site of the proposed work immediately encountered very stiff material. At first it was found almost impossible to pull the dredge ahead against the kind of material found in place. Ordinary 3,000-lb. and 4,000-lb. anchors were insufficient in weight to hold, and it was impracticable to use piles. In this contingency, Mr. George O. Rogers, Master of the dredge *Taber*, suggested the use of sheet steel jet anchors, and their use has proven very successful. It is thought that the design and method of operation of these anchors may be of general interest to operators of dredges throughout the United States, and the accompanying description with drawings is, therefore, furnished.

The anchor consists of a steel plate $\frac{5}{8}''\times16''\times42''$ to which is attached a 2-inch jet pipe. This pipe is flattened at the lower edge until the opening is about $\frac{1}{2}''$ wide. At the upper edge of the steel plate a pipe sleeve is attached, so that the upper portion of the pipe can be unscrewed and removed after the anchor has been jetted down to a sufficient depth. Two anchor lines are attached to the plate by U-bolts 1 inch in diameter, and the two lines come together about 8 feet from the plate, and are connected to the cable by a shackle. At the upper edge of the plate is a shackle to which is attached a cable leading to a buoy. The anchor plate up out of the material. The accompanying illustration and after it has been jetted to sufficient depth the upper section of the pipe is unscrewed and removed. When the time arrives for the removal of the plate, the derrick picks up the buoy fastened to the cable and simply pulls the plate up out of the material. The accompanying plate shows method of fabrication, position of anchor sunk, and position of anchor after stress has been put on the cable.

The use of these anchors has been proven very advantageous, as they are much lighter than the heavy ship's anchors formerly used, can be jetted to any desirable depth in a few minutes and can be removed and handled much more easily than can be the ordinary anchors.



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The Insignia of the Corps of Engineers

By

S. A. McCarthy

Chief of Division, Office Chief of Engineers

IT is a matter of common knowledge that the use of regimental badges instead of the more prosaic and less picturesque "regulation" devices does a great deal to encourage esprit de corps. Badges that can boast a definite meaning, commemorate notable achievements, by characteristics and suitable design, are regarded with reverent pride by those privileged to bear them.

The Corps of Engineers is particularly fortunate in the choice of its two time-honored distinctive devices—the embrasured bastion, and the turreted castle. They have a long and inspiring history, now the premier badges of the Army, and the story of their origin is interesting.

There is no record of the use of insignia to designate the Engineers during the Revolutionary War.

During that period the different branches of the Army were distinguished from each other only in the uniform. In the orders from Short Hills, June 18, 1780, the Corps of Engineers appears for the first time with a distinctive uniform:

> The Corps of Engineers and that of Sappers and Miners, a blue coat with buff facings, red lining, buff underclothes, and the epaulettes of their respective ranks.

General Orders from Newburg, December 5, 1782, directed a change in the uniform of the Infantry and that—

> The Corps of Artillery is to retain its present uniform, and the Sappers and Miners will have the same.

Thus it appears that the traditional "blue and buff" of the Revolution was worn generally only by the general officers, unattached aides, the Corps of Engineers, the Sappers and Miners, Washington's Body Guards, the 1st and 2nd Continental Infantry, and the 1st and 2nd New York Continental Infantry.

At the conclusion of the Revolutionary War the armies were disbanded and the military establishment reached its lowest point. In May, 1784, the army consisted of only 80 men, all artillerists.

The Act of May 9, 1794, provided for a Corps of Artillerists and Engineers to consist of four battalions. In 1798, an additional regiment of artillery was raised. This Corps had its distinctive buttons and uniform, patterns for which were deposited in the public stores in 1800. The buttons of the different branches of the service began to have definite individuality. Those of the Corps of Artillerists and Engineers, found on a uniform of Colonel Henry Burbeck who commanded the 1st regiment of Artillerists and Engineers from May 7, 1798, to April 1, 1802, were stamped "1st Regt. U. S. A. & E.," together with a field piece and a stack of cannon balls.



Insignia of the Corps of Engineers of the Spanish Army (enlarged)

It is not a castle but a "towered tower, crenellated, bracketed, and machicolated"

In Spanish heraldry towers are used frequently, sometimes singly, as above, or in groups of two or three. In turn, they may have towers superimposed on them, and thus become towered towers, double towered or triple towered towers.—S. A. M.

It was soon discovered that the Corps of Artillerists and Engineers could not combine effectively the duties assigned to its members. A law was therefore enacted by which it was abolished and the Corps of Engineers and a regiment of artillery created, and the Military Academy established under the Corps of Engineers. This Act, March 16, 1802, is the organic act of law for the existing Corps of Engineers.

Major Jonathan Williams, late of the 2nd Regiment of Artillerists and Engineers, was appointed to the command of the Corps of Engineers and superintendence of the Military Academy.

He recommended a uniform for the new Corps. In approving it, the Secretary of War commented:

> Having carefully examined the sample forwarded by you for the uniform dress of the Corps of Engineers, but one objection presents itself and that is the dress will be an expensive one and I am fearful that the officers of the lower grades may find it difficult at times to furnish themselves. If, however, in your opinion this objection may be obviated it will receive my approbation and you are hereby authorized to consider it as the adopted uniform of the Corps.

No description of this uniform can now be found. The Purveyor of Public Supplies (later styled the Commissary General of Purchases) in Philadelphia, was the custodian of all patterns for clothing, buttons, epaulettes, belts, plates, hats, shoes, harness, etc., entered into contracts for their manufacture, and issued them to the army on requisitions therefor. The records of his office are very complete and contain much information of interest.

At that period buttons were imported plain (principally from Birmingham) the adopted design being stamped on them later.

The records of the Purveyor contain considerable correspondence with Colonel Williams on the subject of changes in the uniform. Having been so recently derived from the Artillery the Engineer uniform followed to a considerable extent the style of the elder corps, the principal difference being in the coat and the hat. The hat was the subject of much correspondence, whether it should have a brim all around or not; if not all around, it was called a "yeoman," or human crown; whether black feathers were to be used or a woolen knob. But there is nothing to show the use of a distinctive button or other insignia

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for the Engineers. Invariably Artillery buttons are mentioned as being supplied for the Engineer uniforms, occasionally Infantry buttons when those of the Artillery were not available.

After the separation of the Engineers from the Artillery a change was made in the button of the latter Corps so as to show—

An eagle standing on a field piece which points to the left and stands on an earthen parapet, a dull ground of parallel lines, the whole in an oval, the outer edge milled.

A variation shows a stock of cannon balls at the bottom.

In the early days of the Army, the chief of each corps fixed the uniform for his command. In 1810, the Purveyor says: "The Secretary of War authorized Colonel Williams to vary at his election the clothing of his little Corps of Engineers."

At the time of its organization, the Corps of Engineers consisted of only seven officers, and under the law it had expanded to only sixteen prior to the War of 1812. As only 28 buttons were necessary for use on the exposed parts of a uniform (non-uniform buttons were used on the unexposed parts) the total number used was hardly enough to warrant the expense of making a separate die for stamping them.

Artillery buttons, probably of the designs mentioned above, continued to be used on Engineer clothing until the "Essayons" button was adopted for the Corps of Engineers.

Essayons Button

The earliest date to which mention of the "Essayons" button has been traced is 1814. This is found in Gen. George D. Ramsay's "Recollections of Cadet Life," published in General Cullum's Biographical Register of the Military Academy, III, 627, as follows:

Captain Partridge was never known to be without uniform, and it was believed that he had none other than military clothes. His was that of the Corps of Engineers with the embroidered* collar and cuffs and the Essayons buttons.

Captain Partridge was on duty at the Military Academy as acting Superintendent from 1808 to 1817, and General Ramsay was a cadet there from 1814 to 1820.

A uniform coat worn by Capt. Alden Partridge during his stay at the Military Academy, 1808-1817 (probably the same one mentioned by General Ramsay), was found by Prof. E. S. Holden of the Military Academy, at the home of Captain Partridge and deposited in the Museum at the Military Academy. As no record of the Engineer uniform of that period has been found elsewhere the following description of it is printed:

In a general way it resembles the coat of the Engineer officer shown in plate 15 of "Uniform of the Army of the United States, 1774-1889," published by the Quartermaster Department.

The coat is of blue cloth. It has a high standing collar of black velvet; there is no collar ornament. The coat has a single row of nine flat Engineer buttons, precisely like the buttons of today. The buttons are stamped: T. Potts, Birmingham, and fasten on wire rings through eyelet holes.

The herring-bone pattern braid has no loops at either end.

The cuffs of the sleeve are of velvet cut on the outside to fit the lower one of three herring-bone braids, as in plate 15 referred to. On the inside of the cuff the velvet runs straight across. It is slashed half way up so as to leave the sleeves loose for the hand. There are three Engineer buttons on the sleeve.

*He meant black velvet.

The tail of the coat has two buttons at the waist, two buttons halfway towards the tail, two buttons at the extremity of the tail, and three buttons at the points of the herring-bone on each flap. There is one pocket in the inside of the right coat tail.

A single epaulette is worn on the right shoulder to designate a captain's rank. (The button at the top of the epaulette is a light artillery, *i. e.*, an eagle sitting on a wheeled cannon.)

Doubtless this is the style of the uniform referred to in the orders of May 1, 1813, and of 1816, prescribing the uniform for the Army, as follows:

Note. Officers of the Corps of Engineers will wear the uniform already established for the Corps.

The device of the Engineer button is unique and does not resemble that of the Engineer service of any other country.

France, Belgium, Norway and Greece use the cuirass and helmet. That of France has had an existence of nearly 200 years, except during the Revolution, when republican symbols were substituted.

Italy—helmet, shield and cloak.

Netherlands—helmet for the army; torch, arrow and anchor for the navy.

Sweden—star and rays.

Switzerland—crossed hatchets.

Spain, Portugal and Brazil—tower in various forms, which in Spain and Portugal is surmounted by a royal crown.

Mexico—a fascine with wings, and an anchor with lightning issuing from the stock.

Great Britain—Royal cypher with the words "Royal Engineers."

Russia—Imperial eagle, hatchet and spade crossed.

Confederate States—Old English E.

The device of the Engineer button shows the masonry of the bastion of a marine battery, embrasured, casemated and crenellated, surrounded by water, a rising sun with rays, all surmounted by a soaring eagle bearing in his beak a streamer displaying the motto "Essayons."

The whole is splendidly symbolical of the work of the military engineer and commemorates the first great public achievement of the youthful Corps of Engineers. The design has not undergone any change from its first appearance and it is the production of an artist of rare merit and excellence.

Prompted by the unsettled condition of our foreign relations and by the indications of the approaching war with England, steps were taken in the first decade of the last century to put the defenses of the country in safe condition. Heretofore such defensive works as had been undertaken were defective in design, small, weak, and being built for present economy, of cheap materials and workmanship, were very perishable.

While exercising the superintendence of the Military Academy, Colonel Williams devoted himself personally to the fortification of New York Harbor. In 1807 he planned the construction of Forts Richmond and Tompkins for the City of New York.

Most of the forts which constitute the inner line of defense of that harbor—Fort Columbus, Castle Williams (at first designated "the stone tower"), Castle Clinton, and Fort Gansevoort—were planned by him and built under his supervision.

They were the most important works of fortification that had been attempted by the national government, and in them Colonel Williams introduced a notable innovation into the system of military defense of this country, that of

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the casemated embrasure. Casemate is combined from two Spanish words: *casa,* house, and *matar,* to kill. The term came later to mean any vaulted room under the earthwork of the rampart or glacis whether intended for the service of guns, quarters for troops or storage purposes.

Castle Williams was the first casemated battery erected in this country. Its construction was commenced in 1807. It was planned under the systems of Montalembert with which Colonel Williams had made himself acquainted while resident in France as American Agent during the Revolutionary War, and where he pursued his professional and scientific studies.

Says Colonel Williams in 1807:

> It was further considered that the modern improvements of marine batteries which give double the number of guns on the same horizontal base and by multiplying the tiers may give six times the number of the heaviest metal with a bomb-proof security above, rendered the question of combat a question of floating wooden walls against impregnable stone walls on shore with equal power as to celerity of action and number of guns within the same space and weight of metal. It is not a very bold assertion to say that no ship sails on the ocean that would engage on such terms.

Such was the enthusiasm created by the brilliant project of the Chief Engineer and the vigorous measures taken for defense that the freedom of the city of New York was granted to Colonel Williams, August 1, 1807, together with the gift of a large sum of money, but the latter he declined.

The works of defense were finished in 1810, and "the stone tower" was named after Colonel Williams:

> Orders. Fort Columbus, Nov. 24, 1810.
>
> In future, the stone tower on this island (by the approbation of the Secretary of War) will bear the name of Castle Williams, in honor of the commandant of the United States Corps of Engineers, who designed and erected it. And on Monday next, at twelve o'clock, a national salute of seventeen 42 pounders will be fired from the lower battery of Castle Williams in commemoration of the 25th of November, 1783, the date on which the British troops evacuated the City of New York.
>
> HENRY BURBECK,
> *Colonel, Commanding the Harbor of New York.*

It may be noted that the gateway of Castle Williams was ordered to be as follows:

> The gateway of plain stone work, with a plain stone arch, turned over the gate, with a table or inscription for the words Castle Williams and with the month and year in which it was completed—an eagle over the center and no other ornamental work.

Thus we find the principal elements typified in the button: a casemated, embrasured, crenellated battery of masonry defending a waterway, the national eagle over the center.

Of the remaining elements the challenging French motto would naturally be suggested by Colonel Williams' residence in France and the influence of his studies and associations there; and the sun rising in his radiance portrays the coming of the genius of the new Corps.

In July, 1821, new Army Regulations were issued. Article 64, Section 41, directed:

> The button of the Engineers will be flat, of yellow metal, with only the device and motto heretofore established.

This remains the earliest authoritative reference to a distinctive device for the button for the Corps of Engineers. The same order directed that the belt plate be yellow; that the black velvet standup collar be embroidered with a sprig of laurel encircling a star, and velvet cuffs.

No change has been made in the design of the button since it was originally adopted. Until 1840, it was made flat. In that year it was ordered to be made slightly convex with a raised, bright rim; and the device was described for the first time officially:

> An eagle holding in his beak a scroll with the word "Essayons," a bastion with embrasures in the distance, surrounded by water, and a rising sun; the figures to be of dead gold upon a bright field. (G. O. 7, A. G. O., Feb. 18, 1840.)

For a short time, 1832 to 1839, the Engineer belt plate carried the device of the button, but in the latter year that was changed to the turreted castle.

The rank and file attached to the Corps of Engineers (bombardiers, sappers and miners) used Artillery buttons until 1846. From 1846 to 1851, turreted castle buttons were used. From 1851 to 1857, the Engineer soldiers wore buttons corresponding with those for the officers of the Corps; after 1857, they returned to those of the Artillery which finally changed to "regulation."

In 1902, when "regulation" buttons were adopted for the Army, the Corps of Engineers alone was allowed to retain its distinctive button.

Star and Wreath

The star and wreath was a distinctive collar device worn by officers of Engineers from 1821 to 1851.

Originally the Engineer collar was of plain black velvet. In 1821 it was ordered to be "embroidered with a sprig of laurel encircling a star." (Army Regulations, 1821, Article 65.)

In 1832 this was changed to a "gold embroidered wreath of laurel and palm crossing each other at the bottom encircling a star of gold embroidery." (G. O. 50, A. G. O., 1832.)

The use of this device ceased with the issue of new clothing regulations in 1851.

Its passing was probably unregretted. It displayed no originality or invention. It had no story to tell, recorded no particular corporate achievement. As a device it was hackneyed. While it served as a collar ornament for the Engineers, it was displayed on other portions of the anatomy in other branches of the Army, on the skirts of the general officers and staff; and the star was used as a badge to indicate rank for the general officers.

The Turreted Castle

The turreted castle as an insignia of the Corps of Engineers was adopted by General Totten in the summer of 1839. In that year new clothing regulations were under consideration and when published (G. O. 36, A. G. O., 1839) it was ordered that the belt plate of the Engineers be "gilt, according to the pattern in the Engineer Department."

This pattern was the device of the "turreted castle." It may be described as representing a portion of a castle with a central arched entrance, grilled, and approached by steps, in a central tower, leading at either side by galleries pierced by two windows, to a corner octagonal tower, the galleries and towers crenellated.

The appropriateness of the castle as a symbol of the military engineer is at once apparent. The medieval castle is inseparably connected with the subjects of fortification and architecture.

In heraldry, the castle and the tower are frequently used in coats-of-arms of persons, cities, corporations, and guilds. They are often given as charges in the shields of persons who have reduced them, or who have been the first to mount their walls in an assault, or for a successful defense. In the arms of medieval cities they indicated that the cities in question were walled towns. Such castles occur in the Arms of Berlin, Hamburg, Budapest, Limburg, Madgeburg, Klausenberg, Linz, Oldenburg, Toulouse,

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Bordeaux, Caen, Dublin, Carlisle, Exeter, Norwich, Barnstable, etc.

Heraldry's universal requirements in the designing of a badge or coat of arms are the commemoration of some noteworthy thing, simplicity of design, and practicability. All these are happily consummated in this badge.

In this country, the term "castle" was applied to the strongest of our early works of fortification, viz.: Castle Williams, Castle Clinton (which now survives in Castle Garden), and the Castle on Hendricks Reef, N. Y.; the works on Castle Island in Boston Harbor, and Castle Pinckney, S. C. These, together with the entire system of permanent defense of the country, are the particular achievement of the Corps of Engineers.

The design represents a castle in its most conventional form without decoration or embellishment, even the usual machicolations and supporting brackets being omitted, to secure simplicity of design and practicability in use.

General Totten was the military engineer par excellence. From 1808 to 1838, when he became Chief Engineer, his time was almost entirely devoted to the construction of heavy masonry fortifications. The great work of his life was the fortification of the Atlantic coast. He was an indefatigable analyst and experimenter. It would be almost impossible to enumerate the various objects of his researches. There is scarcely a subject connected with the art or science of the engineer, civil or military, which did not engage his attention and of which he has left some record, such as the thickness of sustaining walls, thrust of arches; composition of stuccoes, paints, lacquers, washes for stone and brickwork; tests of timber, and of building stone. He was the author of many publications of professional and scientific interest. His "Hydraulics and Common Mortars," published in 1838, constitutes to this day an authority relied on by the American engineer.

While designed as the badge of the Corps of Engineers, it is a matter of record that the device was first used by the cadets at West Point. In response to a request from General Totten, in September, 1839, Colonel Delafield made suggestions regarding changes in the uniform of the Corps of Cadets which, with very slight modifications had remained unchanged for about twenty-five years. For the cap-plate, in lieu of the yellow eagle and crossed cannon, he proposed "to have the eagle surmounting the wreath encircling the castle, as prescribed for the Corps of Engineers, being the distinctive characteristic of the Corps of which they form a part." The suggestion was approved by General Totten, October 10, 1839.

February 17, 1840, General Totten submitted to the Secretary of War his recommendations for the uniform of the Corps of Engineers specifying among other items:

Epaulettes—gold, according to rank, as described in G. O. 36 of 1839; within the crescent, a turreted castle of silver.

Belt plate—rectangular, dead gold field with a bright gold double rim, a wreath of laurel and palm enveloping a turreted castle, raised, in silver, according to design in the Engineer Office.

Colonel Totten's recommendation having been approved by the Secretary of War, was published in G. O. No. 7, A. G. O., Feb. 18, 1839, and constitutes the first published mention of the turreted castle device.

In 1841 it was used as the cap plate ornament, and in 1857 as the hat ornament, in 1872 it appeared on the shoulder-knot, but it disappeared from them in 1902 when these devices became "regulation." In 1896 it made its appearance on the saddle-cloth.

As a collar ornament the turreted castle made its first appearance in 1892 on the undress coat collar, embroidered. In 1894 this was changed to metal (silver).

The castle appeared on the buttons and the shako of engineer soldiers from 1846 to 1851, and on the forage cap plate from 1846 to 1902, when a "regulation" device was adopted.

A resemblance has been suggested to the insignia of the Corps of Engineers of the Spanish Army, founded 1711. This is not true, however. The insignia of the Spanish Engineers is not a castle but a tower, or rather a towered tower. In Spanish heraldry the tower is a favorite device, sometimes used singly, as in this case; other times in groups of two or three. In turn they may have towers superimposed on them, and thus become towered towers, double towered towers, and triple towered towers.

Prize Essay on "Citizens' Military Training Camps"

Recently the War Department set aside $100.00 to be offered as prizes for an essay contest among the enlisted men of the 2nd Corps Area. The subject of the contest to be "The Benefits to be Derived from One Month's Training at a Citizens' Military Training Camp."

Approximately 150 essays were submitted by enlisted men at the various posts, camps, forts and stations throughout New York, New Jersey and Delaware. A Board of Officers, which was appointed at the Headquarters, 2nd Corps Area, on Governors Island, to determine the winners, had considerable difficulty in arriving at a unanimous decision on the essays submitted.

Master Sergt. Joseph M. Woods, of Cornell University, who is working under the direction of the Professor of Military Science and Tactics at that College, was adjudged winner of the first prize, and received $50.00. Other prize winners within various stations were as follows: 2nd prize, $25.00, First Sergt. Allen G. Spitz, 2nd Co. C. A. C., Fort Dupont, Delaware; 3rd prize, $15.00, Master Sergt. Michael Tansey, Governors Island, N. Y.; 4th prize, $5.00, Staff Sergt. Richard Bennett, Station Hospital, Fort Totten, New York; 5th prize, $5.00, Sergt. Arthur Carlton, Station Hospital, Fort Totten, New York.

The camp for the 2nd Corps Area, which was the subject of the essay, will open at Plattsburg on August 7th, and will continue for 30 days. It is open to young men from 16 to 35 years of age, and the government will pay all the expenses incurred, car fare, uniform, food and all expenses that are necessary for the students. Young men who are selected for the camp will be on a cadet basis, and afternoons during the month will be devoted to sports under competent physical directors and coaches. A number of dances and excursions are being arranged by the citizens of Plattsburg.

The prize-winning essays read as follows:

Dear Jimmie:

They're goin' ter hev a camp ter train civilians in this summer an' frum all I hear 'em tellin' yer kin bet she'll be a hummer. Durn funny why a thing like thet wuz never done afore. You bet yer bottom dollar thet I'm goin' ter be thar, shore. The camp whar I'm goin' is the one they call the RED, whar yer git the first installment uv this nowlege in yer head. It ain't called thet in honor uv no Bolshiviki rag, but frum the bright red stripes yer see on our ol' starry flag. Bob sed

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he wisht he had a chance ter git a better trainin' afore they took him over whar the shot an' shell wuz rainin'.

The last war I wuz most too young ter git inter a battle. Pap kep me home upon the farm a milkin' uv the cattle, but brother Bob went over thar an' fit with all his might. I like ter set around an' hear him tellin' uv the fight.

I reckin thet frum what he sez there's many a pore feller what lost his life through ignorance an' not because he's yeller. I figgered out thet I would git sech nowledge as I could, an' ef I'm ever in a pinch she'll do me lots uv good. Not only maybe save my life frum bullet or exposure, but lives uv others who hev never heard uv the disclosure uv all the different ways an' means a soldier gains his end ef he gits inter a fix where on him other lives depend.

A soldier's life in times uv war is not a bed uv roses, ez stories of the latest one to every one discloses. So ef a bunch of fellers hev some nowledge uv their job, they're right smart mor effective than a nervous, scary mob.

Hoss sense will tell most any one thet ef he don't know how, he'd never build hisself a watch or even milk a cow. An' so I'm goin' ter learn an' ef the country needs my service, I'll no jest what I hev ter do an' then I won't git nervous.

Expect I'll hev a pile o' fun frum what I hear 'em say, fer 'sides the work uv drillin' they'll be lots uv games ter play. Learn more uv human nature mixin' with my feller creatures than I ever would at college with it's eddicated teachers. They'll teach me how ter live a life what's healthy, clean an' true, besides a lot uv other things a soldier hez ter do. So ef the time should ever come the country needs my backin', I'll be a man whut no's his work when rifles get ter crackin'. I'll no jest how ter guard my health when sickness is around. The other fellers would too, ef they'd not hung back an' frowned when they wuz offered sech a chance ter pick up all this learnin'. I bet they'll be durn sorry when the fever gits ter burnin'.

Now, Jimmie, make yer mind up same ez me an' go thar too. We'll show folks how we're backin' up the ol' Red, White an' Blue.

Yer friend,

HIRAM.

Origin of the "Sam Browne" Belt

[Reprinted from *U. S. Army Recruiting News*]

The recent authorization of the Sam Browne belt as a part of an officer's equipment has doubtless raised in a great many minds the question of where and by whom the Sam Browne belt originated.



The original Sam Browne was Gen. Sir Samuel Joseph Browne, K. C. B., K. C. S. I., a most gallant English officer and gentleman, and one of the best known English officers who took part in the early Indian campaigns and the Indian Mutiny. He first saw service with the English army in India in the Punjab campaign in 1848-1849, and also served in India throughout the great Indian Mutiny and Sepoy Wars, during which he was twice severely wounded, and lost an arm at the battle of Seeporah, which nearly cost him his life.

It was the loss of his arm which caused him to devise a new sort of saber belt, which was later generally adopted by the British Army, and also by numerous other military forces. This is the belt, which, with some modifications, is to-day known as the Sam Browne belt.

Lord Roberts, English field marshal, and advocate of preparedness in England who was a close friend of the dashing cavalry officer, gives in his "Forty-one Years in India," the following account of the dead hero who during and since the late war has received so much publicity.

"This popular and gallant officer, well known to every native in Upper India as 'Sam Brun Sahib,' and to the officers of the whole of His Majesty's Army as the inventor of the swordbelt universally adopted on service, distinguished himself greatly in the autumn of 1858. With 230 sabers of his own regiment and 350 native infantry he attacked a party of rebels who had taken up a position at Nuria, a village at the edge of the Tari, about ten miles from Tilibhit. Browne managed to get to the rear of the enemy without being discovered.

"A fierce hand-to-hand fight then ensued, in which he got two severe wounds, one on the knee, from which he nearly bled to death, the other on the left shoulder, cutting right through and severing the arm. The enemy were completely routed, and fled, leaving four guns and 300 dead on the ground. Browne was deservedly rewarded with the Victoria Cross."

Sam Browne died at The Wood, Ryde, Isle of Wight, March 14, 1901. A memorial tablet has been erected for him in St. Paul's Cathedral in London.

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A Visit to the A. F. in G.

By

H. A. Finch

Major, Corps of Engineers

ONE of the few pleasant though minor by-products of the World War is the opportunity now open of visiting the American army colony on the Rhine. Callers on our flourishing army posts in and around Coblenz can not fail to be impressed by the delightful surroundings in which our forces are serving in this beautiful and interesting part of the world. There are also some who upon dropping in on our garrisons in Germany are forcibly reminded of the contrast between the service on the Rhine and that rendered by a similar outpost of our army established in 1911 in the days of Yuan Shih Kai's coup d'etat in Tientsin, China, and still "sitting on the lid" in that far country. Those who have visited both stations reflect that on the one hand we saw a flat, treeless and melancholy land, inhabited by a Mongolian race with whom, for all their virtues, we can have no genuine intercourse as man to man and can therefore never fully understand. On the other hand in the Rhine Valley we are transported to a land of legends, legends with which we are familiar and many of which we have inherited. We see a beautiful country, well-ordered, highly cultivated and delightful to look upon, and diversified by hills with vineyard-covered slopes, by fields in all tones of green and brown and by entrancing stretches of forest, river and mountain scenery.

One does not need to hold a brief for the Germans to reflect to oneself that surely a people capable of maintaining such a civilization can not be altogether untrustworthy and useless as world citizens.

For the lucky army officer who secures a furlough to visit the Coblenz colony the pleasant impressions begin as the monthly transport clears from Hoboken. On board the tight little steamer he and his family will find fifty or more officers, some, like him, on leave with their families, others bound for duty as *attaches* in European capitals or detailed abroad for some months to study foreign languages or perhaps slated for service with the troops in Coblenz. The days slip by very pleasantly. There will inevitably be friends aboard whom one has not seen for years; there will also be the customary quota of army children of assorted sizes, a flapper or two, and always, *always*, a young male mandolin player. Why this last should be is a mystery unless it is so ruled that every ointment must have its fly! Since the mandolin player has broken into this discussion, and that is one of the very best things he does, it might perhaps be worth while to digress for a moment to put down, free of charge, a prescription by which travelers in the future may rid themselves of this perennial pest. This step is taken in the interest of public morals, for though charity is a virtue, bad music is an incentive to crime. A chapter out of the experiences of Captain J. will serve to point the moral even if it doesn't adorn this tale: Late one evening the Captain was retiring as the mandolin mosquito was twanging away just outside the defenceless officer's stateroom. Captain J. does not testify as to his thoughts at that moment, but perhaps he was agreeing with Joseph Conrad that there is a dreadful fascination about systematic noise. At all events as he was resignedly climbing into his upper bunk the boat gave a providential lurch and he stepped downward and backward toward the floor. His foot came down squarely on top of the little covered enamel-ware vessel doing duty in that particular room. It set up an awful clatter—and the mandolin player stopped short. He seemed to realize that Captain J.'s brand of music was of far higher class and more soothing to the ear than anything he could hope to coax out of his benighted box, so he "quit cold!"

After twelve or thirteen days of bridge, books and conversation the south tip of England is sighted and shortly afterward the boat slips along the white cliffs near Dover; then comes the anchorage at Flushing, Holland, to await the favorable tide up the Scheldt to Antwerp. At Flushing no one is allowed to go ashore, but one is treated to a near view of an immaculate Dutch city with houses of stone, roofs of tile and slate and with gleaming window panes. A hundred or so burghers gather on the pier to gaze at the U. S. boat across the narrow stretch of water separating us from the shore but no one comes out to barter either lace or liquor for our money. This fact leads one thirsty soul to remark that "if those fellows were Americans things would be a whole lot different," and he goes on to explain that if an American city were situated as the port of call for ships from a dry country the anchor would not have time to take hold before the vessel would be surrounded by boats lined with rows of men carrying bottles equipped with 15-foot straws so that the passengers could drink without descending from the deck! It is said that prohibition took the breath away from some of our best citizens; with others it seems to have made no great difference.

Upon arriving in Antwerp one has a day for exploring that interesting old city before taking the night train for Coblenz. During the month just past (June) the interest of the new arrivals seemed to be about equally divided between the Rubens pictures in the cathedral and the wonderful strawberries, each as large as a fair sized peach, and packed in baskets in which the bottom layers (unlike the familiar American practice) are found to contain berries even finer and larger than the "facers" on top! The tourist soon learns to stop every fifteen minutes to offer thanks to Providence that the rate of exchange is in his favor, but at that the cost of living is not so low. The French and Belgian francs (now about 8 cents) have fallen to about two-fifths of their prewar values, but prices in francs have been raised to 50 per cent and more above their 1914 level. A double room with bath at a hotel, not of the first rank, now costs at least 45 francs per day in Brussels. This is a prewar figure equivalent to about $9.00 but now amounting to only $3.60. In 1913 such a room could doubtless have been had for about F4.50 per day, perhaps a bit less. Dinners, without wine, for two

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will amount to 40 to 50 francs, now equal to $3.20 to $4.00, including such items as 8 francs (a prewar equivalent of $1.55) for one portion of sole, 6 francs for a portion of macaroni and 3 francs for soups.

Modest travellers content to occupy a room without bath would probably have difficulty getting along on less than 12 to 15 dollars per day per person, including travel and living expenses only.

On reaching the territory occupied by the American troops the army tourists' financial spirits begin to rise, for the mark, once rated at about 24 cents, can now be bought at 65 to 75 for the dollar. Prices in marks have also been raised enormously but the heavy depreciation in German money makes the difference in favor of the American traveller much greater than in Belgium or France. A good double room without private bath can be had in Coblenz for 40 to 60 marks per day (68c to 90c) thanks to the army billeting rates in force. Very wholesome, well-cooked meals, also without wine, are served for 50 marks per person, the equivalent of about 75 cents. All transactions are conducted in marks, and the tourist handing over 20 or 25 five-mark notes for a meal is inclined to think the German money is about on a par with that of the Confederate States. O. Henry wrote, by the way, that the Confederacy maintained the only sensible and comprehensible system of coinage that had come to his notice—one in which prices were stated in terms of money measure instead of some arbitrary value assigned to the bank notes by the authorities. He points out the simplicity of such a system where a pair of hundred dollar bills bought a pair of shoes, a hat full of bank notes purchased a hat and a barrel of money was exchanged for a barrel of flour!

The American army garrison in and around Coblenz numbers some 420 officers and about 13,000 enlisted men. So far as a dozen conversations with the rank and file can develop an outstanding idea among these soldiers, the force may be said to be intensely proud of their little army and anxious to remain on the Rhine for the year or two remaining of their three-year enlistments. Soldiers, as Kipling says, don't grow into plaster saints, but the American visiting Coblenz will have no cause to feel anything but pride in the military representatives of his country stationed there. The men throughout are well set up and smart looking; they are busy with their maneuvers and school duties and their conduct appears to be excellent. The American soldier is apparently considered by the Germans as a good enough fellow if he isn't imposed upon, and the American doughboy in turn seems to feel that so long as the Germans work and behave themselves they should be entitled to a "show." Observers seem to agree that after a round two years of discontent and unrest the Germans are now hard at work and will come back strong industrially.

Map Reading: Discussion

Hugh A. Drum
Colonel, Infantry
Commandant, General Service Schools

The article of Major Adams in the July-August issue is very much to the point. Our officers are not sufficiently trained in map reading. However, we are learning rapidly, and the various army schools, from the lowest to the highest, either teach map reading or require a knowledge of map reading.

At the General Service Schools the members of the School of the Line have a course in map reading which takes up considerable time in an already crowded course of study. This map-reading course is really intended only as a review subject, but much is taught to the officers, and these are many, who have an incomplete knowledge of the subject. The course comprises a study of slopes, contours, differences in scales, magnetic declinations, topographical signs, etc. The officers are required to apply a knowledge of the above to designation of proper location for artillery, selection of roads for night marching, consideration of visibility from hill tops and from balloons. Each day a number of practical questions are asked, and selection is required of most suitable places for command posts, military crests, aid stations, etc. Beginning next year, a short time will be devoted to reading or aeroplane photographs, with a view to showing how details can be obtained from these photographs to fill in between control points and how it is even possible within certain limits to obtain an approximate idea of certain sections without any control whatever.

The course in sketching, which includes three tactical rides and three terrain exercises, is an application of map reading and requires further study of ground forms and the reading of maps. The best way to learn to read a map is to make one. This is exactly what is done in the course in sketching. The officers are required to make maps showing the essential military features of the terrain. As a result they are better able to pick out on a map the topographical features which will have especial bearing on the military situation. The results have been unusually satisfactory.

At these schools, although some officers are taught much about map reading, it is only just to say that most of the officers are fairly well taught before they come here. In the American Expeditionary Forces there were many reports of errors due to failure to properly read the map, but luckily none of these errors were of vital importance. The most remarkable case of which I have heard was the assertion of a field officer, a regular, who claimed that the Germans had changed the location of a forest in order to confuse us in reading our maps.

The reading of aerial photographs has not, however, received the attention it deserves, and special time is devoted to it. It is realized that proper control is necessary for accurate mapping, and that aerial photographs are best used for filling in the unmapped spaces or for bringing up to date the maps already available, but valuable results can be obtained from aerial photographs of unmapped areas. The field for study is very great, and it is regretted that more time cannot be devoted to it than is available here. It takes an expert to determine the hill forms even approximately; but every officer should be able to read aerial photographs sufficiently well to determine the general character of the country, the woods, cultivated fields, roads, etc., and the relative distances. It is impressed upon them that, if central points are available, it is possible for experts to produce valuable maps.

In future wars we can hardly expect to obtain the excellent maps we had in France. Therefore, we shall have to get along with much poorer maps. This means that we shall have to know ground forms, estimate the contours from the general character of the country, and make our plans from insufficient data. As in the Philippines, where the maps are poor, we shall look for and expect on the ground to find roads and trails in accordance with our knowledge of the country and of the inhabitants. Aerial photographs will help very greatly in finding these roads and trails; but in spite of every effort on our part, the fog of war will be greatly increased in these future wars, owing to poor maps or none at all, and we must learn to make every possible use of the available maps. For such work we must have a better knowledge than we now have of map reading; we must be prepared to do more work with less data.

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The Development of Heavy Ponton Equipage for Increased Army Loads of the Future

By

Theodore Wyman, Jr.

Captain, Corps of Engineers

Requirements for Future Ponton Bridges

THE adoption for the mobile army of recently developed heavy mobile cannon, self-propelled or tractor drawn, heavy tanks and heavy truck transportation, has necessitated the development of heavy ponton bridge equipage, of greater capacity than the present standard equipage. Heavy ponton bridge equipage of construction along the lines of the standard equipage, of minimum weight, and adapted to being transported readily on vehicles subject to being animal drawn, truck drawn or tractor drawn, must carry safely the heaviest loads which accompany the Corps, namely, the loaded 5½-ton Mack truck, which, when loaded to capacity, has a maximum concentrated axle load of 13,500 pounds on the rear axle and 7,800 pounds on the front axle, the distance between axles, center to center, being 13 feet 4 inches. There must also be developed a reinforced type of ponton bridge, using the new equipage, supplemented by special materials deemed necessary to carry safely the loads which accompany the army, which recent developments of Ordnance materials indicate may include the new Christie Self-propelled Mount for a 6-inch Gun, weighing 19 tons, and the Christie Medium Tank, weighing 18 tons. Extensive studies of all available records showed that the allowable weights for a ponton equipage, readily transportable, would limit the capacity of the ponton boat to a supporting power of 20,000 pounds, with a 9-inch freeboard, and the length of the normal bay to 16 feet, which would require a super-structure consisting of seven or eight balk of weights readily handled by two men, rigidly connected to two side rails by transverse balk and balk collars, and a double thickness of 2-inch chess.

Ponton Boats

Three types of experimental boats, namely, wooden, steel and aluminum boats were designed, manufactured and tested.

The wooden ponton boat was of the scow type, similar to the present standard boat. Its dimensions were: length 32 feet, beam 5 feet 8 inches, depth 3 feet 1 inch, and it weighed 2,225 pounds. It was constructed entirely of wood with an oak frame and ⅞-inch white pine skin.

The steel ponton boat was of the boat type of galvanized steel construction throughout and its dimensions were: length 31 feet 6 inches, beam 5 feet 8 inches, depth 3 feet 1 inch, and it weighed 1,765 pounds. It was constructed of galvanized sheet steel, riveted to an angle iron frame and channel iron gunwales and was divided into four watertight compartments by transverse bulkheads, which materially strengthened the boat and increased its flotation, as it was necessary to pierce at least two compartments in order to sink the ponton when in its position in a ponton bridge.

The aluminum ponton boat was of the boat type and was constructed of aluminum skin mounted on an oak frame, of sufficient flotation to prevent the ponton from sinking when filled with water. Its length was 31 feet 6 inches, beam 5 feet 8 inches, depth 3 feet 1 inch, and it weighed 1,635 pounds. This boat was also provided with four separate watertight compartments by means of transverse bulkheads, in order to increase its strength and its carrying capacity when one or two of the compartments were punctured by gun fire or otherwise.

These boats had sufficient displacement to carry superimposed loads as follows and allow for a 9-inch freeboard:

Wooden boat	20,000 pounds
Steel boat	22,000 pounds
Aluminum boat	23,000 pounds

Tests of Boats

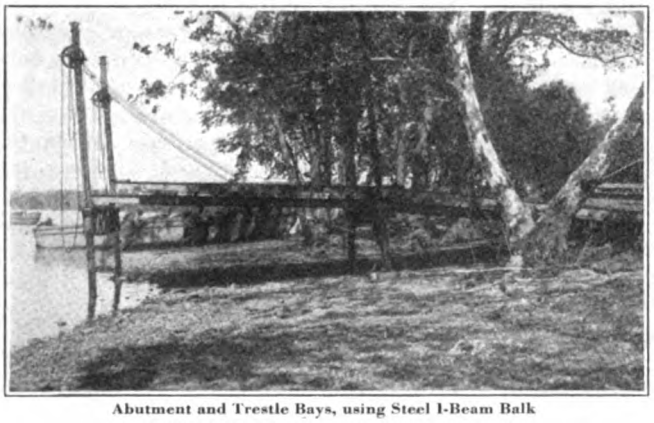
During tests conducted at Camp A. A. Humphreys, Va., those boats functioned equally satisfactorily in a ponton bridge constructed in water, and carried successfully axle loads ranging up to and including 17,900 pounds. The Mack truck and the 10-ton Holt tractor were passed over the bridge without incident, and later the Mack truck and 10-ton Holt tractor were passed over the bridge together, spaced so that the centers of the loads were located over adjacent ponton boats. A Mack truck was loaded until its gross weight was 27,280 pounds, divided approximately with 9,380 pounds on the front axle, and 17,900 pounds on the rear axle, and then passed over the bridge. Under this load the saddle boat was immersed until it had only 4 inches freeboard, while under the same load the second boat in the bridge from the shore had 9 inches freeboard. This indicated that the capacity of the saddle boat determined the maximum load which could be passed over the bridge. This was due to the fact that the span between the trestle and saddle boat was longer than the normal span and also because only a small part of the load was transmitted to the adjacent pontons.

A ponton bridge of five bays was built on land with the pontons resting on a bed of river gravel simulating the bottom of a stream. All of the experimental ponton equipage carried axle loads up to and including 17,000 pounds without incident. Under a 30,000-pound axle load both the aluminum boat and the steel boat commenced to fail by buckling of the gunwales. Under a 40,000-pound axle-load the gunwales of the metal ponton boats were so badly

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crushed that they had to be removed. Both metal boats failed to the extent to make their repair difficult. An axle load of 46,000 pounds was successfully carried by the wooden boat without showing any signs of failure. These tests showed conclusively that the wooden boat was superior in a grounded bridge. In view of the wide tidal fluctuations of the coastal streams of this country, it is believed essential for ponton boats to carry successfully the increased army axle loads when the boats are grounded on the bottom of a river.

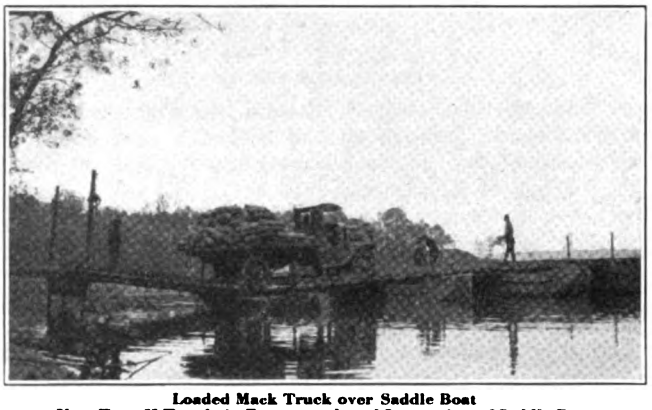
All three types of boats were readily loaded and unloaded and none presented any difficulties when handled by a detail of eighteen to twenty men. The differences in the weights of the boats made no material differences in the tractor drawn and motor drawn transportation tests. In a horse drawn test all were easily hauled. All boats were easily handled in the water, and the higher freeboard presented no real difficulties in rowing. A load of sixty soldiers with heavy marching packs were readily transported by each type of boat. Under rifle fire at a range of 125 yards five shots were sufficient to put the steel boat in danger of sinking. In each case the bullet made a clean entrance hole through the near side and from two to six ragged holes through the far side. Eleven shots were sufficient to flood the aluminum boat. In each case the



Abutment and Trestle Bays, using Steel I-Beam Balk

holes through the aluminum skin, in and out, were clean and no bullet caused more than two holes. One hundred and twenty-five rounds were fired at the wooden boat without stopping to doing any patching. Holes were generally clean and the water entered very slowly. The results of the rifle tests were decisively in favor of the wooden boat. However, it must be remembered that the range was only 125 yards and that at a greater range difficulties might be encountered in penetrating sufficient compartments below the waterline of the steel and aluminum boats to flood same with water. Furthermore a ponton bridge constructed of boats subject to being readily sunk might prove extremely advantageous during a retreat when, due to lack of time to remove same, the destruction of a ponton bridge might be highly desirable. A few hand grenades properly applied to the steel ponton boat could easily accomplish this result. The bullet holes in both metal boats were readily plugged before the boats were filled with water, by a rubber gasket patch which consisted of a rubber washer on a wide headed bolt provided with a wing nut. Several other types of patches were tested but did not prove adaptable to patching ragged holes in the skins of the boats.

All of the boats were equipped with four skids which proved a decided improvement and aided materially when moving boats on land and handling same in the water. All boats were equipped with a windlass located in both the bow and stern, similar to that used in the German pontons, but under tests this equipment did not present



Loaded Mack Truck over Saddle Boat
Note Type II Trestle in Foreground, and Immersion of Saddle Boat

any great advantages over the mooring post now in use.

The principle argument in favor of the metal boats is their resistance to time and the elements while in storage in a hot arid climate and their immediate availability for service at all times after construction. So far as availability of materials for construction and rapidity of construction is concerned, our experience in the manufacturing of boats indicated that the steel boat should rank first, the wooden boat second and the aluminum boat third. In general the performances of the aluminum boat under tests were superior to those of the steel boat, and the officers conducting the tests recommended to the Chief of Engineers that sufficient aluminum boats for an experimental ponton division be procured and subjected to field tests over a long period of time.

Balk

Due to results of tests conducted by the Bureau of Standards and the Forest Products Laboratories, of lumbers which may be secured in large quantities, Douglas fir was selected as the material most suitable for balk construction.

Tests of balk constructed of Douglas fir, reinforced by steel plates and ½-inch twisted steel rods, indicated the impracticability of reinforcing wooden balk with metal. Studies indicated the impracticability of using steel I-beams for balk due to excessive weights.

The following table shows the types of balk constructed,



10-ton Holt Tractor and Loaded Mack Truck on Bridge

dimensions and weights of same, and the loads carried by bays constructed of same. In each case seven balk plus two side rails were used per bay.

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Type	*Size*	*Weight*	*Type of Bay*	*Load under which bay failed*
1 Piece wooden balk of Douglas fir, rectangular cross section.	4¼ inches by 6⅜ inches by 23 feet	166 pounds	Boat to boat span 16 ft. Transverse balk used.	This bay carried an axle load of 46,000 pounds without failure.
Do	Do	Do	Boat to boat span, no transverse balk.	Failed under an axle load of 44,500 pounds.
Do	Do	Do	Boat to trestle span 18 ft, 10 inches. Transverse balk used.	Bay failed under an axle load of 36,000 pounds.
2 Piece wooden balk. Two pieces of Douglas fir bolted together. Rectangular cross section.	4½ inches by 6⅜ inches by 23 feet	155 pounds	Boat to boat span, 16 ft., transverse balk used.	Bay failed under an axle load of 42,000 pounds.
1 Piece wooden balk of Douglas fir, I-beam cross section.	4¾ inches by 6¾ inches by 23 feet	146 pounds	Boat to boat span, 16 ft., no transverse balk.	Bay failed under an axle load of 40,000 pounds.
Do	Do	Do	Trestle to trestle span, 20 ft., transverse balk used.	Bay failed under an axle load of 19,000 pounds.
Steel I-beam balk.	5 inches, 9¾ lbs., 15½ feet long.	155 pounds	Trestle to trestle span, 13½ feet, no transverse balk.	Bay failed violently under an axle load of 40,000 pounds.

From the foregoing figures it is obvious that the one-piece balk, constructed of Douglas fir of rectangular cross section, 4¼ inches by 6⅜ inches, is the strongest type of balk. However, all bays made up of the various types of balk carried successfully a loaded 5½-ton Mack truck, a 10-ton Holt tractor, and axle loads up to and including 17,000 pounds without incident or excessive deflection. The figures also indicate clearly the advantages obtained from the use of the transverse balk for partially transmitting the load to the side rails. The transverse balk was constructed of Douglas fir 4¼ inches by 6⅜ inches by 12 feet, and was equipped with spacing cleats which engaged the longitudinal balk. It was rigidly connected to the side rails by means of balk collars constructed of steel. These collars consisted of two pairs of lazy tongs which opened to receive the transverse balk and supported it when closed, and which were flexibly connected to a saddle provided with a jack-screw that rested upon and across the side rail balk. The balk collars tested were equipped with a cam to open and close the tongs. This refinement proved unnecessary and it is believed that a simplified design will provide a strong and flexible means of lashing the side rails, chess, longitudinal and transverse balk firmly together. The balk collars may be quickly installed from the bridge floor.

All of the balk tested were equipped with steel pins which engaged in balk-pin sockets on the pontons, thereby providing a positive though flexible connection between balk and boats and also eliminating the temporary lashing now made when laying balk in place. The retention of the balk pin is favored. It did not present any difficulties when stacking the balk in piles or transporting same on wagons. In addition to the balk pin connection, the balk were lashed to the boats by means of the standard ½-inch lashing, to prevent movement in the vertical plane only. Numerous studies were made of designs for mechanical lashings which in most cases were a mechanical contrivance located on the balk, thereby precluding an adjustable length of bay. The aluminum boats were equipped with a mechanical lashing consisting of a strap constructed of brake-lining material, one end directly connected to the gunwales and the other end adjustably connected by means of a ratchet device and adaptable to lashing the balk to the boat at any point along its length. However, under test they proved cumbersome and unreliable and presented no advantages over the rope lashing now in use.

The boats were provided with lashing hooks. However, it is believed that a waling piece fastened to the inner sides of the ribs of the boat, about 6 feet below the gunwales, would provide a more suitable means for lashing balk at any location throughout the width of the roadway.

In order to make all ponton boats identical as to the layout and location of the balk pin sockets, it is necessary to lay the balk with a slight slant, or at an angle whose offset from the center line of the bridge equals the width of the balk. It would be impossible to lay the balk parallel to the center line of the bridge unless three alternate balk pin sockets are provided for each balk location. Another advantage gained by the angular method of laying the balk applies to the side rails of the bridge. When the side rails are laid in this manner, the inside roadway end of the balk pointing towards the far shore on the right-hand side, no projecting balk ends are in a position to be struck by, or to interfere with, traffic which bears to the right in the usual manner.

Chess

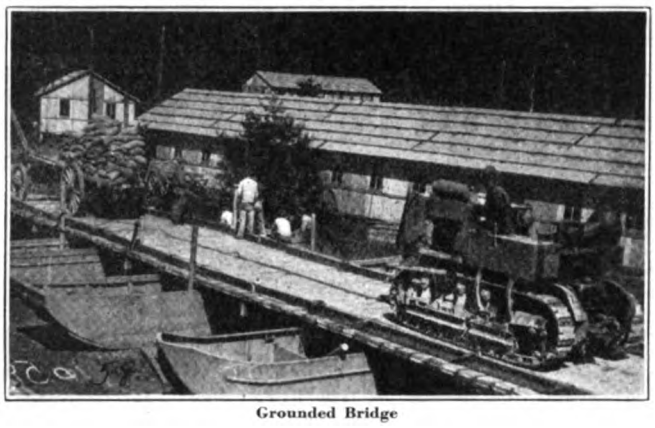
The chess were constructed of white pine on account of its lightness, 1 11/16 inches thick by 12 inches wide by 12 feet long. Twenty-three inches at each end was reduced to a width of 10½ inches and reinforcing rivets of ¼-inch steel were riveted through the chess 1½ inches and 21½ inches from each end to prevent the chess from splitting. Its weight was 43 pounds. A double thickness of chess was used on the bridge tested and proved to be the weakest element. The white pine was badly crushed under the wheels of the heavy loads and in many cases the loads cut through the double layer of chess when the wheels were not located directly over a balk. These tests indicated that white pine is no longer adaptable for the construction of chess intended to carry the increased loads, and studies of the possibilities of longleaf Georgia yellow pine, maple and oak, for use as chess, are being made. The width of the roadway of the bridge tested was 9 feet 6 inches, but later developments proved the necessity for a bridge with a 10-foot 6-inch clear roadway. This increase will undoubtedly require eight balk per bay in order to decrease the chess span between balk to a minimum.

Trestles

Two types of trestles were designed, manufactured and tested. Type No. 1 trestle was constructed entirely of structural steel and Shelby cold-drawn tubing. It consisted of two threaded steel columns that adjustably supported, by means of capstan nuts, housing and clamp members, a 9-inch 21-pound I-beam transom together with its rein-

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forcing members. The entire transom unit could be raised, lowered and clamped in place from the roadway of the bridge by two men. The trestle consisted of seven separable units: the transom, two struts, two columns and two trestle shoes, and weighed complete 1,090 pounds. In



Grounded Bridge

order to strengthen the transom, its unsupported span of 12 feet was reduced to 8 feet by the use of two struts of 3-inch 5½-pound I-beams, 2 feet 8 inches long, used as diagonal braces. When the transom and its struts were placed in their respective housings and the suspension members and cross guide rods were tightened to their home positions, the entire assembly became a complete bridge panel, adapted to be supported by its two side columns and trestle shoes. The trestle shoes had approximately 4 square feet of area and were constructed of wood, reinforced with angle iron around the bottom edge and across the bottom face, and equipped with steel teeth projecting downward to prevent side slipping. The connections between the shoes and the columns allowed the shoes to accommodate their positions to inequalities of the foundations without disturbing the vertical position of the side columns.

Type No. 2 trestle consisted of a lattice angle iron transom slidingly adjustable along its two end supporting steel columns by means of chain hoist supported by the upper end of the side columns. The transom was supported in place by pins that passed through the end plates of the transom and corresponding holes in the column. The trestle consisted of seven separable parts, transom, two columns, two chain hoists, and two trestle shoes, and weighs approximaetly 1,300 pounds. The transom was of 12-foot 6-inch span, 18 inches deep and 9 inches wide. It was built up of two lattice transoms, 2 inches by 18 inches by 12 feet 6 inches, set back to back, the ends of the transoms being riveted to the transom column housing and the intermediate portions of the separate transom members connected together by splice plates. The shoes consisted of flat steel plates reinforced with angle iron around the lower edges and provided with teeth at the corners to prevent side slipping. Their construction was such that the shoes could rest firmly on their foundations, and at the same time allow the side columns to stand in vertical positions.

Both types of trestles functioned equally satisfactorily under tests and successfully carried axle loads up to and including 46,000 pounds without excessive deflection or incident. The second type described is favored because of its simplicity and relative ease of assembly. It is well to note here that a standard wooden trestle was used in the ponton bridge constructed on land until it failed under an axle load of 13,500 pounds. The wooden shoe failed by splitting, allowing the unsupported leg to enter the ground a distance of 16 inches, which in turn allowed the wooden cap to strike the ground with such force that the cap and three balk were completely fractured. This incident showed the relative weakness of the standard wooden trestle.

Saddle Boat Support

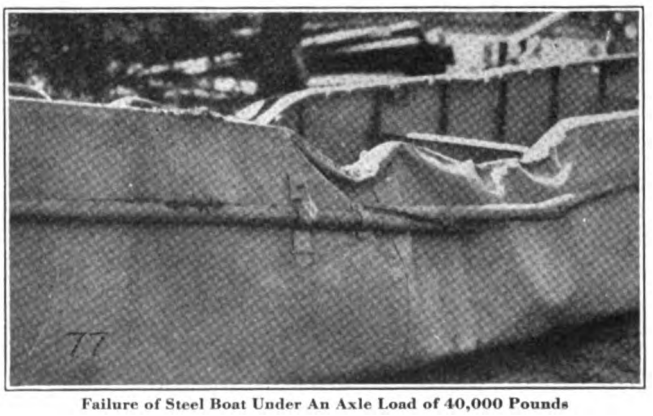
The tests indicated that the weakest bays are those adjacent to the saddle boat and the trestles. An effort was made to eliminate the standard saddle and to adapt the long balk for use in the bays adjacent to the saddle boat. The saddle boat was equipped with seven saddle transoms designed to secure a long firm bearing over the center of the supporting boat, independent of any rise or fall in the water level resulting from rain or tides. Each saddle consisted of two wooden rockers constructed of oak, lying side by side and free to move independent of one another. The rockers supported their respective balk across the entire width of the ponton boat, the balk being held in position by balk pins that engaged in balk pin sockets in their respective rockers. The rockers were housed in a steel cradle that extended across the gunwales of the ponton boat. Under tests those saddle transoms did not function as expected due to the fact that the saddle boat turned on its side in the water before the wooden rockers adjusted themselves to the gradient of the roadway. In view of the fact that the tests showed that an axle load which could not develop the full capacity of adjacent boats would immerse the saddle boat to a 4-inch freeboard, it appears advisable to construct the saddle support of two boats fastened together by lashings, with transom members lashed to the gunwales of both boats supporting a sill of the standard type now in use to carry the super-structure. It would also be advisable to reduce the length of the spans adjacent to the saddle boat.

Miscellaneous Equipment

An abutment sill similar to the standard type and equipped with balk pin sockets to engage the trestle balk, 14-foot hickory oars reinforced with a special aluminum tip to prevent splitting, rowlocks adaptable to the higher freeboard of the pontons, and pickets constructed of standard galvanized wrought iron pipe, were tested and found suitable for use with the new ponton equipage.

Transportation

Studies of the requirements of modern armies in the



Failure of Steel Boat Under An Axle Load of 40,000 Pounds

field showed the desirabilty of having ponton vehicles subject to being animal drawn, truck drawn or tractor drawn.

The following extract from the historical record of the

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464th Engineer Ponton Train indicates clearly the necessity for having our ponton vehicles constructed along automobile lines and capable of being truck drawn:

"On October 29th we received an order to prepare to move overland to Bethelainville. Twenty trucks were provided to complete the movement overland of 67 vehicles, movement to be completed in one haul.

"As this was a physical impossibility we decided to comply with the order to the best of our ability. On October 30th, 19 motor trucks arrived and departed at 9:30 a. m. with 38 vehicles, each truck towing two vehicles. We were obliged to borrow one hundred horses to bring this equipment from the Island to the main road, this work being done during the night of October 29th under a bombing attack aimed at the adjacent Steel plant. At 10:00 p. m., October 31st, this convoy completed the movement to Bethelainville and at 4:00 a. m., November 1st, the equipment was hidden in the forest.

"It would be well to note that we had advised very strongly against towing the ponton equipment behind motor trucks, and this trip reduced the efficiency of the equipage about fifty per cent. All tongues were broken, braces twisted, bolts sheared and in some instances entire wagons overturned.

"On October 31st, 1918, about 4:00 p. m., fifteen French motor trucks arrived for the purpose of convoying the balance of the equipment to Bethelainville. Seventy-five horses were again borrowed from the Ammunition Train of the 92nd Division and by working all night the twenty-nine wagons were hauled up onto the main road and hooked in pairs ready for the trucks. At 5:30 a. m., November 1st, all supplies, rations and office and equipment were loaded on the trucks at Pompey. The train then proceeded to Harbach where the wagons were lashed on and convoy started off at 8 a. m. The last truck reached Pierfeitte at 9 p. m. the same date, some motor trouble was experienced but the greatest trouble was due to broken tongues and wheels on the ponton wagons as these wagons were never made for this method of transportation.

"At 4:30 a. m., November 3d, four trucks (attached from 23rd Engineers) were started out with billeting detail, kitchen detail, all supplies and office equipment. At 5 a. m. Captain Goodwin left with seventeen boat wagons drawn by four horses each, thus using all horses fit to work. It was found en route that four horses were not sufficient for handling the wagons over the rough and muddy roads encountered and in many cases it was necessary to put eight and ten horses on a wagon to get through some of the bad spots. At 6 a. m. eighteen of the promised trucks arrived and left with eighteen wagons. At 1 p. m. same day all horses fit to move were sent forward on a moving picket line."

A ponton wagon to transport the balk and boats, a chess wagon to transport the chess, and a trestle wagon to transport the trestle equipment, all capable of being drawn with equal facility by animals, tractor or truck, were designed, manufactured and tested. The wagons weighed approximately 2,400 pounds each and were equipped with 40-inch rubber tired wheels, suitable pintles, lunette rings and drawbars, and constructed in accordance with the general type of automobile design and practice. The wagons were reversible and capable of being turned or steered from either end when used as a single wagon or in trains of two wagons or more.

Tests of those wagons were conducted on the roads in and about Camp A. A. Humphreys, Va. A horse drawn test of ten miles was made. The loaded ponton trailers were drawn by six line mule teams and the loaded chess and trestle trailers by four line mule teams. On the whole the march was very satisfactory, the roller bearing wheels reduced the friction so that the team pulled the greater loads with greater ease than the standard equipage. The route included several very steep grades, both up and down, ditches and several soft spots where the wheels cut in from twelve to sixteen inches. The day was warm and the mules came in sweated but showing no lather and were apparently good for ten miles more.

Various types of trucks, including the 1½-ton Garford, 3-ton Liberty and 5-ton Mack, were used to haul from one to three trailers over various types of roads including concrete, gravel and dirt, at various speeds for distances up to and including fifteen miles. These tests indicated that the 1½-ton Garford and 3-ton Liberty trucks were on the whole more successful for this work than the 5-ton Mack and that the lighter trucks were better for the poorer roads. More than two trailers should not be drawn by trucks except under very favorable conditions when the truck may operate over a two-way road with little opposing traffic. The speed should not exceed twelve miles per hour. At higher speeds the trailers skidded away from the crown of the road towards the ditch, especially for speeds exceeding fifteen miles per hour.

The Cadillac 2½-ton tractor, the 5-ton Holt tractor and the 10-ton Holt tractor, were used to draw trains of one to five wagons. The vehicles tracked as well as could be expected. On narrow roads with a high crown, the third wagon would often slide off the road into the ditch. On turning a train made up of two ponton boat wagons and one chess wagon, drawn by a 5-ton Holt tractor on a 60-foot curve, the rear wheels of the third vehicle tracked 9 feet inside the track of the front wheel of the first wagon. Trains of two or more wagons could not be backed in any desired direction. No more than three vehicles should be hauled by a tractor on a good road and not more than one vehicle on a poor narrow road. The stability of the load was increased materially when the ponton boat was loaded on the ponton wagon bottom side up. In general the tests were severe and the wagons stood it well but many weaknesses in the design developed which indicated that the trailers tested would not stand up under service conditions for a very long period. When the vehicles were drawn by animals the brakes, which were of the automobile type, were applied over long periods of time, which caused same to overheat and wear rapidly. The rubber tires wore out too rapidly, indicating the necessity for wider treads. The requirement for reversibility introduced many intricate features in the designs, requiring a two-point suspension similar to that of the Ford automobile, which obviously is inferior to a three or four-point suspension. It also necessitated a complicated brake mechanism which quickly became unserviceable. However, a direct action brake precludes the use of rubber tires which are considered essential for a truck drawn vehicle. The springs proved to be too light. The radius rods proved to be weak and were badly bent when the ponton boat wagon was mired in a mud hole and drawn therefrom. In general, all small parts such as steering arms, brake rods, tongues, pintle hooks, chains, etc., were too lightly constructed, due to an effort made to develop a ponton wagon trailer weighing less than 2,000 pounds, and would soon become unserviceable under severe service conditions. The superstructures of the various vehicles proved satisfactory.

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Discussion

C. P. Gross

Major, Corps of Engineers

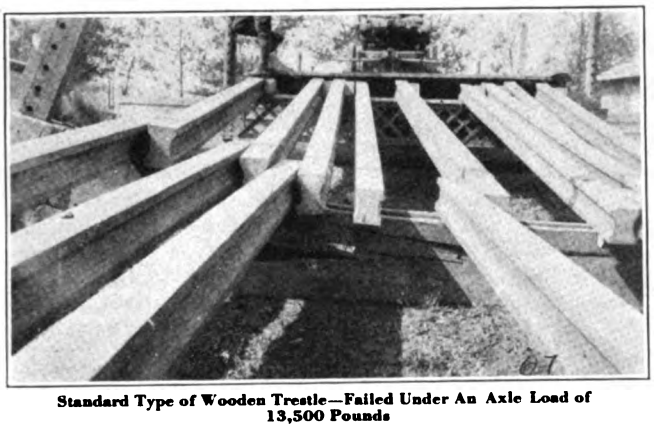
In the main Captain Wyman has faithfully set down the results of the experimental tests of the new heavy ponton equipment recently conducted at Camp Humphreys, Va. His article does convey, however, an impression that the bridge will be based on the metal boat and that all elements of a heavy bridge train have been developed to the point where relatively simple modifications will result in standard equipment.

During the tests the chief interest naturally centered on the comparative performances of the three types of pontons. Was a metal boat to upset our traditional faith in the wooden ponton?

The wooden boat did prove its superiority. In order to emphasize its victory the following rating is submitted. Entries bracketed indicate opinion, largely; others, fact.

	First	*Second*	*Third*
Light Weight	Alum	Steel	Wood
Nonsinkability	Wood	Alum	Steel
Minimum attention required	(Wood)	(Alum)	(Steel)
Ease of repair	Wood	(Steel)	(Alum)
Resistance to time and elements	(Alum)	(Wood)	(Steel)
Construction approximating boat lines	Alum	Steel	Wood
Rapidity of construction	(Wood)	(Steel)	(Alum)
Availability of material for construction	(Wood)	(Steel)	(Alum)
Immediate availability for service	(Alum)	(Steel)	(Wood)
Ease of loading and unloading	Alum	Steel	Wood
Ease of transporting	Alum	Steel	Wood
Behavior under rifle fire	Wood	Alum	Steel
Ferrying capacity	Alum	Steel	Wood
Strength in bridge	Wood	Steel	Alum
Displacement capacity	Alum	Steel	Wood
Cost	Wood	Steel	Alum

As all types can be drawn by a six-line team, the differences in weights of the boats are relatively unimportant. The three pontons are so easily handled in the water that a consideration of ship lines should have no weight. All are readily loaded and unloaded. All have practically



Standard Type of Wooden Trestle—Failed Under An Axle Load of 13,500 Pounds

equal ferrying capacity. These points, therefore, are not decisive in recommending any one particular type of ponton. As far as they go they do favor the aluminum boat.

In nonsinkability, ease of repair, behavior under rifle fire, strength in the grounded bridge and in lower cost, the superiority of the wooden ponton is decisive.

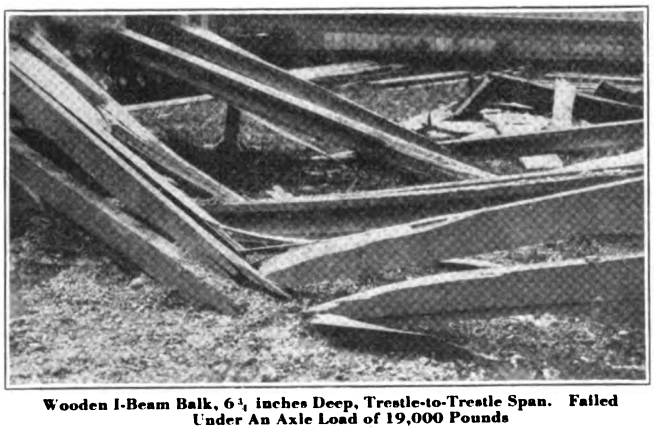
A constant argument by the advocates of the metal boat is that materials for the construction of the wooden one are not readily available. A journey along the seaboard reveals such quantities of idle wooden vessels that the lumber interests prevailed on Uncle Sam to believe would win the war, that one trembles to think of the flood of pontons that would result if the idea were conceived that pontons were to win the next war. The high quality of lumber demanded in the past is not entirely essential. Necessity would satisfy itself with commoner grades. Better a few knots than leaking rivets.

The wooden boat is unsatisfactory when stored in a hot climate. The aluminum boat seems to offer relief in being at all times serviceable. Such serviceability is, however, more apparent than real. For instance, in unloading this equipment for test, two holes were stove through the bottom of the metal boat. Four hours were required for its repair by welding with results none too good. In the field such repairs are not easily made and such condition would frequently invite abandonment.

The one argument not to be disputed in favor of the aluminum boat is the fact that for the same loading it has a 2-inch higher freeboard, and as a support, therefore, has a buoyancy greater by two tons than the wooden ponton.

The wooden type is hardly an experiment. Its advantages are known through long experience. No new discoveries concerning it were made in the tests conducted. It just lived up to its traditions.

The recommendation referred to by Captain Wyman, to purchase a division of aluminum boats is not to be considered a decision in favor of the aluminum ponton. Funds available were for experimental purposes. It was thought that little more could be learned with respect to the wooden boat. It was felt that the many advocates



Wooden I-Beam Balk, 6¼ inches Deep, Trestle-to-Trestle Span. Failed Under An Axle Load of 19,000 Pounds

of metal would hardly be satisfied by tests so short in duration, and which could not, in fact, be called complete.

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Additional experiments with the metal boat were, therefore, urged to give it a better chance to recommend itself as a type, or failing that to hush the clamor of its champions.

The equipment tested, with numerous minor modifications, does contain the elements of a bridge carrying the



Steel Boat—Rifle Test—Range 125 Yards. Departure of Fourth Shot Produced Four Holes

loads for which designed. All elements are not, however, properly balanced. The pontons will support greater loads. The chess, doubled, will not. No matter for what load intended, in the field the bridge will get all it can take. Chess 1 11/16 inches thick belong to the old equipment. They have no real place in the new. This thickness should be increased to 2½ or 3 inches, one wagon carrying enough for one bay (chess doubled).

The manual of bridge construction remains very much the same. Placement of the trestle requires sixteen men, however. Boat crews, balk carriers and balk lashers have no new duties. The balk, while of larger cross section, is shorter and still a two man load. The chess, even if 2½ inches thick, continues as a one man load. The side rail section has a slightly easier task. An added section of four men must be added, however, to place the transverse balk and balk collars.

While the bridge equipment proper is reaching a solution, no satisfactory transportation has yet been developed to carry it. That tested failed beyond hope of recovery by simple modification. The requirements asked were far from simple, demanding construction not even commercial. The basis of military success is utter simplicity. It would seem apparent that to require a vehicle to be horse drawn, motor drawn and reversible must necessarily produce a hybrid. Reversibility is not essential. In this country of poor highways, the railroad rather than the motor truck should be used for the longer hauls. The vehicle must be animal drawn. For controlled speeds it can be made capable of being tractor drawn. Sure mobility even though slow is far more successful in campaign than bursts of speed separated by wild scrambles for spare parts.

Reginald Whitaker

Captain, Corps of Engineers

Captain Wyman in his paper leaves little to be said by way of controversy. The actual tests made upon the experimental heavy ponton equipment were conducted by Company C, 13th Engineers, from April 3, 1921, until June 2, 1921, at the Ponton Grounds, Camp A. A. Humphreys, Va. The site was in every way favorable to the prosecution of the tests, Gunston Cove affording suitable space for the water tests and its flat open shore room for storage, parking, and the construction of land bridges. The tests in order to be as thorough as it was possible to make them within a limited space of time, included the following general points:

Transportation Tests,
Boat Tests,
Tests of the Material in the Ponton Bridge,
Tests of the Material in a Grounded Ponton Bridge.

Transportation Tests

The transportation tests lasted from April 3 until April 25. Vehicles to be tested comprised three ponton trailers, one chess trailer, and one trestle trailer, built on automobile chassis lines, all steel, and with solid rubber tires. A method for loading each type had to be worked out, a matter which caused no difficulty as the bodies of these trailers were admirably designed to carry the new equipment.

First the loaded trailers were hauled by tractor singly and in trains up a hill whose maximum slope was 13½ per cent. The Cadillac 2½-ton tractor took one loaded ponton trailer and one loaded chess trailer up the hill easily, two men riding on each vehicle to work the brakes in case of mishap. In addition to the men riding, about three squads followed the train ready with shovels and logs to prevent slipping and backing. Incidentally, in several cases when the train seemed to be about to stall, the men riding worked the brakes with such enthusiasm that the iron handles were completely broken off.

The Holt 5-ton Ordnance Tractor similarly pulled one ponton trailer, one chess trailer, and one trestle trailer up the hill. The length of this train made the rear vehicles follow but poorly in the path of the tractor.

The Holt 10-ton Ordnance Tractor hauled all five vehicles to the top of the hill quite easily, but the same difficulty was experienced of keeping the rear of the train on the road. After the hill climbing test a run of four miles was made with the tractors.

The next phase of this test consisted in repeating the hill climb with motor truck traction, the ¾-ton G.M.C., the 1½-ton Garford, the 3-ton Liberty and the 5-ton Mack trucks being used successively. One trailer, either ponton, chess, or trestle, was the most that each truck could haul up this grade.

Upon completion of the hill climb a test run of fifteen miles was made, over concrete road, gravel and dirt road, and dirt road. While on the concrete road the steel pole



10-ton Holt Tractor Going Up Ponton Hill with Five Trailers

of a ponton trailer broke and before the brakes could be applied the trailer ran off the road, smashing running gear and springs.

The next phase of the tests consisted in a ten-mile mule drawn test. Six-line teams hauled the ponton trailers and

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four-line teams hauled the trestle and chess trailers without trouble.

Boat Tests

The boats were put into the water and manned with crews of five men each—four rowers and a steersman. They were loaded in accordance with the provisions of the Ponton Manual with men in heavy marching order. As we are told by that manual, the troop ferrying capacity of the boats is limited by space rather than buoyancy and by the necessity for allowing freedom of movement to the rowers. It was found that a load of sixty men could be be carried safely.

In the test of the ability of the pontons to withstand rifle fire, one of each type was moored about 125 yards off shore, and fired at with a service rifle. At this point I wish to dispute a statement made by Captain Wyman with reference to the steel ponton that each bullet made a clean entrance hole through the near side. On the contrary, bullets striking above the waterline made round holes much larger than the bullet, nearly 5/8 inch in diameter, and bullets striking at or below the waterline tore jagged, irregular holes from two to three inches across, because of the striking effect of the water itself upon the brittle steel of which the ponton is made.



10-ton Holt Tractor Hauling Ponton Boat Wagon through Mud Hole

Tests of Material in the Ponton Bridge

A bridge of eleven bays was constructed, with the same number of men and practically the same details as are normally prescribed for the present ponton equipage. The capacity of the boats in the bridge was measured by applying both static and moving loads to it and measuring the height above water of the gunwale of every ponton. In the case of static loads sandbags of known weight were piled on a two-wheeled cart which was placed over the ponton whose immersion was to be measured, the bridge was cleared of people and gunwale heights read with tapes weighed at the ends. The same measurements were taken for moving loads, applied by auto trucks while passing over each boat.

Tests of Material in a Grounded Ponton Bridge

The purpose of this test was to determine simultaneously the supporting power of the several types of materials in the superstructure and the supporting power of the three types of boats in the bridge when grounded. A dry ponton bridge of five bays was built with no two bays similar. Each bay and therefore each type of material was tested to failure. One ponton of each type and both experimental trestles were used, every ponton resting on a prepared bed of river gravel simulating the bottom of a stream.

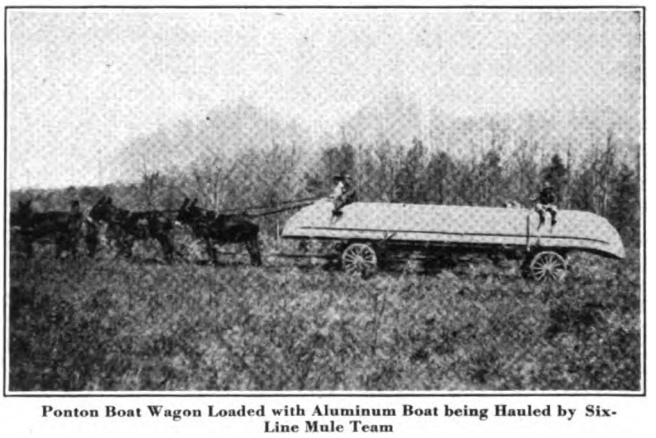
To determine the action of the various kinds of superstructure the actual deflection of the bridge under all loads was measured by taking six sets of level rod readings for each load and on each span. One rod was placed on the bridge floor just outside the side rail and directly over the inside gunwale of a ponton; another rod was placed on the bridge floor just outside the siderail in the exact center of the span and a third was placed to correspond with the first but at the other end of the span. After readings were taken with a level on the rods in these positions they were placed in corresponding positions over the reinforced balk, *i. e.*, at the tread line of the bridge, and level readings again taken. These readings gave the difference in elevation between the center and the ends of the span, at the edge of the flooring and at the treads of vehicles, and whether or not the ends of the span were level was immaterial.



Ponton Boat Wagon After Going Through Mud Hole
Note the Bent Radius Rod and Broken Steering Arm

To obtain the maximum effect, loads were applied on one axle and that axle placed in the center of the span when readings were taken. In addition, however, a loaded 5-ton Mack truck and a 10-ton Holt tractor were run over the bridge and the deflection of each span noted.

The single axle loads up to and including 13,500 pounds were obtained by placing bags filled with sand and gravel, each bag weighing 150 pounds, on a cart built upon the detached rear axle of an old ponton wagon. For all loads greater than 13,500 pounds a complete ponton wagon was used with the bags so arranged over the rear axle that the front wheels were balanced and imparted no weight to the bridge. The axle to be loaded was first placed at one end of the bridge and sufficient bags placed on it to bring the gross load to 2,500 pounds. It was then moved along the bridge and brought to rest at the



Ponton Boat Wagon Loaded with Aluminum Boat being Hauled by Six-Line Mule Team

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center of each bay in turn and level rod readings taken as described above. Having reached the other end of the bridge more bags were added and the load moved back and deflections measured as before. Whenever a span broke it was rebuilt and reinforced and attention directed thereafter to the unbroken spans until they, too, failed.

Although the methods followed in this work lacked the refinements of the laboratory it is thought that the results obtained furnish a reliable index to the characteristics and action of this experimental equipment.

A. A. Keesler

Major, E. O. R. C.

It is quite evident from Captain Wyman's description of results in the tests of heavy ponton equipage that the vehicles tested were inadequate for the duty required. It is not necessary to use either a reversible trailer for this purpose or one equipped with rubber tires. The objection to the reversible trailer is that its construction is greatly complicated and its efficiency greatly reduced by the attempt to make it suitable to haul from both ends. The fact that it is reversible is partly the cause for its inability to track well on a crowned road. The reversible feature also increases both the difficulty of production and the cost, far beyond their worth. There is occasionally a situation in which it would be an advantage to attach the power to the rear end of the train but these situations are rare and it is thought that a one way trailer of simple design would be an advantage.

It is not necessary that the cushion be obtained by means of rubber tires. It is entirely practicable to construct a steel tired wheel which will maintain speeds up to fifteen miles per hour and the cushion for vehicle and load should properly be obtained by means of spring suspension. The difference in cost as between rubber and steel is approximately $100.00 per wheel or $400.00 per vehicle and this sum, in ordinary times, would go far toward procuring the complete trailer.

The outstanding requirement for a vehicle to be hauled by truck, tractor or animals interchangeably, is that it be mounted on a frictionless bearing such as balls or rollers, and it must be borne in mind that mounting a vehicle on ball or roller bearings does not particularly decrease the force required for traction. It will move much easier on level roads but in ascending a grade the problem is one of foot pounds. I agree entirely with Capt. Wyman as to the necessity of having these vehicles so that they may be drawn both by animals and motors. It would appear that the problem of the bridge for heavy weights has been practically solved. The matter of transportation vehicles must receive further attention.

Appointment of Nominating Committee

In accordance with Article VIII, Paragraph 4 of the By-Laws, a Nominating Committee, consisting of Messrs. E. P. Ellis and Robert Coe, representing the membership at large; Col. John Stewart and Maj. J. J. Beaman, representing the Reserve Corps; and General Harry Taylor, C. of E., representing the Regular Army, has been appointed, and has organized by electing General Harry Taylor chairman and Maj. J. J. Beaman secretary. This Committee is charged with the duty of nominating the following officers for the ensuing year: President, First Vice-President, Second Vice-President, and six Directors to serve for three years, of whom two shall represent the Regular Army, two the Reserve Corps and National Guard, and two the membership at large.

The By-Laws provide that the list of nominations made by the Committee shall be transmitted to the Secretary of the Society not later than the twenty-fifth day of October and that the list so made shall be published in THE MILITARY ENGINEER for November or in the discretion of the Executive Committee shall be otherwise published to the members not less than sixty days before the date of the annual meeting.

Paragraph 5 of Article VIII is quoted for the information of our members:

In addition to the nominations so made by the committee, nominations may be made by a "nominating letter," signed by not less than ten active members:

Provided, That such nominating letter shall be received by the Secretary not later than the first day of December. The Executive Committee shall verify the eligibility of all nominees and their acceptance of nominations, and all nominees found eligible for election shall be included in the printed election ballot, which shall be mailed to all active members between the first and fifteenth days of December. The names of candidates for each vacancy shall be arranged in alphabetical order, with such data as to place of residence, civil and military record of each candidate, as the Board may deem pertinent or desirable: *Provided*, That no person shall at any one election be a candidate for more than one office or position.

The nominating committee will be glad to receive suggestions from the membership, but such suggestions should be in the hands of the committee not later than October 15, in order to receive consideration prior to the date on which the nominating committee must transmit its report to the Secretary. Nominations made thereafter by "nominating letters" prior to December 1st, will be handled by the Executive Committee under conditions specified in the By-Laws.

"Dollar Membership" Drive

Have you sent in the blank in the front of this issue with the names of six prospective members who should be interested in our special dollar membership offer?

Under the terms of this offer, one dollar sent in any time after September 1st will pay the dues of anyone qualified for membership in the Society to January 1, 1922, and will entitle him to a recent number of THE MILITARY ENGINEER (as a sample copy) and also to a copy of the regular November-December issue.

Application blanks covering this special membership have been mailed to all local posts, and will be furnished to members upon request.

The names of individual members and the names of local posts, with the number of applications secured, will be published in the next issue of THE MILITARY ENGINEER.

How near the top is your name and your post going to be?

Personals

Col. EARL I. BROWN, Corps of Engineers, has been transferred from Cincinnati, Ohio, to Wilmington, Delaware.

Col. JOHN MILLIS, Corps of Engineers, has been transferred from Fort Sheridan, Ill., to Chicago, Ill.

Col. MERIWETHER L. WALKER, Corps of Engineers, has been relieved as Commanding Officer at Camp A. A. Humphreys, Va., and ordered to report to the Governor, Panama Canal, for assignment to duty.

Col. GEORGE M. HOFFMAN, Corps of Engineers, has been appointed as a member of the board of officers to prepare a detailed plan for marking American battlefields in Europe.

Col. GEORGE P. HOWELL, Corps of Engineers, has been appointed as a member of an Army Retiring Board to meet at Fort McPherson, Georgia, for the examination of such officers as may be ordered before it.

Maj. LAYSON E. ATKINS, Corps of Engineers, has been granted leave of absence for one month.

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Cavalry-Engineer Rifle Competition

The Rifle Competition heralded in our last issue took place at Fort Bliss according to schedule and was completed on the 17th of August. The Engineer organizations, while not doing as well as they might, did put up a rather good showing considering the practice and preparation which they were afforded. The main idea of the Shoot was to select the best men for the Cavalry-Engineer team, which will compete in the national matches at Camp Perry and it is believed that this has been done. Two Engineers are qualified to go to Camp Perry—Captain Ross and Sergt. de Hart, both of the Eighth Engineers. In the team match the Eighth Engineers were the only Engineer organization to qualify in the competition open to both services. They finished second among all Cavalry and Engineer regiments represented. In the individual matches the Cavalry produced better shots, with the result that none of our men qualified in the open competition. The individual Engineer championship was won by Captain Andrews of the Engineers.

The Shoot on the whole can be considered a great success as it brought together men from all Engineer organizations for the first time and has indicated to the different regiments what is necessary for them to do in order to produce a winning team. It is now up to all organizations to apply the knowledge gained from this year's competition and turn out a high-class outfit to represent them next year. Detailed results follow:

Cavalry-Engineer Individual Championship:

Gold medal—	
Mr. Fody, 13th Cavalry	321
Silver medal—	
Sgt. Jensen, 16th Cavalry	314
Bronze medal—	
Major Martin, 2nd Cavalry	311

National Engineer Individual Championship:

Gold medal—	
Capt. Andrews, 1st Engineers	302
Silver medal—	
Sgt. Long, 2nd Engineers	301
Bronze medal—	
Sgt. Yearian, 4th Engineers	299

Fort Bliss Trophy Match:

First—Mr. Fody, 13th Cavalry	91
Second—Capt. Gerfen, 13th Cavalry	88
Third—Sgt. Frank, 5th Cavalry	88

Cavalry-Engineer Team Match:

First—7th Cavalry	942
Second—8th Engineers	923
Third—2nd Cavalry	921

National Engineer Regimental Team Championship:

First—8th Engineers	923
Second—13th Engineers	908
Third—1st Engineers	877



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The Military Engineer

Dedicated to the National Defense

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Montgomery Post—Mr. Dwight O. Trevarthen (E. O. R. C.), P. O. Box 763, Montgomery, Ala.

New Orleans Post—Capt. E. H. Coleman (A. L.), 1018 Hibernia Bldg., New Orleans, La.

New York Post—Maj. Percy E. Barbour (E. O. R. C.), 29 W. 39th Street, New York, N. Y.

Philadelphia Post—Lt. Col. W. B. Ladue (R. A.), 815 Witherspoon Building, Philadelphia, Pa.

Pittsburgh Post—Mr. Wm. M. McKee (E. O. R. C.), 1708 Farmers Bank Building, Pittsburgh, Pa.

Portland Post—Capt. P. Hetherton (E. O. R. C.), Chamber of Commerce, Portland, Ore.

San Francisco Post—Capt. D. W. Dodge (E. O. R. C.), 733 Rialto Building, San Francisco, Calif.

St. Louis Post—Lt. Col. John L. Buchanan (E. O. R. C.), 7th and Clark Avenue, St. Louis, Mo.

Seattle Post—J. M. Clapp (A. L.), 637 Burke Building, Seattle, Wash.

Washington, D. C., Post—Mr. E. P. Ellis (A. L.), U. S. Coast and Geo. Sur., Washington, D. C.

Wilmington Post—Secretary, Society of American Military Engineers, U. S. Engineer Office, Wilmington, Del.

The "Plattsburgh Idea" Again

THE little city of Plattsburgh, on the Canadian border, became famous during the Great War as the site selected by General Wood and his supporters for the notable experiment in volunteer training, known as the "Plattsburgh Idea."

The American people have a tremendous prejudice, inherited from their European ancestors, against compulsory service in war, or compulsory training in preparation for war. Realizing, at the outbreak of the war, the probability of our becoming involved in it, General Wood devoted his energies to overcoming the national prejudice, and preparing the country for what he knew was coming. The two outstanding results of his efforts were the Plattsburgh volunteer training camps and the selective or compulsory service act of May, 1917. To these we owe the successful outcome of the war. The early Plattsburgh camps were the experimental laboratory for the Officers Training Camps in which we trained the many thousands of officers who led our forces on the battlefields of Europe.

In the Great War the principle of universal obligation to service was recognized in the form of law. It is recognized for all time, and in any future war of sufficient magnitude we will have compulsory combatant service. There is no question of that. And it is to be hoped that, as a result of our painful experiences, we shall have also *compulsory industrial service.*

But the prejudice against compulsory training in time of peace, the necessary preliminary to compulsory service in war, remains to be overcome.

The prejudice is natural, deeply rooted, and probably just. It can be overcome, not by oratory, invective and abuse, but by practical demonstrations of the advantages of proper military training. A splendid demonstration of this was given during the late war, but it was evidently not sufficient. The War Department is continuing the demonstration, and Plattsburgh is again in the limelight as the most notable locality at which the demonstration is being given.

Our military policy now includes compulsory service in time of war, a notable improvement. In time of peace it includes volunteer training in the Regular Army, National Guard, Reserve Officers Training Corps (the R. O. T. C.), and Citizens Military Training Camps. All of these are being carried out this year at Plattsburgh and other similar camps.

The R. O. T. C. is already well established, and includes in its junior and senior units approximately 100,000 boys and men. It is the most practicable and the cheapest method of providing suitable material for junior officers under our policy of volunteer training.

The Citizens Military Training Camps are having their first demonstration this year. It is planned to give the rudiments of a military education to about 10,000 volun-

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teers. If the experiment proves a success it is hoped to increase this number from year to year until each summer will see about 100,000 men undergoing training. If these figures are realized it is conceivable that we may be able to build up a reserve of a million partly trained men within the age limits of the draft act. Many of these men will have passed through three successive camps (Red, White and Blue), and will have a good preliminary training as non-commissioned officers and officers. This scheme, however successful, cannot produce results comparable to those of universal training. But it can provide a good asset to the National Defense, and it can do much to overcome the prejudice against military training.

The summer training camp should be and must be regarded as a military kindergarten. The characteristic feature of the kindergarten is that the instruction is made so pleasant and entertaining that the children do not realize that it is work, but regard it as play. They receive their instruction in the form of a sugar-coated pill. This is perfectly proper and justifiable. Education should certainly be made as pleasant as possible, even when it is compulsory. We wish our children to have pleasant recollections of their school days. When the education is purely voluntary, as is the case with military training in America, it must be made pleasant and entertaining if it is to achieve any measure of success. This should accordingly be regarded as the mission of the officers who direct our summer training camps. The training administered should be considered as of secondary importance, or rather as something that will result as a matter of course in a successful camp. The camp must establish a reputation as a pleasant summer outing to which many young men will wish to come. When this is achieved, the success of the scheme is assured.

Knowledge and Wisdom

THE MILITARY ENGINEER has probably become characterized in the minds of many of its readers, by its continued insistence on the fact that the engineer who hopes to be successful in war, must have a knowledge of the fundamental principles and economies of the military art, as well as a knowledge of the technical work he will be called upon to perform.

An engineering structure or mechanical installation of any kind will not fully serve its purpose unless those who design, and erect or install it, are familiar with the purposes which the structure is to serve, and the conditions under which it is to be used.

In civil practice this essential knowledge need not all be possessed by one man. Consulting experts will be called upon to give advice on various phases of the work. If necessary, work may be suspended, pending an examination by the experts. Time is not always the chief element.

In war time, expert advice is certainly desirable, but will all too frequently be lacking. The consulting expert will not be at hand when he is needed, and the work must proceed without delay. The engineer must be his own consulting expert. Frequently, in fact usually, he must himself perceive the need for the structure, prepare the plans, obtain the materials and supervise the construction. He must be able to view his own work from every side. Any engineer in war is liable at any time, and certain sooner or later, to be thrown entirely upon his own resources, and to have nothing to consult except his own knowledge and experience. Such, in fact, is the usual situation in time of war, and the engineer must prepare to meet it. This any man of average talents may do, if he will remember that military structures and installations must be the last word in simplicity.

Further cumulative evidence of the truth of these statements is contained in Colonel Jackson's article on Engineer Supply, which appears in this issue. Colonel Jackson insists that a successful engineer supply officer must have a knowledge of both construction and combat. It should be quite plain that the engineer who is to be successful in either (engineer) combat, construction or supply service, must have a thorough knowledge of the economics of all three of these activities.

The bearing of all this upon the training of the engineer for war will be apparent. Profound technical knowledge is not essential, although it may be useful. It is not to be desired at a sacrifice of the qualities of adaptability and resourcefulness. What we need is plenty of engineers of average intelligence and training, men who have kept their eyes open and cultivated the faculty of observation, not allowing themselves to become narrowed by the too ardent pursuit of a specialty. We need men with sound fundamental ideas, a correct sense of proportion, a knowledge of good practice, open minds, high initiative, resource, determination and courage. In brief, we need men who can be depended upon to erect simple structures for simple needs, on their own initiative, in the minimum of time, under trying conditions, without calling for or expecting help from anybody—men who will produce results, make no excuses, and who will regard delay or failure as the only unforgivable sins.

It has been said that knowledge is power. It is so in a potential sense. We cannot *do* unless we *know*. But it is also true that too often "knowledge comes while wisdom lingers." Wisdom, or the ability to use one's knowledge effectively, is the great desideratum. It is not what we know but only what we do that counts in wartime. A mind stored with knowledge but lacking wisdom is like a great factory full of splendid tools and materials, but without the cunning artisans who alone can produce the commodities. It is better to have a moderate amount of knowledge with the wisdom to use it intelligently than infinite knowledge with no power of application. It is possible to cultivate wisdom, just as it is possible to amass knowledge, but the former is by far the more important, as well as the more difficult.

The engineer, whether in peace of war, should take advantage of every opportunity to increase his knowledge. But he must learn to think along common-sense lines, in true military fashion to "estimate the situation" that confronts him, decide upon a good plan of action, and carry it out with unwavering courage and energy. In this manner the man of average intelligence and information will achieve success. In no other manner can the best informed attain practical results, whether in peace or in war.

The Organized Reserves

THE Army of the United States consists of three components: the Regular Army, the National Guard, and the Organized Reserves. The first component having recently been reduced, it follows logically that additional reliance must be placed upon the two remaining components, in order that there shall be no decrease in the effective defensive strength of the nation.

"The organization of the Regular Army into a limited number of effective military units," said the Secretary of War recently, "will not only release a greater proportion of officers for duty with other portions of the Army of the United States, but will facilitate great economies in the maintenance of the peace establishment. As I interpret the intent of Congress in providing for the division of the country into corps areas, their primary object is to

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form a decentralized organization for the promotion and development of the National Guard, the Organized Reserves and the Reserve Officers' Training Corps. It is my desire, therefore, that this function should be especially emphasized in the War Department."

Special Regulations No. 46, General Policies and Regulations for the Organized Reserves, have lately been published. These regulations are the result of several months' exhaustive study of the subject by officers of the General Staff, and will be read with great interest by reserve officers of all branches of the service.

The organization, training, and mobilization of the Organized Reserves are functions of the corps area commander. The normal allotment is three infantry divisions to each corps area, together with a proper proportion of corps, army, auxiliary and special troops. The allocation of units within the corps areas will be determined by boards that will include reserve officers, and the names, numbers and designations of divisions and subordinate units thereof that served in the World War will be preserved as far as practicable. Reserve officers will be assigned to units in the vicinity of their places of residence, with the exception of those whose special qualifications lead to their assignment to special duties and activities controlled exclusively by the War Department. This procedure is bound to result in the establishment of close bonds between the reserve units and the communities that will furnish their enlisted personnel in time of emergency. The assignment of reserve officers to units will also be made in such a way as to enable each officer to develop his military usefulness to the maximum.

Regular Army personnel will be assigned to the Organized Reserves on the following basis:

To the headquarters of each division—
3 General Staff officers,
1 adjutant,
1 supply officer, and
5 enlisted men.

To each regiment or equivalent organization—
1 officer, and
1 enlisted man.

An engineer regiment, for example, will be commanded by a reserve colonel and officered as far as possible by reserve officers. The officer of the Corps of Engineers assigned thereto will perform the duties of executive officer and will devote his entire time to the development of the regiment.

As to the individual obligations of reserve officers, it is provided that "to the extent permitted by appropriations for this purpose, members of the Officers Reserve Corps may be ordered to active duty for not to exceed 15 days within any one calendar year, and for further periods with their own consent." There is a further provision, however, to the effect that "in the exercise by the War Department of the authority given by law to require this period of active duty, due consideration will be given to the occupations and other civil duties and responsibilities of reserve officers." It thus appears that while the 15-day training period is regarded as an important factor in the development of reserve officers, it is not contemplated that reserve officers shall be called upon to sacrifice their business or other civil interests in order to undergo the training in question.

Lectures, conferences and correspondence courses will be arranged for the furtherance of voluntary training while on inactive status.

When on active duty the reserve officer will receive the same pay and allowances as an officer of the Regular Army of the same grade and length of active service, and mileage from his home to his first station and from his last station to his home, but will not be entitled to retirement or retired pay.

The foregoing are only a few of the salient points dealt with in Special Regulations No. 46, which will well repay careful reading and study by all reserve officers.

New Posts

The following Posts are now in course of organization:

Akron Post—Lieut. Sears S. Day, Lock Box 254, East Akron, Ohio.

Baltimore Post—Capt. John S. Doyle (E. O. R. C.), 309 Custom House, Baltimore, Md.

Boston Post—Lieut. Lewis A. Armistead, Room 701, 108 Massachusetts Avenue, Boston, Mass.

Cincinnati Post—Capt. Hugh J. Krampe (E. O. R. C.), 1608 First National Bank Building, Cincinnati, Ohio.

Denver Post—Mr. Charles H. Rankin, 700 Tramway Building, Denver, Colo.

Indianapolis Post—Capt. C. L. Harrod (E. O. R. C.), Public Service Commission of Indiana, Indianapolis, Ind.

San Antonio Post—Mr. Ray S. Quick, Box 262, San Antonio, Texas.

St. Paul Post—Capt. John F. Druar (E. O. R. C.), 512 Globe Building, St. Paul, Minn.

Minneapolis Post—Wm. P. Cowles, The Iowa Bridge Co., 317 McKnight Bldg., Minneapolis, Minn.

Silver Button Winners

A number of silver button winners have failed to advise the Secretary the character of emblem desired—button, charm or brooch-pin. If you have not as yet received your silver emblem, will you not promptly advise the kind you prefer so that an order can be placed with the manufacturers the latter part of this month.

Proposed Amendment of By-Laws Approved

The Board of Directors has unanimously approved the proposed amendment to Paragraph 1, Article VIII, of the By-Laws, which changes the date of the annual meeting of the Society from the Friday *preceding* the third Wednesday in January to the Friday *following* the third Wednesday in January. This paragraph as amended reads as follows:

"The annual meeting for the election of officers and for the transaction of other business of the Society shall be held in the city of Washington, D. C., on the Friday following the third Wednesday in January."

The object of the amendment is to bring the annual meetings of the Society of American Military Engineers (in Washington, D. C.) and the American Society of Civil Engineers (in New York) within the same week, thus enabling those who are members of both societies to attend conveniently both annual meetings.

Society Emblems

Orders may be placed with the Secretary of the Society for emblems at the following prices:

Material	*Button or charm*	*Brooch-pin*
Bronze	$0.75 each	$1.00 each
10k solid gold	5.00 each	5.50 each
14k solid gold	6.00 each	6.50 each

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Activities of Our Local Posts

Detroit Post

MR. HARRY GARDINER, 708 Ford Building.

The adjourned meeting of June 1st was held in the Chamber of Commerce, June 20, 1921, at which time the following officers were elected:

President, Maj. Richard B. Hewitt;
Vice-President, Frederick H. Mason;
Secretary-Treasurer, Harry M. Gardiner;
Director, First Year, Col. E. M. Markham;
Director, Second Year, Col. Alfred Lovell.

Local organization being perfected, several very interesting talks and general discussion on objects of the organization were given by Col. Edward Heckel, Col. Alfred Lovell, Col. E. M. Markham, Major Hewitt and Frederick Mason.

All present being qualified, signed the application for charter for the local post, and the secretary was instructed to mail formal applications for membership.

William B. Stout gave an excellent resume of the development of airplanes with special detailed information on the liberty motor, during and since the war.

Col. Edward Heckel followed Mr. Stout with a much appreciated description of present and future plans of the Detroit Parks and Boulevards Department in improving harbor lines, etc., on Belle Isle. Several blue prints illustrating work completed and that yet to be finished on the site for the Scott Fountain, including approaches, were shown. Colonel Heckel also described the proposed method of handling refuse and dirt by building a new municipal dock on property recently purchased, so constructed as to allow teams and trucks to dump directly into scows underneath the dock, hereby effecting a larger saving in handling costs.

Col. Alfred Lovell of the University of Michigan, explained his conception of the benefits to be derived from membership in the Society, advising of his interest and the possibilities of large membership throughout the state.

Major Hewitt, whose efforts were instrumental in the organization of the local post, gave an excellent description of objects of the society, qualifications for membership, etc., with a plea for society co-operation from all.

General business being over, all present adjourned to the buffet room where an excellent luncheon thoughtfully provided was greatly enjoyed.

Meeting adjourned 10:30.

No further meetings will be held during July and August.

Why not a mission for each Post?

The following self-explanatory letter has been sent by the Detroit Post to each of its members:

Dear Comrade—

Have you read the activities of the other posts? A post has a mission; we have the post and we must decide as to what our mission is to be. A mission should be comprehensible and constructive, also one within our man power and financial ability to carry out, otherwise we court defeat.

To help us decide, let us have a heart-to-heart paper talk:

1. What work (one project) do you suggest for the post this year?

A.

2. Of what national engineering society are you a member?

A.

3. What are your present business connections?

A.

4. What work do you like best?

A.

5. Were you in the service during the late war? Arm and rank?

A.

6. What is your hobby?

A.

7. What is your ambition in the engineering line?

A.

8. What is your pet peeve? Social, Economic and Military?

A.

9. How much time can you give to the Society affairs?

A.

10. When and where were you born?

A.

These are personal questions, however, if you will think them over forty-eight hours, then fill in the answers and return promptly we will have a mission and a message for you at our next meeting. Use another sheet if you require more space.

Thanking you for your co-operation and looking forward to seeing you in the near future, I am,

Sincerely yours,

RICHARD B. HEWITT,
President.

New York Post

Maj. PERCY E. BARBOUR, 29 West 39th St.

On Saturday morning, May 28, sixty members of the New York Post, headed by General Langfitt, President of the Post, entrained at the Grand Central station for Garrison, N. Y., and thence by ferry to West Point. Through arrangements made by Maj. Percy E. Barbour, Post Secretary, a special railroad coach was provided and the party soon proceeded to smoke up. Col. Roger D. Black gave a series of informal short talks on West Point, and every one in the car was furnished with a copy of the latest annual report of the Superintendent of the Miliary Academy and a map showing location of various buildings and points of interest on the military reservation.

The details of arrangement and registration were in charge of a committee consisting of Maj. Edward L. Sherwood, Maj. W. E. Boughton and Capt. Samuel G. Hibben.

Upon arrival at the dock at West Point the party was divided into equads of five men each and marched to the Assembly Hall, and from there conducted about the reservation by Maj. Willis D. Crittenberger, Cavalry; Capt. George Von W. Pope, Infantry, and Capt. Henry C. Jones, F. A., each acting as liaison officer or guide for twenty visitors (four squads); the remainder of the morning was occupied by a walk taking in the buildings and grounds before joining the cadets for luncheon—two visitors being assigned to each mess table.

The afternoon activities began with an inspection of cadet quarters and company inspection; each of the twelve

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tactical officers was accompanied by a squad of five members of the New York Post, following which the review was witnessed by the visitors, who were again in the hands of the liaison officers. After the review there was a most delightful organ recital, followed by a ball game between the cadet nine and Fordham University, both of which events were attended by the entire party. Following the ball game, Lieut. Col. Danford, Commandant of Cadets, addressed the party briefly in front of the Headquarters building, and last, but not least, was the tea and dansant at Cullum Hall. On the return trip Colonel Black gave an outline of the next year's program, which it was hoped would include another visit to West Point with perhaps a tactical ride or walk with the cadets.

The program for the day was arranged by Col. Thatcher T. P. Luquer and Col. Roger D. Black of the Program Committee in consultation with Brig. Gen. Douglas McArthur, the Post Superintendent, who invited the party to lunch with the cadets and very courteously arranged for the escorts and inspection.

Portland, Oreg., Post

MR. E. BURSLEM THOMSON, 321 Custom House.

At the annual meeting on June 14 the following officers were elected:

Capt. Frederick S. Cook, President; Capt. P. Hetherton, Vice President; Mr. E. Burslem Thomson, Secretary; Mr. F. C. Schubert, Treasurer; Capt. A. D. Monteith, Assistant Treasurer.

The annual meeting took the form of a social function, the members and guests of members bringing their wives, sweethearts or merely lady friends. The ladies brought a basket lunch, which took until about 8 o'clock to consume. Thereafter the meeting was held, consisting purely of election of officers. Flashlight pictures were taken of the group, and when the smoke of combat had cleared away, dancing commenced.

On Tuesday, June 21, there was a joint meeting of the retiring officers and the new officers. Policies were discussed for the coming year and papers, correspondence and cash transferred. We look forward to a very successful year and are expecting to have at least one problem to discuss each month. The map problem which appeared in a recent issue of THE MILITARY ENGINEER will be discussed.

Following the editor's suggestion, we will have a discussion of THE MILITARY ENGINEER, and hope to be able to bring out some suggestions.

San Francisco Post

Capt. DOUGLAS W. DODGE, 733 Rialto Building.

On the evening of June 28 the Society held a social evening at the Cliff House. Dinner was served at 7:30 in the north end of the main ballroom overlooking the Seal Rocks at four large round tables which were delightfully decorated. During the dinner the members present enjoyed dancing, which was continued after the dinner until late in the evening. Arrangements had been made for card playing on the lower floor, but the members were so well pleased with dancing that no one in the party desired to play cards.

The following members and their lady friends were present: Major Ward, Colonel Wing, Colonel Deakyne, Major Grant, Captain Dodge, Captain Miller, Captain Malatesta, Captain Tolbrook, Captain Toklas, Mr. Duncan, Mr. Landis, Lieutenant Colonel Hunt.

Major Ward, chairman of the Committee, was responsible for the success and enjoyment of the entertainment, which was heartily appreciated by all present.

Trip Over Properties of Spring Valley Water Company

Leaving San Francisco, Spring Valley Building, at 8:30 A. M., July 8, a party of members of the Post made an inspection trip by automobile over the properties on the San Francisco Peninsula of the Spring Valley Water Company. The members of the Post were the guests of the Spring Valley Water Company, through an invitation extended by Mr. S. P. Eastman, vice president and general manager, initiated by the suggestion of our member, Robert E. Child.

J. J. Sharon, assistant manager and engineer of the company, together with "D. R." Clemens and Theodore Wilder, personally conducted our visit.

The general route followed was to Lake Merced Pumping Station, through the Lake Merced properties to Colma, thence to San Andreas Dam, Pilarcitos Lake and Dam and Stone Dam, where party arrived about noon. At this point the company provided a lunch, for the excellence of which a memory will long remain, and for the preparation of which our members are indebted to "Bill" Yount and his staff. After lunch we viewed the Crystal Springs Reservoir and inspected the Crystal Springs Dam, thence to the Belmont Pmps, and return to San Francisco.

Copies of a reprint of an address by Mr. Hermann Schussler were distributed among the members, one of which is filed as a part of this record, and in which is contained the full description of our observations.

It was proposed that at our next regular meeting, which will precede the second portion of the Spring Valley Water Company trip, a paper illustrated by slides will be given us by Mr. J. J. Sharon, descriptive generally of the entire system, followed by a specific summary by Colonel Child, bringing out the particularly important points of military bearing.

The importance of this entire system is in connection with the defense of San Francisco and vicinity is immediately apparent, and the question has arisen whether the Headquarters have this property, together with all its vital points, so charted that a guard can be immediately placed on it for effectual protection in case of sudden emergency. If such preparation does not exist, would not the Department appoint a commission of reserve officers, E. R. C., to complete the necessary reconnaisance.

The members and guests present were as follows:

Fred C. Toklas, B. P. Miller, George W. Duncan, P. B. Delano, Colonel Wood, Wm. B. Hall, Col. Chas. B. Wing, C. A. DeCamp, R. E. Child, Lee Landis, C. W. Tilbrook, Lieut. Allen Hoar, U. S. N.; Robert Wing, Col. Herbert Deakyne, H. B. Truett, D. W. Dodge, Capt. F. D. Jones, Percy Burr, Lieut. Col. C. L. MacRae, U. S. N., and Maj. U. S. Grant 3d.

Letters expressing the appreciation of the Post, and of the members individually, were written to Mr. Eastman and to Messrs. Sharon, Clemens and Wilder.

The Entertainment Committee of the San Francisco Post, of which Mr. Thomas M. Ward is chairman, has arranged for a trip to Mt. Tamalpais and a picnic at Muir Woods for members and the ladies for August 21st. Through the courtesy of Colonel Williams, a member of the local post, the Northwestern Pacific Railway will attach a special car to its regular train leaving San Francisco at 9:45 A. M. It is planned to stop at Muir Woods for lunch and from there to proceed to Mt. Tamalpais, returning to San Francisco late in the afternoon.

New Orleans Post

Capt. E. H. COLEMAN, 1016 Hibernia Building, New Orleans, La.

The Post had a delightful outing August 20, with Maj. R. T. Coiner, the District Engineer, as their host, accompanying him on the steamer *Newton* on an inspection trip. visiting one of the nine levee-building machines operated by the Federal Government in the Fourth Mississippi River District in the construction of levees.

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Training an Engineer Regiment

By

Lytle Brown

Colonel, Corps of Engineers

[The method of training an engineer regiment hereinafter described has been employed with excellent results in the Second Engineers at Camp Travis, Texas, Colonel Lytle Brown commanding. It appears to meet in a satisfactory way the varied and numerous conflicting demands which are made upon the regimental commander and which are inevitable under conditions now obtaining in most divisional camps. The method enables regiments to perform the construction work required by the division and at the same time affords opportunity for the instruction of the enlisted men in their duties as soldiers. It also gives the officers experience in handling their various commands.

The outline of the system as given below, together with some hints on training has been prepared from data furnished by the Commanding Officer, Second Engineers, Second Division.—ED.]

RECRUIT training in the Second Division was handled entirely by Division Headquarters until enlistments became so rapid that it was necessary to have the actual work done within the regiments. Training was directly controlled, however, by G-3, and an inspector from his office made frequent visits to all regiments, to assist with advice and to insure that instructions were being carried out properly. Each recruit upon assignment to a regiment had a recruit card prepared for him. This card listed all the subjects which the soldier should know before being assigned to full company duty. It embraced infantry drill through the School of the Platoon, First Aid, Interior Guard Duty, Courtesy and Discipline, Equipment, and the Articles of War. The recruit was tested once a week in the subjects listed on the card, and was marked proficient in such subjects as he could perform or explain satisfactorily. Upon qualification in all subjects, he was sent to the company for straight duty. This record system assured that every man was qualified in every subject considered essential for recruit instruction. Upon joining the company, the soldier's instruction was carried on in accordance with the company training schedule. These schedules covered one week's work and were based on regimental schedules covering a similar period, which in turn were based on general programs of instruction covering a greater length of time. The details of engineer instruction were left to the regimental commander. The basis for all engineer instruction in the regiment is Engineer Field Notes, No. 25, A. E. F. The subjects which were to be covered to enable a regiment to perform the functions prescribed by Engineer Field Notes No. 25, were listed, together with the amount of time which should be expended on each. All men were to be instructed in:

Communications,
Organization of the Ground,
Small Arms Firing,
Ceremonies,
Combat Instruction.

Selected men were to be trained in such subjects as demolitions, animal transportation, reconnaissance, etc. The weekly schedules were based, of course, on this general program.

There was, of course, a large amount of construction work required of the regiment by division headquarters, in the nature of barrack construction, athletic fields, target ranges, etc. This work was almost entirely of an engineering nature, and afforded an opportunity for the training of the command in engineer work.

The work was assigned to the organizations in the regiment, as explained later. Each company had a chart showing the amount of time each man had had in each of the subjects in which he was scheduled for instruction. This was, of course, to insure that all men should receive instruction in all of the subjects considered necessary in their training. The preparation of a qualification card for the average engineer soldier was given serious consideration, but this has not been accomplished because of lack of time. Units are tested for the adequacy and proficiency of their instruction, the lower units by higher commanders. It was not possible to determine the proficiency of each individual soldier by actual test in all the duties he was expected to be able to perform. It was possible, however, to determine by these tests of the men, the efficiency of their commander as an instructor. Thus two things could be assured, that the instruction the men were receiving was good, and that the proportion of time spent by any man on any subject was correct.

In the performance of work, the assignment was always by organization. Each task, no matter how small, was given directly to a battalion commander, and he was held responsible for the prompt, efficient completion of the job, although the work itself might actually be done under a sergeant or corporal. Work was always done by the task system. A definite amount of work was always assigned for each day, and only upon its completion were men released. Thus was assured proper organization of all work, proper inspection by higher commanders, and rapid, efficient work by the men.

The system briefly outlined above proved to be very successful, and gave very good results in the training of the regiment. There are numerous points in the Hints on Training which follow that go into greater detail on the practical workings of the plan.

Hints on Training

(*a*) Use the organizations as they exist for all training and all work; or conversely do not make special organizations for instruction purposes. Those who are responsible for the work of men in campaign must also be responsible for their training. A lieutenant must instruct his own platoon, a captain his company, etc. In the assignment of work, no matter how small the amount, assign the task

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The Field Artillery Journal

Official Organ of the

United States Field Artillery Association

The U. S. Field Artillery Association was organized in 1910, and is composed of officers of field artillery of the Regular Army, the National Guard, and the Officers' Reserve Corps, and other persons interested in field artillery.

The Field Artillery Journal is published bi-monthly by the Association. Each number contains approximately one hundred pages of technical information of value to officers of all arms of the service, although of course of particular value to those who are interested in the development of field artillery.

Subscription price, $3 per annum, including all dues. Single copies of the magazine, 75 cents.

Address—

The Secretary
United States Field Artillery Association
War Department, Washington, D. C.

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to the next lower commander, and hold him responsible for results. That is, the regimental commander assigns to a battalion commander a task, possibly requiring only one squad to perform, and holds the battalion commander responsible for the proper execution of the task. If the task is large enough to require the entire regiment, the work should be divided between battalions, and then closely supervised.

(*b*) Inspections for results must begin at the top. The regimental commander must make his influence felt by inspecting personally all the work of the regiment.

(*c*) The greatest force in the hands of a company commander is personal knowledge of his men. In inspecting to determine the efficiency of a company commander as an instructor, the first step is to see that the company commander knows all his men by sight and can call them by name. If he cannot, there is no need of inspecting further. Either he has not acted as instructor, or he is totally ignorant of the first points of handling men.

(*d*) In all instruction of enlisted men (or any men) carry the instruction to the men in the manner Colonel MacNab has demonstrated in rifle practice. A man, properly instructed, knows his subject and can tell it in his own words. Having the man so reveal his knowledge is a test of his instruction. By impressing the men that such a test is coming, the difficult problem of holding their attention is solved. Each man must feel that at any moment he is liable to be called out by name before his squad, platoon, or company, and asked to repeat the instruction that has just been given. This method must be pursued throughout his course of instruction.

(*e*) If instruction is to have any personal appeal, an individual efficiency record of each man's instruction must be carefully kept to date in the company. It may be on a consolidated sheet or on individual cards or both. The sheet is best for display in barracks and should be kept posted under glass for inspection by all. Inability to keep such a record shows that something is wrong with the command as a school of instruction. The remedy may or may not be in the hands of the immediate commander; if not, then the situation should be brought to the attention of the next higher commander.

(*f*) All commanding officers should have a knowledge of the value of the force of the spirit of emulation among organizations as well as among individuals, and a free use of the publication of comparative results with the names of the responsible authorities, should be made in all accomplishments of real weight.

(*g*) The physical fitness of the soldier is a consideration of the first importance. All authorities from the highest to the lowest must show by their acts the appreciation of this fact. Athletics must be given a very high place in the training of the soldier. In commands of any size an annual athletic program should be adopted. The preparation for the events of this program should begin with companies; teams from companies should contest within the battalion; when the winning company is determined a team should be selected for the battalion, trained, and then battalion teams should contest for supremacy in the regiment. Then a regimental team should be chosen to compete in the contest within the division. Then a divisional team should represent the division, should it contest in the Corps Area. Generally, organized athletics for a team in a lower unit should at once cease when the team of the higher unit is selected. As a rule athletics should be highly varied; long baseball, basketball, or football schedules should not be made. If an an-

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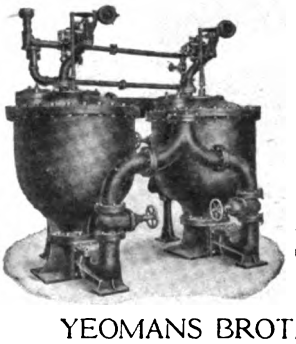
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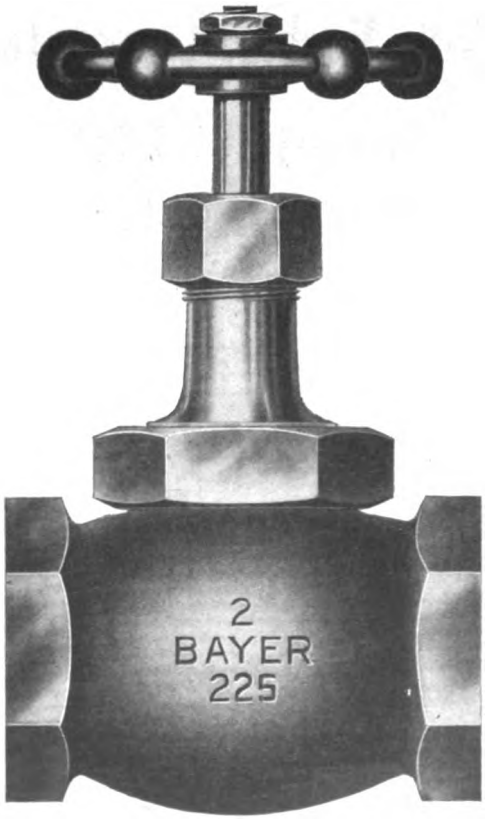
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nual schedule of athletic games is not prepared by the larger units they will be made at random by smaller organizations and amount to but little. Athletics in the army has not been cultivated for as much as it is worth, due to the failure of higher headquarters to get out an annual forecast of the dates and events and games that they propose to hold. Once such a forecast is made it must not be changed except for unavoidable causes.

In athletic contests those in authority must not overlook the fact that there will be no encouragement to athletics unless there is provided, besides the contestants, an audience—the larger the better. The measures to secure the audience must be taken by those in highest authority. The audience must include the high authority. If it is company team contests, the battalion commander and his staff must be fully in evidence at the contest, and all of the battalion not engaged as contestants must be there.

All of the above points have been brought out by successful work in the Second Division in the Eighth Corps Area.

A good athletic field is a necessity at every station of importance. The events of an athletic meet should conform to the events of our national athletic games which are largely governed by the colleges of the land.

A good athletic team for a regiment is a great factor for morale. A prime young athlete is a model for clean living set before the eyes of all the men of the command, and a finer argument for such living than can be made by word of mouth.

(*h*) It is necessary for all in authority to recognize that the soldier, particularly the engineer soldier, is not a day laborer. He does not get the day laborer's wages and he does not have quite the liberty of action of a day laborer. But when a soldier works in peace, he must work just as he works in war, with speed. This is very particularly the rule with engineer soldiers.

The proper results in the line of work are gained by always following the task system. Tasks must be made light enough so that their completion can be assured by swift, efficient work in time to allow the man ample time for leisure and recreation. No daily task should ordinarily be set which requires more than four hours of vigorous sustained work for its completion, taking into account the skill of the men employed. Soldiers who are lazy and shiftless must be held to their work until it is completed, even though time for recreation be consumed.

Commanding officers must bear in mind that time and patience are required to finish works when tasks are made as light as they should be. The task system applied with the idea of producing instructed soldiers will probably not accomplish the same amount of work as if the men are handled as day laborers.

(*i*) Every piece of work performed by engineer troops must be regarded as a problem in organization methods and supervision, with the idea of securing efficient training in these things so essential to the proper performance of any task in time of peace or in time of war. Even a poorly performed piece of work will be instructive, if the faults are found out. If the faults are not found out, it may be the beginning of shiftless and inefficient habits.

The following appendices A to D, inclusive, are published as typical documents in use in the regiment:

A. Recruit Card,

B. Training Instructions for the year October, 1920-September, 1921,

C. Training Memorandum 43, 1920,

D. Training Memorandum 8, 1921.

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APPENDIX A.

RECRUIT QUALIFICATION CARD

NAME ..... ORGANIZATION ..... DATE .....

School of Soldier	*Test*	*Date*	*School of Soldier*	*Test*	*Date*
Position of attention			Suspend and Cease Firing		
Rests			SCHOOL OF PLATOON		
Eyes Right			Platoon Right		
Facings			Right Turn		
Salute with Hand			Column Right		
Steps and Marchings			Right Front Into Line		
Quick Time			On Right Into Line		
Half Step			Route Step		
Side Step			Right by Twos		
To Halt			Right by File		
March by the Flank			As Skirmishers		
To the Rear			To Assemble		
Change Step			Squad and Section Column		
WITH ARMS			Advance by Rushes		
Order Arms Standing			Advance by Infiltrations		
Present Arms			SCHOOL OF ARMS		
Port Arms			Service Rifle		
Right Shoulder Arms			FIRST AID		
Left Shoulder Arms			Arteries and Veins		
Parade Rest			Artificial Respiration		
Trail Arms			Care of Wounded		
Rifle Salute			Bites		
Fix Bayonets			Trench Feet and Blisters		
Inspection Arms			Sun and Heat Strokes		
SCHOOL OF SQUAD			GUARD DUTY		
Fall in Count Off			General Orders		
Right Dress			Saluting		
Take Interval			Prisoners		
Take Distance			COURTESY AND DISCIPLINE		
Stack Arms			Saluting		
Right Oblique			Addressing an Officer		
Right Turn			Wearing Uniform		
Squads Right About			EQUIPMENT		
Follow the Corporal			The Pack		
Skirmishers and Assemble			The Belt		
Kneel and Lie Down			Clothing		
Set the Sights			ARTICLES OF WAR		
Volley Fire			Read and Explain		
Fire at Will					

1. APPROVED: This Soldier will be relieved from further Recruit Drill.
X Means qualified in TEST.

	Low	Below Average	Average	Above Average	Superior
INTELLIGENCE					
ADAPTABILITY					
CHARACTER MORAL					
DISCIPLINE					
PERSONAL PRIDE					

REMARKS.

1st WEEK

2nd WEEK

3rd WEEK

4th WEEK

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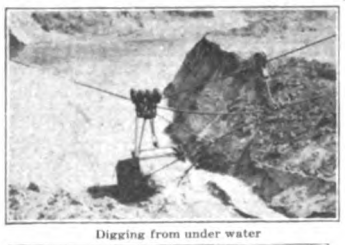
"DIAMOND N-Y" LAG SCREW SHIELDS are so constructed that when the lag screw is turned in the full expansion is reached when the lag has progressed about two-thirds through. From that point on the bore is parallel causing the shield to bend slightly and to form a PARALLEL ULTIMATE EXPANSION.

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APPENDIX B

Training Instructions for the Year October 1, 1920, to September 30, 1921, Second Regiment of Engineers

1. In accordance with General Orders No. 7, Headquarters Southern Department, and Memorandum No. 152, Headquarters Second Division, the following instructions are issued for the government of the training of this regiment, officers and men, for the year October 1, 1920, to September 30, 1921.

2. The year is divided into two periods: October 1 to June 30, and from July 1 to September 30. The first period will be largely devoted to the individual instruction of the men and officers in their duties according to grade and previous instruction. The latter will be largely devoted to their instruction by organization.

3. The instruction will be under the general supervision of the regimental commander. The next senior field officer assisted by the remaining field officers and specially designated officers will be responsible as directors of training for the whole training of the regiment.

These instructions will give the results to be accomplished and the means for their accomplishment. Such orders as are necessary to further carry them into effect will be prepared by the director of training and his assistants for the approval of the regimental commander.

Unit School

4. All schools in the regiment will be branches of the unit school, and will be—

(*a*) Schools for officers.

(*b*) Schools for non-commissioned officers and selected privates.

These schools will be formed for two distinct purposes:

(*c*) To prepare instructors for the proper execution of current schedules of instruction, and to secure in the command an intelligent comprehension of orders received.

(*d*) To prepare by general instruction, officers, non-commissioned officers, and selected men for the general duties in their grades, or to train them in specialties. Under this heading will be included any trade or vocational schools that may be established in the regiment. At present no trade school will be established in the regiment, when that trade is taught in the vocational schools established at Camp Travis.

5. There will be established at once a school for non-commissioned officers in each company which will include all non-commissioned officers who are available for company duty. It will meet daily, and the object mentioned under (*b*) will be secured by the best instruction that can be devised by the company commander; the object described under (*c*) will be secured as far as company commanders may under their own initiative prescribe.

6. There will be established at once a regimental school for non-commissioned officers, at which will attend at times to be prescribed, within the period October 1-June 30, all available non-commissioned officers of the regiment. These non-commissioned officers will be given twelve (12) lectures:

(1) Responsibilities of non-commissioned officers in relation to company officers and their relation to the enlisted personnel.

(2) Handling of men.

(3) Example of non-commissioned officers to the men under them. Deportment in barracks, at mess, off duty; proper mode of address; discipline.

(4) Summary and explanation of the orders of the Second Division bearing on the conduct of the enlisted personnel of the Engineer Regiment of the Division in campaign, in quarters, in camp and off duty.

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(5) Organization of the company and of working parties and the duties of non-commissioned officers therein.
(6) March discipline of a command on the road.
(7) The organization of the Division and the duties of the Engineer personnel, when attached to the various units thereof.
(8) Care of men in the field and in trenches; cleanliness, personal hygiene.
(9) Police of quarters; sanitary regulations of this camp, and in the field.
(10) History of the Regiment.
(11) The opportunities and advantages of continuous service in the Regular Army.
(12) The legal rights of the enlisted men; explanation of the various courts-martial, and of the Articles of War that particularly apply to the enlisted men.

Lecture No. 10 will be delivered shortly before Organization Day.

A meeting of the regimental non-commissioned officers' school will be called whenever in the judgment of the regimental commander, or the direction of training subjects may be best brought home to the entire command through this agency.

7. There is, and will be continued to be established in the regiment as a part of the unit school, the officers' school. This school will fulfill both the objects (*b*) and (*c*), but the study of matter to be covered by schedules will be made when the regiment is acting together under a detailed schedule of instruction, which is not intended to be the case generally. A detailed weekly schedule of the work of this school will hereafter be submitted by the director of training (see paragraph 10) of this regiment.

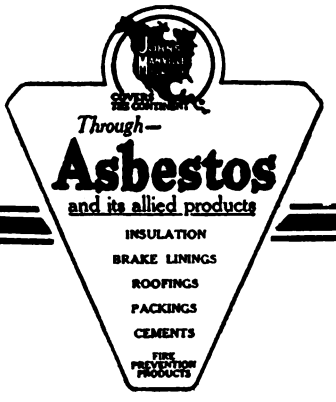
The subjects to be taught in the officers' school, and the period to be allotted to each, are as follows: The last day of each period will be the day of examination in the subject, unless that date falls on Saturday, Sunday, or a holiday, in which case the next prior available date will be the day of examination.

(1) Field Service Regulations—October 4-November 10.
(2) Administration, Company—November 11-December 1.
(3) Military Law—December 2-January 15.
(4) Military Hygiene—January 15-February 1.
(5) Rifle and Pistol Marksmanship—February 1-February 16.
(6) Military Topography and Map Reading—February 17-March 17.
(7) Duties of Engineer Divisional Troops in War—March 18-June 30.
(8) Minor Tactics—June 30-September 30.

8. Trade schools will be established within the regiment for such trades as are required in the military duties and which are not conducted by the Divisional Vocational Schools. These schools will have strictly regimental direction outside of companies. The companies will detail men either to the Vocational Schools of the Division or to the trade section of the unit school in accord with requirements deduced, from the following tables, which shows the number of qualified tradesmen of each class which should be in a company determined by percentages of the total enlisted strength, one being the minimum in any case, and major fractions counted units:

	Per Cent		Per Cent
Carpenters	10	Draughtsmen, General	1
Plumbers	5	Map Reproduction	1
Blacksmiths	5	Photography	1
Painters	5	Saddlers	1
Electricians	5	Surveyors	2
Farriers	1	Teamsters	6
Horseshoers	2	Motorcycle Drivers	2
Motor Mechanics	2	Truck Drivers	2
Draughtsman, Topographic	2		

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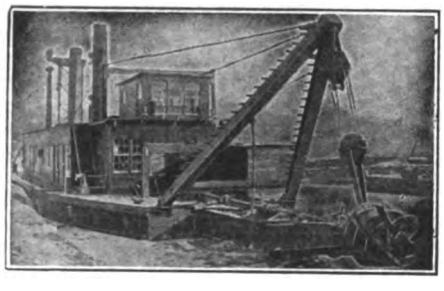
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9. The general training subjects which shall be covered in the instruction of the command as a whole in the period, October 1, 1920, to June 30, 1921, will be as follows and in about the progression as indicated. Instruction by company for the period, October 1, 1920, to June 30, 1921, as a rule:

All Grades

(1) Interior discipline and police.
(2) Care and nomenclature of the rifle.
(3) Personal hygiene.
(4) Calisthenics.
(5) General Orders for sentinels.
(6) Infantry drill, close order, to include the company.
(7) Use of tools, to include pick, shovel, axe and cross-cut saw; men to qualify once; amount of work in given time qualifying.
(8) Knots and lashings, individual qualification.
(9) Bayonet combat.
(10) Tent pitching.
(11) Making of the pack.
(12) Extended order drill to company inclusive.
(13) Signalling—in accord with War Department requirements.
(14) Interior Guard Duty.
(15) Musketry, full preparation for range firing—Supplementary Range Practice.
(16) Pistol—full preparation for range firing—Supplementary Range Practice.
(17) Gas defense.
(18) Regiment in ceremonies.

Non-commissioned officers and selected privates.

(1) Trench types.
(2) Revetments.
(3) Obstacles.
(4) Bridges, types floating and fixed; sub-types foot and all traffic.
(5) Explosives.
(6) Road construction and repair for military use.
(7) Light and standard railroad constructions.
(8) Water supply for division.

Period from June 30-September 30, 1921.

(1) Road march discipline.
(2) Road construction and repair.
(3) Bridge construction, all types.
(4) Ferries.
(5) Layout, defensive position.
(6) Trench construction, complete with revetments.
(7) Obstacles, construction.
(8) Machine-gun emplacements.
(9) Command post.
(10) Observation post.
(11) Trench drainage.
(12) First-aid Stations.
(13) Marking routes.
(14) Demolitions.
(15) Range practice.
(16) Regiment in ceremonies.

Non-commissioned officers and selected men.

(1) Engineer reconnaissance.
(2) Route sketch.
(3) Position sketch.
(4) Panoramic sketch.
(5) Minor tactics.

10. All instructions shall be by schedule prepared weekly. On Friday the director of training will submit to the regimental commander the schedule for the next week, which shall give the subjects to be taught on each day of the following week in companies, and in the unit school under regimental direction and the time to be devoted to each subject, with the authority or text to be used. On Saturday each company commander will submit to the regimental commander, in accordance with the director's schedule, a detailed schedule of the work of his company or school for the next week, giving, under the subjects to be taught, the

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exact references to the governing texts or authorities which apply to the day's work, this in order that the instructors, and students as well, may prepare themselves for each period of instruction. The company commander or school director is best able to make the final sub-division of time to suit the progress of those under instruction, hence, the requirement as to detailed allotment of work under subjects.

The director of training must be governed in the weekly allotment of time to subjects by the average progress made, the importance of the subject, the total ground to be covered in the total time available, and the requirements as to time by higher authority.

Work for the Division

11. There will always be a considerable amount of work done by the regiment under the orders of the Division Commander. This work will, as far as practicable, be allotted to the regiment by company, each company commander being held responsible for the accomplishment of the work allotted to his company. Such work will take precedence over all training and regimental work. It will be done promptly and vigorously, and in such a manner as to give the best practice to all concerned in thorough, prompt, and well organized work, such as Engineer Troops must always be trained to do. Lazy, desultory and lagging endeavor on any of this work will not be permitted on any pretext. Let it be undertaken with the determination and the arrangements for prompt and effective completion.

The adjutant will keep a tabulation in chronological order of assignment of all such work, giving in the table a description of the work, the reference to the authority for its performance, the organization to which assigned, the responsible officer, the date of commencement of work, the probable date of completion and the actual date of completion. This table will be shown to the Regimental Commander, whenever new work is to be assigned, whenever any item is completed, and whenever the probable date of completion is exceeded.

APPENDIX C—Training Memorandum No. 43

Schedule for training for the week ending November 13, 1920.

	8:00 to 9:00 A. M.	9:00 to 11.30 A. M.	1:00 to 4:30 P. M.	2 to 4 P. M.	5 P. M.
Monday	Calisthenics Close Order Drill* School of Co. I. D. R.	Interior Discipline and N. C. O. School.	Interior Discipline and Police.	Officer riding Instruction.	
Tuesday	Offensive combat. The Company.* I. D. R.	Same	Same	Same	
Wednesday	Same*	Same	Same	Same	Battalion Parade.
Thursday	Advance, Rear, and Flank Guards** F. S. R.	Same	Same	Same	
Friday	Same**	Same	Same	Same	
Saturday		Inspection.		Half Holiday	

BAND.—8 to 9 A. M., play for drill; 9 to 11:30 A. M., practice; 1 to 4:30 P. M., individual practice and fatigue. Wednesdays at 5 P. M., Bn. parade. Saturdays at 9 A. M., review or inspection.

*All available men consolidated into one company. Company commanders will be changed during periods of drill.

**Each company sent out on different roads. To march out 15 minutes; return in formation for exercise selected.

PRIORITY OF WORK.—1, Roofs; 2, Mess halls, repairs to barracks, ditches, improvements, plots around barracks. General police must not be neglected in favor of work outlined above. (Sanitation also.)

By order of Colonel Brown:

W. H. CROSSON, *Captain, Corps of Engineers, Adjutant.*

APPENDIX D—Training Memorandum No. 8

Schedule of training for the week ending February 26, 1921.

	8:00 to 11:30 A. M.	1:00 to 2:00 P. M.	1:00 to 4:30 P. M.	2:30 to 4.30 P. M.
Monday	School of Company, Close Order, I. D. R. pars. 237 to 271 and pars. 43 and 44, N. C. O.'s School; also pars. 308 to 315 I. D. R. Instruction in Small Arms Firing, McNab System, p. 1-27. Exact subdivisions of work to appear in Company Schedules.	Officers' School. See Schedule of Lessons, and Field Training Problem.	Interior Discipline and Police. (See note).	Officers' Riding Class.
Tuesday	Same	Same	Same	Same
Wednesday	Regimental Work Drill (also 2-4 P. M.—Regtl. Athletics)			
Thursday	Same as Tuesday	Same as Tuesday	Same as Tuesday	Same as Tuesday
Friday	Same	Same	Same	Same
Saturday	Inspection (11-12 Lecture Serv. Club No. 4)		Half Holiday	

Wednesday.—Regimental Parade on Divisional Parade Ground at 5:15 P. M. Caps will be worn. Field and Staff Officers mounted.

BAND.—Play daily from 8 to 10 A. M., except on Wednesday, Saturday and Sunday, on recruit drill field, and from 1 to 4 P. M., as prescribed by Band Leader. On Wednesday the band will play at Regimental Parade on Divisional Parade Ground at 5:15 P. M., and at Divisional Consolidated Band Practice in the morning.

PRIORITY OF WORK.—1 Drainage; 2 Plumbing; 3 Walks; 4 Roads; 5 Repairs to Buildings. General police and thorough sanitation not to be neglected in favor of work outlined above.

RAINY DAY SCHEDULE.—Small Arms Firing. Inside band practice.

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The Susitana River Bridge, Alaska Government Railway

The longest bridge span on the United States Government Railway in Alaska is the 504-foot steel through truss channel span of the Susitna River bridge, which was completed in February, 1921. Besides the main span the bridge includes two 121-combination Howe-truss flanking spans and two 70-foot combination pony Howe-truss end spans with 392 feet of trestle at southern approach and 28 feet at the northern approach, making a total length of 1322 feet. It is located 150 miles north of Anchorage and 264 miles north of the southern terminus at Seward.

The Susitna River has a heavy ice run in the spring that would carry out any timber pier, while concrete piers would have to resist not only the ice pressure but the undermining scour resulting from the ice jams forming against the piers. Comparative estimates for a main channel crossing of two 250-foot steel spans on three concrete piers and the single 540-foot steel span on two concrete piers were slightly favorable to the latter which was therefore adopted.

The combination of steel trusses and timber trusses in the same bridge was justified by the high prices of steel and concrete at the time of construction. It was cheaper to build all approach spans of timber and to make provision for possible renewal with steel and concrete when the life of the timber has reached its limit. For this reason the main piers were designed to support 200-foot steel flanking spans at some future time, each to replace the present 121-foot and 70-foot spans.

The Cooper E60 loading was adopted for the 504-foot span, E50 for the timber and E44 for the trestling, which has 14-foot spans. In the design of the steel span the 1910 specifications of the American Railway Engineering Association were followed mainly. Wind loading was an exception to this; the bottom lateral system was designed for 40 pounds per square foot on the area of train and floor in elevation, and on 1½ times the area of truss members of one truss not covered by train and floor while the top laterals were designed for 500 pounds per linear feet of span.

Test holes 60 to 75 feet deep to determine the nature of the foundation for the piers, disclosed compact sand gravel and boulders in layers of varying thickness, and capable of supporting the piers without foundation piles. An open caisson was used for the north pier excavation, and a cofferdam of Wakefield triple-lap sheet piling for the south pier. Excavation was started in the wet with orange-peel buckets operated by two stiff-leg derricks until hard material was struck; then the holes were pumped out and work was continued by laborers with pick and shovel filling dump boxes operated by the derricks. For both foundations, excavation was carried to an average depth of 25 feet below the ground. Drain ditches about 12 inches deep were maintained around the edges, being sloped to carry seepage water to a sump at the downstream end of the pit where one 5-inch and two 8-inch pulsometer pumps operated continuously in the lower levels of the work.

Concrete Work. Considerable difficulty was encountered in finding sand and gravel suitable for the concrete piers. Aggregate taken from pits in the vicinity of the bridge was not satisfactory, as samples showed humus. Several deposits along the railway line all showed the presence of this constituent in various amounts, except samples from a pit in a glacial moraine in front of Spencer Glacier, 56 miles north of Seward. This deposit tested clear and was used; 7 per cent of sand was added to the bank aggregate, which was deficient in this respect.

After a partial failure in one of the piers during September, 1920, caused by poor cement, the presence of humus in the aggregate and the low temperature of the air and water, special measures were resorted to in placing concrete in main piers.

When the cofferdam was unwatered, the bottom of the enclosure was under a 22-foot head of water from the river, and owing to the porous nature of the boulder and the gravel formation considerable water was forced through the floor of the pit. The enclosure was 33 by 69 feet and it was found impracticable to partition it off and place and hold concrete in the dry against the flow of water. As the low temperature of the water (35° F. in November) and the large area (2,277 sq. ft.) made it impracticable to place concrete under water by bucket or pipe methods, the following plan was devised to meet the conditions of cold running water and low air temperature. A large sheet of canvas was prepared in one piece, sufficient to entirely cover the bottom area and extend about 6 feet up the sides of the inclosure. This canvas was "formed-in" by wooden forms along the sides and ends, to provide a runway for water around the edges. Steam coils were placed around the sides of the pit inclosure and the entire space was housed in and made warm. Sand and gravel delivered on cars were heated by being dumped on a platform holding perforated steam pipe coils, and hot water was used in mixing.

Concrete was poured at the south pier, containing 1,456 cubic yards from October 24 to November 11, 1920, during which time temperature readings ranged from −2° to + 48° F. At the north pier, containing 1,520 cubic yards, the pouring was from December 1 to December 18, 1920, when temperatures ranged from −12° to + 34° F. The pit was kept unwatered, and the concrete was placed from chutes and pipes leading from mixer to pier. All concrete was given sufficient time to set before allowing cold water to come in contact with it.

Erection of Steel Channel Span. To hasten erection of the 504-foot span, it was necessary to proceed without waiting for completion of the piers. False work for this span had been driven from the north end. The north approach trestle, piers and falsework for timber spans were driven and a temporary deck laid. One of the 70-foot pony spans was used temporarily to span the excavation for the north pier, thus permitting the construction of this foundation.

Erection of steel started November 8, 1920, from the north end at panel point No. 2, a yard having been constructed on the north side of the river which was reached

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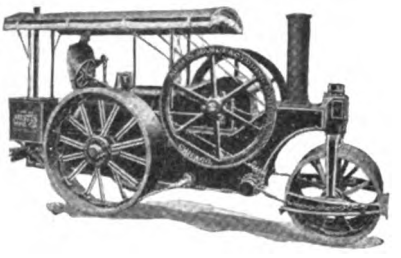
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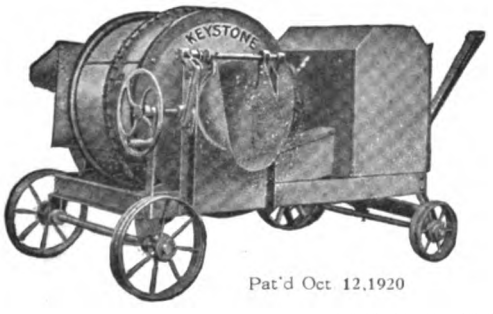
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by means of the temporary trestle. Erection was continued to the south end and all steel except for the two north panels was assembled by December 15, 1920. Steel in these two panels which did not interfere with the 70-foot pony span was placed after December 25. As soon as this temporary span was removed, the rest of the steel was placed, completing the erection on January 8, 1921.

A 100-ton locomotive crane with a boom having extensions to make a total length of 85 feet was used for the erection, being supplemented in the yard by a 35-ton locomotive crane with 50-foot boom. The total weight of steel in the span is 1,803 tons. Only a little riveting was done after December 20, 1920, when over 90 per cent of the span was in place, but the work was then pushed until completion on February 9, 1921, during which time temperatures ranged from —42 to + 34° F. On some cold and windy days the riveters did not work; but on one occasion rivets were driven when it was —42° in the morning and —12° at quitting time. Rivets driven during very low temperatures were retested several times later in warmer weather and showed first class work. The total number of field rivets was about 42,200.

The span was swung February 2, 1921, and the first train passed over on February 6. The work of erecting the timber spans and finishing the trestle progressed simultaneously with the steel erection, so that the bridge was entirely completed and ready for service on February 16.

General supervision of the work was under Col. F. Mears, Corps of Engineers, chairman and chief engineer of the Alaskan Engineering Commission. The preliminary design of the 504-foot steel span and the design and details of the timber spans and foundation work were made by W. J. H. Fogelstrom, former bridge engineer for the Commission, assisted by F. H. Chapin, assistant bridge engineer. Final design and details of the 504-foot steel span were made by the American Bridge Co., which also fabricated and erected the steel. All designs and detail plans of steel work were checked and approved by Modjeski & Angier, consulting engineers, Chicago; Hildreth & Co., Chicago, performed the inspection of steel at mill and shop.—*Engineering News-Record.*

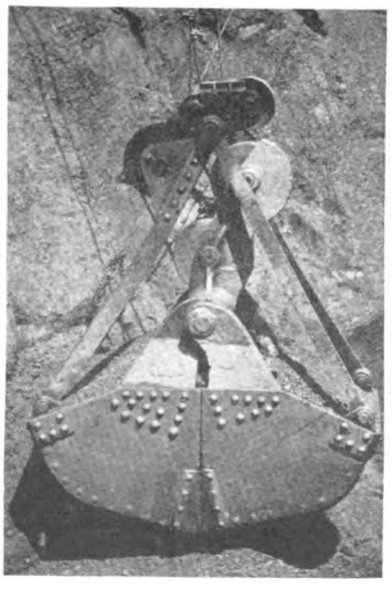
Marine Borers in San Francisco Bay

A committee of the American Wood Preservers' Association has published a "Report on the San Francisco Bay Marine Piling Survey," prepared in co-operation with the U. S. Forest Service and the University of California. This report is of much interest to engineers dealing with timber work in sea water.

The investigation was occasioned by a recent extension of the activity of marine borers to the upper arms of San Francisco Bay. As is well known, San Pablo and Suisun Bays receive a large inflow of fresh water from the Sacramento and San Joaquin Rivers. For this reason they were formerly practically free from marine borers. As their shores offer unusual facilities for the establishment of water-front industries, many structures have been built along them; all on untreated piling. Sporadic attacks of borers had been reported at intervals dating back to 1870, but no case was authentically recorded until 1914. In 1917 marine borers reappeared, and during the two years follow-

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ing spread rapidly. By the latter part of 1919, widespread damage to wharves and similar structures had occurred.

The report is in three parts. The first, prepared by Mr. C. E. Grunsky, assisted by Capt. C. S. Jarvis, Corps of Engineers, deals with hydrography of the upper bay, and the causes leading to a recent increase in the salinity of the waters.

The second part, prepared by Prof. Chas. A. Kofoid, gives a very complete description of the borers infesting San Francisco Bay, their modes of attack, and their methods of propagation. As to boring mollusks, Professor Kofoid says that the well-known teredo (*Terēdo navalis*) is a recent acquisition in the bay, not having been discovered in 1910, when an examination was made. The variety long existent in the lower bay, and throughout the Pacific Coast, is a different species, much larger than the teredo proper. The new arrival will live in water less salty, so that the recent damage may be due to the introduction of the teredo navalis in conjunction with a decrease of the effective fresh-water inflow.

All boring mollusks propagate through free swimming larvæ, minute in size, which have a larval life of about a month; after which they attach themselves to the timber. A single borer will produce two million larvæ in a year, so that the spread of the pest is very rapid. The larvæ do not feed on the wood, but bore into the timber for protection, as a clam buries itself in mud.

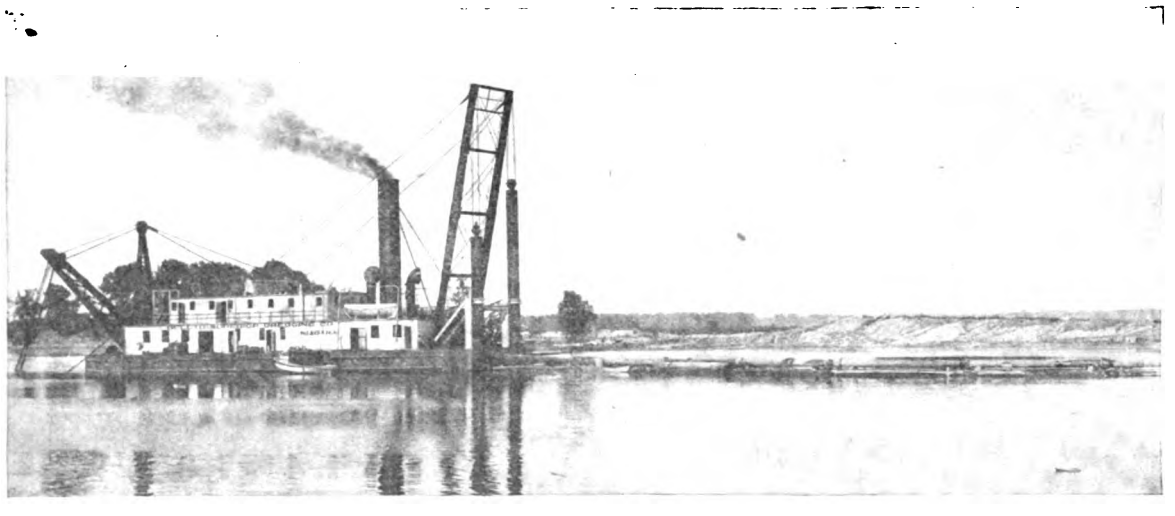
Of crustacean borers, two species, one of which is the well-known limnoria, are reported to infest the bay. Crustaceans do not propagate through larvæ. The comparatively few young produced are ready to dig themselves into the wood at once. The limnoria spread locally therefore in much the same way as the mange spreads. The breaking away of fragments of infested wood, the wash of tidal waters, and occasional wanderings of individuals spread the infestion from timber to timber, and shipping carries it around the world.

The report points out that all ports are subject to repeated invasions of borers from other localities, through larvæ carried by sea currents or in the water tanks of steamers; and through infested driftwood, wooden vessels, and timber rafted by sea. It also brings out the interesting fact that barnacles, ordinary salt water mussels, and certain other marine growth are indicators of suitable conditions for the teredo. Where these are found the teredo is likely to spread if once introduced. The appearance of these parasites in upper San Francisco Bay is reported to be coincident with the appearance of the teredo.

The third part of the report deals with a survey of the protection measures that have been tried in the infested waters of the lower bay. Untreated Douglas fir will last but a few years, sometimes less than a year. An additional life of one or two years is to be expected when the bark is left on the piling, although this protection is fragile, and likely to be knocked off in spots before or after driving. One of the early forms of protection was the sheathing with copper or yellow metal from below the mud line to high water. While this treatment has produced good results, it is expensive, is subject to damage in handling and driving, from driftwood and from thieves after the piling is in place, and also to the danger that mud scour will expose unprotected wood.

Several types of protective coating (heavy bituminous or asphaltic paint, covered with burlap, felt, wire mesh, battens, etc.) have been tried. The committee concludes

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that if piling is properly treated by one of these processes, and is not damaged by careless handling, a life ranging from five to eight years in quiet waters may be obtained. Otherwise such a life cannot be expected.

Concrete protection for wooden piles has been tried, with varying success. The committee gives the details of construction and the results secured by the various processes, and concludes that well constructed precast casings which have been in service for ten years show no evidence of deterioration and seem capable of long further life. Concrete pile jackets and cylinders cast in place give satisfactory results if properly constructed of suitable material. The difficulties in construction are such that the probability of success is less than in precast coverings. A number of failures are reported due to such causes as flooding of concrete while placing; mud and sand pockets, holes caused by arching of the concrete, laitance pockets; and the exposure of unprotected wood on account of dredging or scour.

Treated piling has been largely used in San Francisco Bay, and the committee was able to secure data of value covering structures involving a total of over 35,000 piles. It concludes that properly treated and carefully handled Douglas fir bearing piles may have a life of from 25 to 30 years. Poorly treated piles and those damaged in handling cannot be expected to last nearly so long. Most of the attacks on creosoted piling appear to have begun at spots where the shell of treated wood had been injured in handling and placing.

Precast re-enforced concrete piles have been satisfactory in these waters but none have been in use in this locality for a sufficient time to determine their ultimate life.

The report is published by the San Francisco Marine Piling Committee, of which Mr. F. D. Mattos is chairman. —*G. B. P.*

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Military Instruction

No. 3: SEPTEMBER-OCTOBER, 1921

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Corps of Engineers

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MILITARY ENGINEERING
Maj. Roscoe C. Crawford
Corps of Engineers

GENERAL SUBJECTS
Maj. Cleveland C. Gee
Corps of Engineers

Military Engineering

An Approved Solution

(See Military Engineer, July-August, p. 387.)

Problem No. 1—Military Bridges

Requirement 1—

The selection of the kind of bridge to be built is governed by the load, the nature of the obstacle, the materials available, the time available and the number of men available. These governing factors are laid down in the special situation.

There are two general classes of military bridges, viz.: floating and fixed. We may eliminate the floating bridge from consideration immediately because time, materials and men are available for building a more permanent type of bridge.

The types of fixed bridges to be considered are as follows:

(a) Simple stringer bridges,
(b) Suspension bridges,
(c) Truss bridges,
(d) Spar bridges,
(e) Pile bridges,
(f) Trestle bridges.

Considering each of these types in the light of the factors governing our selections, we arrive at the following:

(a) A simple stringer bridge is out of the question because the load is too great for the length of span and the size of timber available.

(b) Material is not available for a suspension bridge.

(c) It is possible with the material available to span the stream by a wooden truss bridge. Such a bridge will require more time to build than other types. It will necessitate skillful framing and accurate joining to develop its full strength. This type should be selected only in case we should find that another type will not suffice.

(d) A spar bridge is rejected as lacking sufficient strength and stiffness and being only temporary in character.

(e) A bridge supported on pile bents is possible, but should only be considered in case the character of the stream-bed is such that trestle bents can not be supported thereon. Pile driving requires special equipment and consumes time.

(f) In considering a trestle bridge the character of the stream bed is the governing factor here. The bed is such that the trestle can be supported without any elaborate preparation of trestle foundations in the form of cribs or piles and the velocity of the stream is not so great that there will be much danger of the material washing out from under the trestles.

There are, therefore, three possible types of bridge that could be erected at this location using the materials available. These are, the truss bridge, the pile bridge and the trestle bridge. Of the three types the trestle bridge is selected because it is the simplest in construction and requires the least amount of time to build.

Requirement 2—

Notes on Design

The trestles in the design on page 459 are considerably stronger than are required for the immediate load which the bridge is to take. Each trestle will support a load of about 12 tons including dead load, the load being limited by the ability of the trestle cap to support the loads brought upon it by the stringers. The bearing power of the stream bed is assumed to be about 2 tons per square foot. This trestle can be built and erected in about the same time that it would take to build one of 6×6 pieces so that no time is lost in gaining this additional strength and the result is a trestle that can be used in case it ever becomes necessary to alter the bridge for heavier loads.

The stringers are selected on the assumption that each stringer must take a concentrated load at its center equal to one-fourth of the axle load. The axle load is taken as 5,800 pounds which is the weight on the rear axle of the 1½-ton truck. The front axle of the truck is neglected because of the fact that the length of wheel base of the truck is 11 feet 6 inches and the length of bay of the bridge is only 15 feet.

While four stringers would carry the load, six are preferred because of the greater power of resistance thus given to the flooring.

The flooring is made of 4×8 pieces because such a floor can be more quickly laid than could a double layer of 2×8 pieces. A two-inch thickness of flooring will not stand the wear to which the bridge is to be subjected.

Handrails are omitted, although if the bridge is later to be used for the passage of men or horses in considerable numbers their addition would be advisable.

All joints in the trestles are made square in order to simplify construction. The outside posts of trestles are drift-bolted to the cap and sill and the inner ones are toe-nailed. Similarly the outer stringers are drifted bolted to the caps and the inner ones are toe-nailed. Each floor plank is spiked to all stringers although if unforeseen de-

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lays occur they may only be spiked to alternate stringers. The wheel guards are fastened to the floor planks by lag screws spaced 4 feet apart. Longitudinal and transverse bracing are nailed to the trestles.

REQUIREMENT 3—

Prior to the arrival of the material the entire company will be employed on clearing away the wreckage of the former bridge, making measurements, and improving the ford just east of the site so that the wagons for hauling lumber may be put across the stream. At nine o'clock the organization of the company will be as follows:

Hauling detail—3 wagoners with teams and wagons.
Loading detail at cars—1 N. C. O. and 9 men.
Unloading detail at bridge—1 N. C. O. and 6 men.
Trestle building details—2 N. C. O.'s and 12 men.
Footing and abutment details—2 N. C. O.'s and 14 men.
Sawing and boring detail—1 N. C. O. and 8 men.
Carrying detail—1 N. C. O. and 8 men.

The above organization will hold during the first phase of the work which includes the time required to build the trestles and prepare their footings.

When the trestles are ready to be launched the following organization will be made and maintained until the end of the work. When any detail finishes the work allotted to it the members may be assigned to help out other details if necessary:

Hauling detail—As before.
Loading and unloading details—As before.
Sawing and boring detail—As before.
Carrying details—2 N. C. O.'s and 20 men.
Building details—2 N. C. O.'s and 20 men.
Total—7 N. C. O.'s and 66 men.
This does not include the regular details on the platoon tool wagons.

The bridge will be built from both ends simultaneously, there being a building detail of 1 N. C. O. and 10 men at each end with a carrying detail of 1 N. C. O. and 10 men. The N. C. O. in charge of the carrying detail will be placed under the orders of the N. C. O. in charge of the building detail. The building detail will perform all of the actual construction work from the placing of the trestles to the laying of curbs. The carrying detail being subordinate to the building detail may be used on the heavier work of construction where necessary, as for example in the launching of trestles. One lieutenant will be placed in charge of the erection of the bridge.

REQUIREMENT 4—

7 a. m. - 9 a. m.—Removing wreckage, preparation of ford and measuring for trestles.
9 a. m. -11 a. m.—Hauling material, building trestles and preparing footings.
11 a. m. - 3 p. m.—Launching trestles. Placing stringers, laying flooring and curbs, bracing and filling. One-half hour will be allowed for lunch during this period.

The estimated time of completion (3 p. m.) is based upon the assumption that the unloading of the railroad cars will commence promptly at 9 a. m. The first wagon load of timbers (which should be 8×8 pieces for the trestles) should be at the bridge site by 9:30. This will allow each trestle building detail 1½ hours for the completion of its trestle. During the third period 45 minutes are allowed for launching the trestles, 45 minutes for placing stringers (including the middle bay of which three stringers are placed from each end) and 2 hours for laying floor planks and curbs and putting in longitudinal bracing.

REQUIREMENT 5—

Tools Required	*Where obtained*
4 saws—2 man	Platoon tool wagons
12 saws—hand	do.
2 braces and bits	do.
6 augers ship 1 1-16	Platoon tool wagon and company reserve
8 claw hammers	Platoon tool wagons
8 rules—2 foot	do.
3 squares, steel	do.
4 tapes—50 foot	do.
4 chisels, framing	do.
2 mallets	do.
12 hatchets	do.
2 carpenters levels	do.
6 axes	do.
2 plumb bobs	do.
8 sledges	Platoon tool wagon and company reserve
2 adzes	Platoon tool wagons
6 blocks—8 inch	do.
10 picks	do.
20 shovels	do.
4 wrenches	do.
500 feet rope	do.
300 feet tracing tape	do.
3 escort wagons	Div. Eng.

Bill of Materials

14 pieces 8×8×14 (trestle posts, caps and sills and bridge seats)
18 pieces 6×8×18 (stringers)
6 pieces 6×6×16 (curbs)
74 pieces 4×8×12 (floor planks and end dams)
4 pieces 2×8×18 (transverse bracing)
4 pieces 2×8×22 (longitudinal bracing)
20 drift bolts 14″×¾″ (trestles and stringers)
26 lag screws with washers 9″ (curbs)
80 lbs. wire spikes 8″
10 lbs. nails 50 D

All material to be requisitioned from Division Engineer.

REQUIREMENT 6—

There is hardly any need for security measures in this case. Certainly there is no need therefore if the Blue army is to resume the advance the first thing in the morning, but of this we are not absolutely certain. The positions of our advance cavalry and advance guard are such that the only enemy troops against whom security is to be furnished will consist of cavalry which, if it gets this far in rear of our advance guards, will be fast moving and hence confine itself to open country. One automatic team and a corporal placed at the cut where the ACCOTINK STATION ROAD crosses the TELEGRAPH ROAD will therefore be sufficient and even this may be dispensed with after the main body of the Blue army advances.

Solution to Questions on Map Reading

(See page 388, MILITARY ENGINEER, July-August, 1921.)

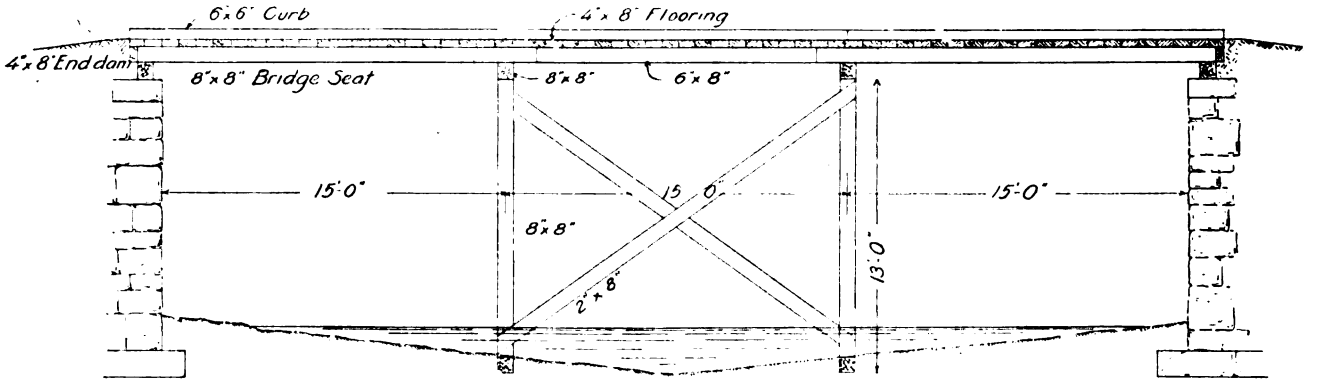
1. (a) 3 inches = 1 mile.

The representative fraction is given on the sheet as 1/21,120, which means that 1 inch measured on the map is equivalent to 21,120 inches on the ground. There are 63,360 inches in a mile. Therefore 1 inch on the map represents $\frac{21,120}{63,360}$ or 1/3 mile on the ground. Hence 3

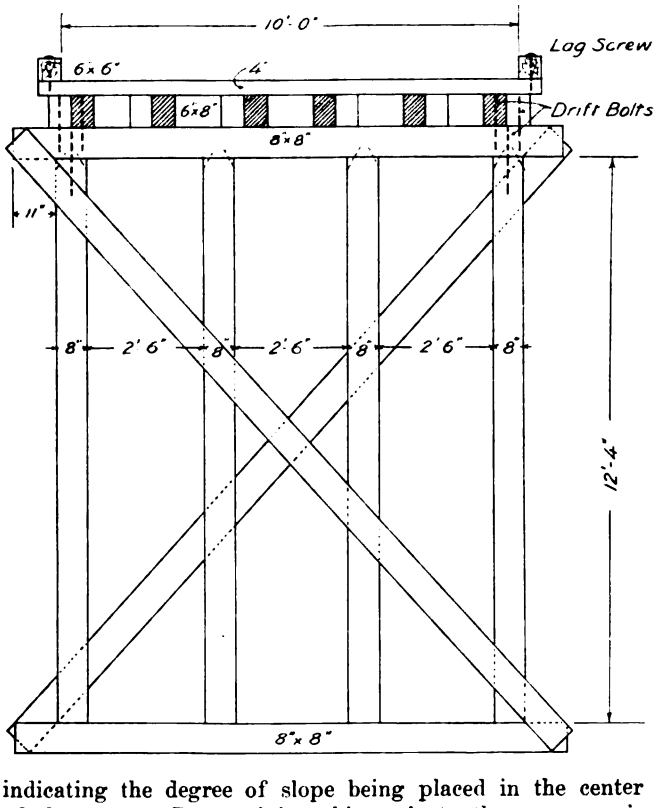
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inches on the map represent one mile on the ground.

(b) The abbreviation M. D. stands for Map Distances, and the scale underneath is called a scale of map distances. This scale shows the distance, on the map, between adjacent contours on slopes from 1° to 10°, the number



ELEVATION



indicating the degree of slope being placed in the center of the space. By applying this scale to the map one is able to express in degrees a slope which is represented on the map by the distance between contours. For any given degree of slope the length of the corresponding division multiplied by the denominator of the representative fraction gives the horizontal distance which one must travel along a slope of that degree in order to rise one contour interval or 20 feet.

2. (a) 280°
   (b) 287°
   (c) N — 73° — W

The above values are found as follows:

Through the cross roads 533 at Koons draw a true north and south line. This may be done with a triangle by drawing a line perpendicular to top boundary line of the map. Then draw a line connecting the cross roads with Centennial School House; place the center of a protractor over the intersection of these two lines and read the angle between them remembering that azimuths read from zero at the north through east, south and west to 360°.

At the bottom of the sheet is a small figure which shows the relation between the true north and magnetic north, the magnetic north being 7° west of true north. This is called the magnetic declination. Hence the angle measured in a clock-wise direction which the given line makes with the magnetic north is seven degrees larger than the angle which it makes with the true north.

Since the given line lies in the fourth quadrant the magnetic bearing is found by subtracting the magnetic azimuth from 360°.

3. (a) 522 feet. This occurs about 150 yards southeast of cross roads 500, the road passing over a divide at this point.

(b) 360 feet. This occurs at the bridge over the Monocacy.

(c) About 3 degrees at cross roads 476.

(d) About 7 degrees 750 yards southeast of cross roads 476.

These maximum grades are determined by finding the points where the contours are closest together along the road and applying the M. D. scale to the distance between adjacent contours.

4. Length of stride: 59.9 inches.

R. F. of this map: 1/8554.

Since the scale of his map is 1:10,000 the length of a 70-inch stride on the scale which he used is $\frac{70}{10{,}000} = .007$ of an inch. In order to plot 10 inches on his map he therefore must have taken $\frac{10}{.007} = 1428.55$ strides. The actual distance from cross roads 472 to cross roads 476 found by scaling it from the Taneytown sheet is 2376 yards = 85,536 inches. Hence the length of strike taken was $\frac{85{,}536}{1428.55} = 59.9$ inches. Since 10 inches on his map represents 85536 inches on the ground the R. F. of his map is $\frac{1}{8553.6}$.

5. Rate of horse: 4.3 miles per hour.

R. F. of his map: 1/14,246.

At the rate of 6 miles per hour, one minute on the scale used represents 1/10 mile = 528 feet. The length of a one minute division on a 1/20,000 scale is therefore $\frac{528}{20{,}000} =$ .0264 feet = 0.3168 inches. Therefore in order to plot 6

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inches the sketcher must have ridden $\frac{6}{0.3168} = 18.95$ minutes. The actual distance is 2376 yards. In covering this distance in 18.95 minutes the correct rate of the horse must have been $\frac{2376}{18.95} \times \frac{60}{1760} = 4.27$ miles per hour.

Since 6 inches on his map represents 85536 inches on the ground the R. F. of his map must be $\frac{6}{85536} = \frac{1}{14256}$.

6. At the farmhouse about 800 yards east of cross roads 533. This is the highest elevation on the road. As it lies on the ridge line about midway between the 560 and 540 foot contours we may take its elevation as about 550 feet. Since this is higher than the observer's station and there is no higher ground along the road to the east of it the patrol will be obscured until it reaches this point.

7. No.

This may be determined either by constructing a profile along the line of sight or by inspection. If a profile is constructed it will be seen that the line of sight from the observer to the ford cuts two intervening ridges. It should not be necessary, however, to construct a profile in order to determine the visibility in this case. By inspection we can see that the ridge about 300 yards northwest of the ford must obscure it as this ridge is 40 feet higher than the ford while the total difference of elevation between the observer and the ford is 92 feet in a distance of 3,800 yards. In other words a ridge 40 feet higher than the objective must not be nearer to the objective than $\frac{40}{92}$ of the total distance in order to permit of visibility of the objective.

8. (a) No.

An inspection of the contours shows that they are grouped much closer together at the bottom of the slope than at the top, so that shots which will just graze the upper slope will be too high to strike an object at the bottom of the slope.

(b) Yes.

The elevation of the gun at the farmhouse is taken as 465 feet. The elevation of the cross roads is 472 feet, and there are no intervening ridges.

(c) Yes. On the ridge about 250 yards west of T-roads 419.

The slope of the line from the farm to the bridge is considerably steeper near the bridge. Hence the bridge will be obscured. The bridge is also beyond the 1,500-yard range of the gun. The gun must therefore be moved toward the bridge. In order for the gun to fire downward on a target the maximum descending slope of the ground along the range must occur immediately in front of the gun; that is, the contours must be closer together at that point than at any other. A location for the gun with such a slope to the front is found on the ridge about 250 yards west of T-roads 419. The elevation of this point is taken as 415 feet. The range to the bridge is 450 yards.

Problem No. 2—Demolition

Map References:

Mount Vernon Quadrangle U. S. G. S.

Northwest Section, Camp A. A. Humphreys 1:5000.

General Situation:

Two hostile forces have been in contact for the past week with their lines of outposts along Accotink Creek—Red, south, and Blue, north. The commander of the Blue force has decided to withdraw from this position.

Special Situation:

You are a lieutenant of Engineers assigned to a company of divisional Engineers of the Blue force. Your division is to withdraw along the Telegraph Road to the northeast. You receive orders from your Captain to prepare to obstruct the Telegraph Road at point 3,751 by means of a crater. The width of the road at this point between the drainage ditch on the up-hill side to the berm on the down-hill side is 25 feet. The roadbed is gravel. The earth underneath the roadbed is yellow clay with a small proportion of sand and gravel. T. N. T., Ammonal, 40 per cent Dynamite and Black Powder are available.

Required:

1. Explosive to be used and number of pounds required.
2. Method of placing charge or charges.
3. Method of firing the same.
4. Time and number of men required to prepare the mine and place the charge after the delivery of necessary materials to the site.

Note.—In the preparation for this problem the following text is given for study and references: Engineer Field Manual, Part V, Pars. 181-236.

Map Co-ordinates:

For the benefit of those who are unfamiliar with the use of rectangular co-ordinates for the designation of points in connection with map problems the following explanation of the system and the method of designation used will be given:

The system used on the Camp Humphreys map is the grid system, now prescribed in Army Regulations 100-15, Section IV. On all standard military maps the continental area of the United States is projected by means of the polyconic projection on seven zones of nine degrees extent in longitude and of indefinite extent in latitude. This division into zones of separate projection was found necessary in order to keep the errors inherent to the polyconic projection within reasonable limits. These zones are lettered A, B, C, etc., from east to west. In each zone a grid system is used in which the north and south lines are parallel to the central meridian of the zone and the east and west lines are perpendicular thereto. The origin of co-ordinates is taken in each zone at the intersection of the 40°-30′ parallel of latitude with the central meridian of the zone. The length of the grid divisions along the X and Y axes is 1,000 yards. In order to eliminate the use of negative co-ordinates to the west and south of the origin arbitrary values of X = 1,000,000 and Y = 2,000,000 are assigned to the origin. In any one zone, therefore, such as Zone A, a place on the earth's surface has an X and a Y co-ordinate which are fixed and remain unchanged no matter what the scale of the map upon which the place is shown. It is possible in such a system to designate the position of such a place down to the nearest yard, as, for example, X = 1,155,643; Y = 2,463,875, which would mean that the place in question is 155,643 yards east and 463,875 yards north of the origin. In actual practice the full designation is rarely used. To illustrate the manner in which the designation is contracted, taken as an example the point given above, whose co-ordinates are

X = 1,155,643,
Y = 2,463,875.

The last three figures in each co-ordinate indicate the number of yards which the point lies to the east of grid line 1,155 in one case and north of grid line 2,463 in the other. Hence, if we wish to designate the point to the nearest 10 yards, the last figure in each co-ordinate can be left out and the co-ordinates could be written as

X = 1155.64,
Y = 2463.88.

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Or if it is desired to give the co-ordinates to the nearest 100 yards we might write

X = 1155.6,
Y = 2463.9.

In both cases the decimal point is used to separate the designation of the 1,000-yard grid line from the number of tens or hundreds yards beyond it to the place in question. The first four figures of the designation indicate the number of the grid line. On a map whose X and Y dimensions are not greater than 10,000 yards, the fourth digit from the left in each co-ordinate designation will occur but once. It is therefore possible on such a map to identify the grid line by means of this fourth digit. Hence the first three digits may be eliminated and the co-ordinates of the point might be written as

X = 5.6,
Y = 3.9.

Instead, however, of giving the X and Y co-ordinates separate they are combined, the X co-ordinate being written first and the decimal point being omitted. The designation of the point, therefore, is 5639. These four digits are all that are necessary in order to give the proper designation of a place to the nearest 100 yards on a map where the X and Y dimensions of the sheet do not exceed 10,000 yards. If, however, the dimensions of the sheet are greater than 10,000 yards, it is evident that the fourth figure in the full designation may occur—that is, here may be two grid lines on the sheet, the fourth digit of whose numbers are the same. In such a case it becomes necessary to give the third figure in the designation, and the proper way of writing the co-ordinates of the place to the nearest 100 yards is

55.6 — 63.9.

When it is desirable to give the co-ordinates to the nearest 10 yards of a place whose co-ordinates are given by means of four digits to the nearest 100 yards, it is necessary, in order to avoid confusion, to use decimals and dashes.

Thus the point 5639 when designated to the nearest 10 yards becomes

5.64 — 3.88

and to the nearest one yard, if necessary,

5.643 — 3.875.

If the co-ordinates of the place to the nearest 100 yards are written in the form

55.6 — 63.9,

and it is desired to designate the place to the nearest 10 yards, the co-ordinates will be written

55.64 — 63.88

and to the nearest one yard

55.643 — 63.875.

The system of designation described above is sufficient to unequivocally define the position of a place on any one map sheet. If several map sheets are used in a problem or operation covering an extended area, it is necessary to precede the co ordinate designation by the name of the map sheet, as, for example, Taneytown 5639.

Exercise in the Use of Map Co-ordinates.

The following exercise is given to enable the reader to gain some practice in the use of map co-ordinates. The use of a 45-degree triangle with the two legs of the triangle graduated in hundreds of yards, the zero being at the vertex of the right angle is recommended. The scale of the graduations should be 1:5000 for use on the Camp Humphreys Map (northwest section), to which the following questions refer:

(1) Give the co-ordinates of the farmhouse at Masons to the nearest 100 yards.

(2) Give the same to the nearest 10 yards.

(3) Where is the origin of co-ordinates of this map with respect to Pohick Church?

(4) How would you write the co-ordinates of the Kernan house to the nearest 10 meters?

(5) Suppose that the Kernan house were on a map sheet the same size as the present sheet, but on a scale of 1:20,000. How would you write its co-ordinates to the nearest 100 meters?

(6) What is the feature whose co-ordinates are given as 2418? What is the feature at 3.24 — 1.72?

(7) Give the co-ordinates to the nearest 100 yards of the following:

(a) Pohick Church.

(b) Intersection of Telegraph Road and Standard Gauge R. R.

(c) Cemetery in Accotink Village.

Military Art, Note 3

Map Problem No. 2. A Solution.

The following is a solution of Map Problem No. 2, which was published in the July-August issue of THE MILITARY ENGINEER, page 392:

First Requirement.

Detachments—

(a) One platoon and one motorcycle via Taneytown-Longville-Harney road to Piney Creek church.

(b) One platoon and one motorcycle via Taneytown-Bridgeport road to vicinity of Alexander house.

(c) Improvised mounted detachment to vicinity of road-fork 433, one and one-half miles south of Bridgeport, via road leaving Taneytown by southwest.

Reasons:

Major M has a rather large area to cover; he must keep it under observation, and he must be sure of getting messages from his detachments without delay, in order that he may transmit information to the regimental commander promptly.

The infantry forces are considerably stronger than any probable Red forces in the area. By taking posts at the points indicated they cover the general road system approaching Taneytown, from Koon's to Bridgeport, both inclusive, and so render reasonably safe the despatch of messages by the motorcycles. They are also sufficiently large to send out patrols large enough to go anywhere within the area that may be necessary.

The mounted detachment covers the roads south of the Taneyown-Bridgeport road and watches the frontier in the general vicinity of Stull's.

The infantry detachments are somewhat larger than he would send if this duty were likely to continue for several days. But this arrangement preserves the integrity of tactical units and, in view of the relatively large force which the detachment commanders will have, the actual fatigue on the individual men should not be great. No other duty is anticipated for Co. B tomorrow and Major M believes that the experience gained in marching in the probable presence of the enemy and the knowledge of the territory which the officers will obtain will prove of value later.

Second Requirement.

Major M sends his orderly for C. O. Co. B, Lts. B (commanding first platoon of Co. B) and C (commanding second platoon of Co. B), Lt. L (commanding the improvised mounted detachment) and Lt. D, the battalion adjutant (who has charge of the motorcycles). At 10:25 p. m., when they have all assembled in his tent, Major M dictates the

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following verbal order, pointing to the map when roads and locations are mentioned and giving the officers time to orient themselves as he speaks:

(Note.—It is assumed that the information concerning the enemy and the Blues contained in the General Situation and Problem No. 1 is known to these officers and that Major M has informed them of his instructions to Co. A.)

"The following telephone message was received from the Regimental Commander at Littlestown at 10:00 p. m." (Reads his record of that message.)

"I shall send out three detachments.

"Lt. B, you will proceed with your platoon and one motorcycle by the Taneytown-Longville-Harney road to the vicinity of Piney Creek church. From there, by means of strong patrols, keep the area Piney Creek church-Koon's-Harney under observation and connect with Lt. C at the Alexander house.

"Lt. C, you will proceed with your platoon and one motorcycle by the Taneytown-Bridgeport road to the vicinity of the Alexander house, half a mile east of the Monocacy. From there send strong patrols to Harney via Pinehill Mill and toward Bridgeport and connect with Lt. L at road fork 433, two miles to the southwest. Do not attempt to enter Bridgeport in the face of strong opposition.

"Lt. L, you, with your mounted detachment, will leave Taneytown by the southwest and proceed via the Harner house to the vicinity of road fork 433, just mentioned. Maintain a lookout of two men to observe the country across the Monocacy and to the south and, about once an hour, send out a patrol of three or four men to get a more extended view from the 426-427 ridge, three-quarters of a mile to the west, and from hill 524, a mile and a half to the south. Relay your messages through Lt. C and, on returning, come by this road. (Fink, 456, 507, 490, Taneytown; south of the Taneytown-Bridgeport road.)

"Report to me here promptly the first definite information concerning the enemy and any later substantial development, such as a new body or material change in position of one previously reported. If no Reds have been seen by 1:00 p. m. send me a message to that effect at that time.

"Patrols will start from camp at 6:30 a. m. and will be back in Taneytown between 6:30 and 7:00 p. m. The men will go in light marching order.

"Lt. D, you will provide Lts. B and C with a motorcycle, each."

Map Problem No. 3—An Outpost

Maps.—

Gettysburg General Map.

Gettysburg 3-inch Map, Kingsdale, Taneytown and Emmitsburg sheets.

General Situation.

This problem is a continuation of Map Problems Nos. 1 and 2, which were published in THE MILITARY ENGINEER, Vol. XIII, No. 69, May-June, 1921, pages 302 and 303, and No. 70, July-August, 1921, pages 391 and 392.

Special Situation.

Same as Special Situations for Map Problems Nos. 1 and 2, with following additions:

Complying with the regimental commander's order to keep the general area Koon-Harney-Bridgeport-Stull-Taneytown-Longville-Koon under observation, Major M sent out the following forces, under light marching order, early on the morning of June 4th:

Detachment No. 1—First platoon Co. "B" and one motorcycle by the Taneytown-Longville-Harney road; to take post at Piney Creek church, send strong patrols to Koon's and Harney and connect with Detachment No. 2.

Detachment No. 2—Second platoon Co. "B" and one motorcycle by the Taneytown-Bridgeport road; to take post near the Alexander house, send strong patrols toward Bridgeport and to Harney, via Pinehill Mill and connect with Detachment No. 3.

Detachment No. 3—Improvised mounted detachment by the Taneytown-Harner house-489-433-Stull road; to patrol between Stull house and Alexander return by the road south and generally one mile distant from the Taneytown-Bridgeport road.

Co. "A" arrived at Taneytown from Silver Run at 10:20 a. m., without seeing any Reds.

By 5:00 p. m. the information received by Major M from his observation groups is as follows: Six or eight mounted men withdrew from Harney west across the Monocacy on the approach of the patrol from Piney Creek church. The crossing at Bridgeport was held in such strength that the patrol from Alexander made no attempt to cross. From the hill one-half mile north of Stull's, four to six mounted men were seen at several times during the day at hill 404, one mile to the west.

The regimental commander telephones from Littlestown that he has no further information of the enemy and that the orders for the regiment remain unchanged.

Required:

(1) Major M's outpost order for the night of June 4-5.

(2) Sketch showing locations and designations of the various elements of the outpost. (Trace outline from 3-inch map.)

(3) Tabulation showing number of men required for each element of the outpost and tactical unit or units from which each element is obtained. Account for the entire force assigned to the outpost by Major M's order.

References:

The following references, in addition to those listed at the end of Map Problems Nos. 1 and 2, should be studied in connection with the above problem:

Technique of Modern Tactics, Chapter X.

Field Service Regulations, pars. 60-88 inc.

General Subjects. Note 3

An Approved Solution Test on Infantry Drill Regulations

(See page 10, Military Instruction, Vol. XIII, No. 70.)

By Maj. Peter C. Bullard, C. E.

(References are to "Infantry Drill Regulations, Provisional, 1919.")

Question No. 1. Ref. Par. 106—

In the squad, seven (including the corporal) are armed with rifles, one with an auto-rifle. One rifleman is equipped with a grenade discharger. They are arranged as follows:

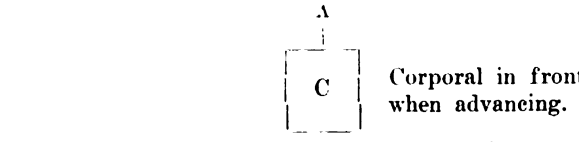
C 4 R	3 R	2 G D	1 R	front rank
4 R	3 A R	2 R	1 R	rear rank

C = Corporal
R = Rifleman
AR = Auto-rifleman
GD = Rifleman with grenade discharger
F = Front rank.
r = Rear rank.

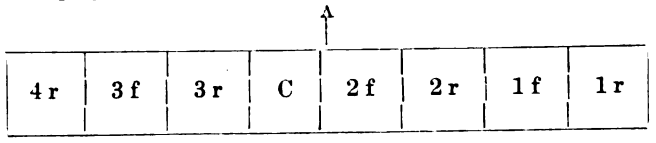
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Question No. 2. Ref. Par. 124—

The squad deployed alone:



Deployed as part of a larger unit.



Question No. 3. Ref. Par. 125—

The normal interval between skirmishers is 5 paces.

Question No. 4. Ref. Par. 119—

Being in line, to turn and march: 1. SQUAD RIGHT (left). 2. MARCH.

At the second command, the right-flank man in the front rank faces to the right in marching and marks time. The other front rank men oblique to the right, place themselves abreast of the pivot, and mark time. In the rear rank, the third man from the right, followed in column by the second and first, moves straight to the front until in rear of his front rank-man, when all face to the right in marching and mark time. The other number of the rear rank moves straight to the front 4 paces and places himself abreast of the man on his right. Men on the new line glance toward the marching flank while marking time, and as the last man arrives on the line both ranks execute FORWARD, MARCH, without command.

Question No. 5. Ref. Par. 185—

Being in column of squads, to form line of sections to the front: 1. Line of sections (so many paces), 2. RIGHT (left), 3. MARCH, 4. *Platoon*, 5 HALT.

At the third command, the leading section moves straight to the front or in the direction indicated by the platoon leader; it halts at the fifth command. The rear section is conducted in column of squads on the indicated flank and halted at the prescribed interval abreast of the leading section; if no interval be indicated in the command, it forms at section frontage from the leading section.

Question No. 6. Ref. Par. 210—

Being in column of squads, twos, or files, or section columns, to deploy as skirmishers: 1. *As skirmishers,* 2. MARCH.

The corporal of the leading squad moves in quick time straight to the front or in the direction indicated by the platoon leader. The leading squad deploys abreast of its corporal (par. 124). The center and rear squads of the leading section deploy abreast of the leading squad, the center squad on its right, the rear squad on its left, men running individually toward their places on the line as soon as disengaged from column. If the leading section consists of only two squads, the rear squad deploys on the right of the leading squad. The rear section deploys abreast of its leading squad and parallel to the line of the leading section as described for that section, the leading squad deploying in place. Unless otherwise directed by the platoon leader, the rear section gains a distance of approximately fifty paces from the leading section, standing fast or moving to the rear after deployment if necessary; if the platoon advances, the rear section follows the leading section, modifying its distance as required by consideration of cover. The platoon sergeant, section leaders and guides, and runners take their prescribed posts.

Squads may be deployed on one flank only of the leading squad of each section by the command: 1. *As skirmishers, right (left).* 2. MARCH. Executed as above described except that in each section the squads in rear of the leading squad of each section deploy on the right and abreast of the leading squad of the section.

Question No. 7. Ref. Par. 207—

The platoon runners are with the platoon leader.

Question No. 8. Ref. Par. 186—

Being in line of sections, to change direction: 1. *Platoon right (left).* 2. MARCH. 3. *Platoon.* 4. HALT. The right section changes direction to the right; the other section is conducted by the shortest line to its place abreast of the right section.

The fourth command is given when the right section has advanced the desired distance in the new direction; that section halts; the other section halts upon arriving on the line.

Question No. 9. Ref. Par. 215—

A section column is a formation in which the section is in column of twos with the leader at the head and the guide at the tail.

Squads are in the same relative order as in normal formation of the section in close order, corporals at the heads of their squads.

Question No. 10. Ref. Par. 249 and page 69.

1. *Squads right.* 2. MARCH.

An Approved Solution. Test on Military Law

(See page 10, Military Instruction, Vol. XIII, No. 70.)

By Capt. Ralph Millis, C. E.

(References are to "A Manual for Courts Martial, 1921.")

Question No. 1. Ref. Par. 198—

(1) The Articles of War. (2) The Federal Constitution. (3) Federal statutes as expressly mention courts-martial. (4) The Manual for Courts-Martial.

Question No. 2. Ref. Pars. 213 (a), *211* (b), *213* (c), *213* (d).

a. No; b. No; c. No; d. No.

Question No. 3. Ref. Par. 206—

a. No, has no bearing on this case.

Question No. 3. Ref. Par. 221—

b. No. Capt. B, who is available, should be called.

Question No. 3. Ref. Par. 222 (8)—

c. Yes. (Statement as to accused's intent or motive.)

Question No. 3. Ref. Par. 222 (10)—

d. Yes. (Statement of deceased person.)

Question No. 4. Ref. Par. 223a—

a. That the person now in court as accused is the same person described in the charges by name, rank, title, and organization.

b. That the person now in court as accused (irrespective of his name, rank, etc.) is the very person who did the act charged and to which act the witness's testimony will refer.

Question No. 5. Ref. Par. 254c—

(1) On cross-examination. (2) To abridge the proceedings, in leading the witness to the points on which he

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is to testify. (3) When the witness appears to be hostile to the party calling him. Also (4) when there is an erroneous statement in the testimony of the witness, evidently caused by want of recollection, which a suggestion may assist. (5) Where, from the nature of the case, the mind of the witness can not be directed to the subject of the inquiry without a particular specification of it.

Question No. 6. Ref. Par. 225b-c—

In view of the military relations of the parties, the affidavit should be admitted only if it is clearly shown that it was voluntary, and made by the accused with a full knowledge of his rights. Corroborating evidence must also be introduced at some time during the trial.

Question No. 7. Ref. Pars. 237, 238—

When (a) the original has been lost or destroyed (b) the original is a public record required to be preserved on file in a public office, or (c) when the copy is of any record or paper in the War Department, any of its bureaus, or at the headquarters of an army, division, regiment, post, etc., and is authenticated by the impressed stamp of the bureau, office, or headquarters having custody of the original.

Question No. 8. Ref. Pars. 214, 290—

(a) By taking the stand as a witness in his own defense. (b) By making an unsworn verbal or written statement, personally or by counsel.

Question No. 9. Ref. Par. 289—

The recognition by the Court of certain facts, without requiring the introduction of evidence thereon as, for example, the ordinary divisions of time, the organization of the army, the contents of general and special orders of the War Department, etc.

Question No. 10. Ref. Par. 285—

Drunkenness is not an excuse for the crime, or justification for a finding of "Not Guilty," but it may preclude the presence of the deliberate intent required for the crime of murder, thus requiring the findings to reduce the grade of the crime to manslaughter.

Question No. 11. Ref. Par. Art. VI, Sect. 1

He should be tried by General Court. The maximum punishment is dishonorable discharge, forfeiture of all pay and allowances due and to become due, and confinement at hard labor for six months.

Question No. 12. Ref. Par. 366—

He forwards it to the appointing authority or his successor in command.

Question No. 13. Ref. Par. 294—

Voting is by secret ballot, the ballots being counted by the junior member, verified by the president, and the result announced by the president. Each member writes on his ballot, without signature, either (1) "guilty," or (2) "not guilty," or (3) "guilty, with exceptions or substitutions (setting them out in full on the ballot) as to each specification: and as to each charge (1) 'guilty', (2) 'not guilty', or (3) 'not guilty, but guilty of violation of the ------ Article of War,'" (setting it out). If the requisite number of votes of "guilty" without qualification is not received to convict the accused of the specification or charge, but one or more exceptions or substitutions are proposed on the ballots, the president reads such proposals to the court, and a vote is taken on each in turn, beginning with the one which the president considers the severest until all have been voted on, or one has been adopted. If none of the proposed exceptions or substitutions is adopted by the requisite number of votes, the accused is acquitted of that specification or charge. All ballots are destroyed as soon as the result is announced, unless some member of the court wishes to verify the count, when they are destroyed immediately after such verification.

Question No. 14. Ref. Par. 386—

He may (a) disapprove the sentence entirely, or (b) if the sentence is divisible, approve and order executed that portion within the legal limit.

Question No. 15. Ref. Par. 401—

On the date on which the sentence was announced in open court; or, if it was not so announced, the date on which the sentence was adjudged by the court.

Questions on Military Hygiene

(Reference: Elements of Military Hygiene.—*Ashburn*)

Wt.	*No.*	*Question*
14	1 (a)	Describe two field methods of rendering water reasonably safe for drinking.
16	(b)	A small stream is the sole water supply for your company of mounted engineers. Name in order, going downstream, how you would segregate the water supply for its various uses.
16	(c)	Sketch a latrine cross-section suitable for use for a four-day camp. How should it be located with reference to the water supply?
10	2 (a)	Why are kitchens and latrines screened?
10	(b)	What is a typhoid carrier?
12	3	What is the difference between an infectious and a contagious disease? Give an example of each.
10	4	What is the necessity of thoroughly cooking pork?
12	5	How is malaria transmitted? How is its spread combatted?

Questions on Military Law

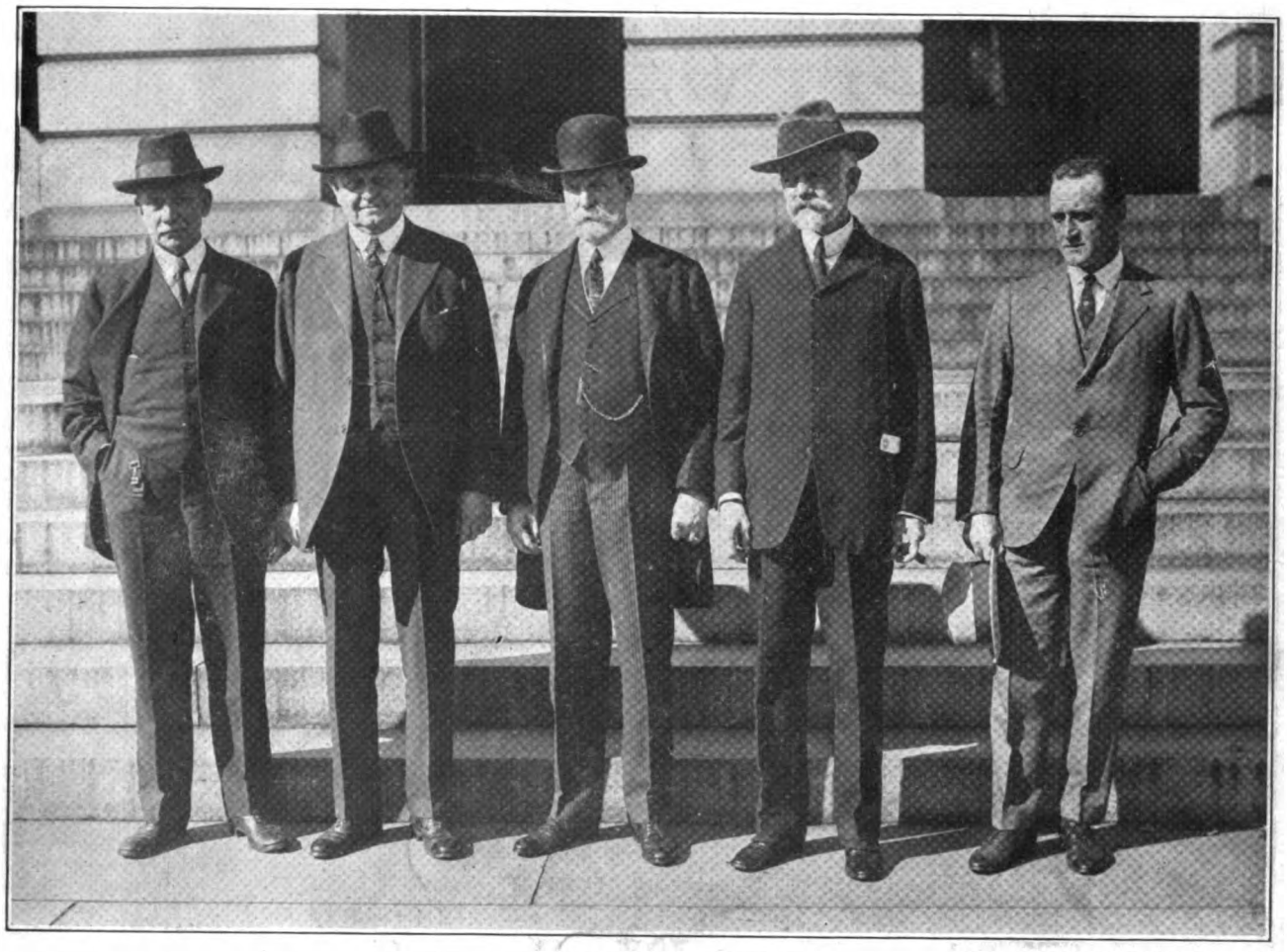
(Arts. 405 to 487 incl. Manual for Courts Martial, 1921)

No.	*Wt.*	*Question*
1	11	A man fraudulently enlisted in the army deserts the service. On trial for desertion he pleads his fraudulent enlistment in bar of trial, claiming that since his enlistment was fraudulent he is not subject to the jurisdiction of a court-martial. Should the court sustain the plea? Give reasons for your answer.
2	10	(a) Define "desertion." (b) What is meant by "short desertion."
3	10	Part I. A soldier is turned over to civil authorities, upon their application, to answer a charge of breach of the peace. Is he punishable for absence without leave for the period he is held by civil authorities: (a) If acquitted of the charge? (b) If convicted of the charge? Part II. A soldier on pass is held by civil authorities to answer to a charge of assault. Is he punishable for absence without leave for the period he is detained after expiration of his pass: (a) If acquitted of the charge? (b) If convicted of the charge?
4	9	(a) What is the distinction between "mutiny" and "sedition?" (b) What is the minimum number of persons who must be involved in a case to make it chargeable as mutiny?
5	8	A person subject to military law is charged with an offense. What are the determining factors in deciding whether he should be placed in arrest or in confinement (assuming that one or the other is believed advisable)?
6	10	(a) Who is authorized to sign charges and specifications? (b) What is his signature under oath intended to cover?
7	10	(a) Sufficient evidence is available to prove that a certain soldier destroyed or injured certain property belonging to a civilian. Is it possible for said civilian to obtain damages or redress by application to the military authorities? (b) If so, state how it would be done. (c) If not, state how redress could be obtained.
8	8	State briefly the difference between larceny and embezzlement?
9	10	(a) For what purposes are courts of inquiry convened? (b) What is the jurisdiction of courts of inquiry as to persons?
10	10	(a) In general terms, what classes of offenses are properly chargeable under the general article (A. W. 96—Conduct to the prejudice of good order and military discipline)? (b) What punishment can be awarded in case of conviction under this article?
11	4	What punishment is mandatory upon conviction of an officer for conduct unbecoming an officer and a gentleman? (A. W. 95.)

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The Military Engineer



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American Delegates to the Arms Conference: Elihu Root, Sen. Oscar Underwood, Secretary of State Hughes, Sen. Henry Cabot Lodge, and Basil Miles, Secretary

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Major General Mason M. Patrick, U. S. A.
Chief of Air Service
Formerly Colonel, Corps of Engineers

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Maintaining the Motor Transport of A Field Army

By

M. D. Mills

Major, Engineer Reserve Corps, formerly of G-4, First Army, A. E. F.

[*Note.* In this valuable article Major Mills epitomizes the experiences of the A. E. F. in maintaining or endeavoring to maintain, the motor transport on which the success of all its operations so greatly depended. The subject is presented in a highly entertaining manner, which indicates that its author possesses "that saving sense of humor," which prevents physical and mental breakdown in the face of the trying conditions of war time. In this interesting and effective way Major Mills drives home the lessons of the war, and indicates the mistakes to be avoided in the the future, and how they may be avoided. We consider this one of the most important contributions which THE MILITARY ENGINEER has been privileged to make to the cause of the National Defense, and hope the article will be as widely read as its interest and importance warrant.—ED.]

IT has been said of the late Theodore Roosevelt that few men could remain indifferent toward him or could maintain a real neutrality in discussing his various utterances and actions, his being a positive character that aroused a strong partisan liking, or an equally strong opposition. Similarly, most men who even remotely came in contact with motor transport in France, developed positive and sometimes violent opinions commending or condemning the work of the Motor Transport Corps in maintaining the motor-driven vehicles of the A. E. F.

The reasons for this attitude are many and varied, but one of the commonest causes of criticism lay in the opinion of the average Yank, who back in peace time had ridden or driven in "flivvers," automobiles or trucks, that he knew about all there was to know regarding the operation of motor vehicles. As a result, the poor old M. T. C. staggered wearily on its way, judged, and generally found wanting, by the motor experts who made up the rest of the army.

Undoubtedly there was much reason for the belief that existed in many combat outfits, that the principal function of the M. T. C. was "to block the game." The medico who vainly scoured France in quest of front springs for Fords, and who in the meantime supported his ambulances on blocks of wood, and the artilleryman who daily watched his ammunition train dwindle and the number of quads tied up for lack of steering-knuckles grow, were not concerned with the fundamental causes of the failure to secure adequate spare parts. They only knew that apparently the divisional M. T. O. could do nothing for them and if, despite orders, they went to Langres or Verneuil they probably got no results, or if they did, it was because they begged, borrowed, or (most likely) stole parts that were on back order for some other outfit. In any event they probably formed a contemptuous opinion of the spare-part supply system, and as a result of their tales as to the number of cars, trucks, etc., parked at Langres and other points, the division G-1 bedeviled corps and army headquarters for additional vehicles, and refused to believe that the transport observed at the parks was on the way to equip some organization in worse shape than his own.

So many factors entered into each individual experience with motor vehicle maintenance in the A. E. F., ranging from the efficiency of the personnel and the operating conditions, to the make of vehicle used and the nearness of spare part and repair depots, that the observations of any one man represent generally his own limited experience and are valuable only in connection with the opinions of others to the end that, by a thorough discussion, different viewpoints and experiences will be developed, and practical improvement suggested. I am well aware that starting a discussion on such a subject as maintenance, is largely a case of rushing in where angels fear to tread. So bring on the anvil chorus!

As I see it, the essentials necessary to maintain properly the motor transport of an army in the field are:

1. *Standardization of vehicles by the assignment of the fewest possible makes and types consistent with operating requirements.*
2. *Proper operaton and inspection of vehicles.*
3. *Light repair facilities immediately at hand capable of making small repairs and adjustments "on the job" thereby forestalling extensive break-downs.*
4. *Overhaul facilities within the army zone where more seriously damaged vehicles may be turned in for repairs and a serviceable vehicle of the same make and type issued as a replacement.*
5. *Reconstruction facilities at the rear of the army zone capable of manufacturing parts and of rebuilding vehicles.*
6. *An adequate supply of spare parts and tools within reach of the combat units.*
7. *Well-trained and disciplined personnel.*

These seven essentials are so inter-related that it is hard to consider them separately in view of their collective effect. For ease of discussion, however, it is perhaps better to take them up individually.

Standardization of Makes and Types of Vehicles

It is unnecessary to take the time of engineers to dwell upon the advantages of standardization in relation to the upkeep of machines. As a result of our war experience it is now considered that the staff, supply, ammunition and evacuation requirements of a field army can be satisfactorily handled by nine different types of motor vehicles, viz, two types of motor cars, one type of motor cycle, one type of ambulance and five types of trucks ranging in capacity from three-quarter to five ton. (Tractors not included.)

Contrasting these actual requirements with the situation in France, we find a total of 162 different makes of vehicles in use by the A. E. F., these including many foreign makes for which it was not possible to secure spare parts. There are about 3,500 different parts in a motor vehicle of which approximately 1,500 parts are known as "parts common," such as bolts, nuts, brake lining, tires, etc.,

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while the balance are parts peculiar to each make of vehicle. A stock of spare parts sufficient to have maintained the vehicles of the A. E. F. would have included 440,000 different items, of which 80 per cent were non-interchangeable. The difficulties of obtaining and keeping up such a stock under war conditions were insurmountable, and the actual records of the A. E. F. show that there were never over 87,000 different kinds of spare parts in France, leaving 353,000 different kinds actually required and not to be had. Under such conditions is it any wonder that the only practical way of repairing a vehicle was by looting the necessary parts from some more damaged vehicle of the same make, temporarily unguarded by its owners?

The early organization of divisions in 1917 and the beginning of 1918 saw a consistent attempt made to limit the cargo trucks within each division to one make. The 1st and 26th Divisions were largely equipped with A. E. C. (British) trucks; the 2nd and 32nd Divisions with the Packard; the 42nd with the Pierce-Arrow and the 3rd and 5th with the Peerless. The rapid arrival of later divisions in France with the ensuing shortage of transport prevented any further efforts at standardization, and the whole situation was made infinitely worse prior to the St. Mihiel offensive by the necessity for issuing the maximum possible equipment to the divisions and the corps and army troops that formed the First Army.

To equip the First Army with the required transport it was necessary, in addition to the equipment on hand within the army and ready for issue in the parks, to practically strip the S. O. S. of cargo trucks on short notice. This resulted in sending forward to an army preparing for battle a mass of transport of all descriptions and in all stages of serviceability. Undoubtedly, the S. O. S. made a conscientious effort to deliver the best possible vehicles, though this necessitated forwarding a great many makes and types of trucks not desirable for use in a combat area. Of the trucks received 14 per cent were rejected as absolutely unserviceable, and many of the trucks accepted were in an extremely dilapidated condition and would barely roll.

An idea of the general condition of these vehicles may be drawn from one typical experience as follows:

A convoy of 50 vehicles was forwarded from Bordeaux. The officer who took them protested verbally and forcibly against their being sent, stating that four out of the 50 were in a safe condition to undertake a hard journey. Of this convoy 36 vehicles were dropped by the wayside and salvaged, while ten (10) more were towed in by the exercise of considerable ingenuity, and the prediction that four would probably prove fit to make the trip was exactly justified.

With the transport from the S. O. S. and that which was already within the First Army, a re-distribution was effected in six days, whereby seventeen divisions, the corps supply trains and artillery parks of three corps, together with numerous units of army troops, were partly equipped, the degree depending largely upon the priority assigned them in the order of battle.

The short time available in which to carry out this distribution prevented any attempt at a homogeneous grouping, even by divisions, and as a result the First Army began the operations, which it was to continue until the armistice, with a mixed mass of transport in all stages of serviceability, and for much of which there existed few or no spare parts.

Conditions such as these could be eliminated in future by rigidly limiting the number of different makes of vehicles within the army to the required number of types. With the vast number of commercial vehicles existing in the United States, this could easily be effected in time of national emergency by commandeering for military purposes all serviceable, privately owned vehicles of the several makes selected as standard, either purchasing them outright or replacing them with non-standard makes.

Proper Operation and Inspection of Vehicles

Given proper operation of all vehicles, maintenance ceases to be a problem. Proper operation and inspection, meaning day-by-day care of the machine, proper lubrication of all moving parts, controlled operation on the road at proper speeds, and a system of inspection which will quickly check up any violation of these things, reduce the necessity for repairs to a minimum.

Maintenance and operation are so inter-related that it is fundamentally wrong to charge one branch of the service with the upkeep and repair of vehicles over the operation of which it exercises no control. Motor transport, excepting only the special technical and combat vehicles, exists for but one purpose, i. e., the most expeditious and economical movement of personnel and matériel between two points. Surely, for example, the actual movement of munitions is no more an artillery affair than is the movement of forage. Certain amounts of ammunition of various calibers are ordered forward from stockage at A to corps dump at B. The movement is purely an affair of transportation, and requires on the trucks not artillerymen, but truck drivers. It is the job of the commander of the stockage at A to see that the trucks get the exact ammunition called for on the order, and it is the job of the convoy commander to see that all his loads are delivered within the stated time to their destinations.

Similarly I have never been able to see the operation of ambulances in a different light, for their movement between the points specified requires drivers, rather than medical troops, and if the services of the latter are required for attention to sick or wounded in the ambulance, they should be sent along for that purpose. The locomotive driver who pulls a hospital train is certainly not a member of the Medical Corps. Why the driver of an ambulance?

Let us examine the situation within the combat forces of the A. E. F. Division staffs as originally organized did not include a representative of the Motor Transport Corps, for that corps did not come into existence, as far as the A. E. F. was concerned, until the late fall of 1917 and then only in the S. O. S. The motor transport within the division was assigned generally according to the tables of organization and was in the hands of the various organization commanders, being largely, however, in the four division trains and at division headquarters. Divisional methods of controlling the maintenance of this transport varied from highly efficient to the reverse. Even within the division, part of the trains were often ably handled and in fine condition, while the remainder were in bad shape. In other words, there existed no uniform practice or standard of inspection, and in few if any cases did any one authority within a division really control *all* the transport assigned to the command.

Motor transport officers were not assigned to corps and armies until June, 1918, and as soon as possible after that date M. T. C. officers were sent to the divisions. There at first they generally did not accomplish much, for on the average they had little rank and small experience as soldiers, and after being pushed well into the mud by the staff and organization commanders, were usually handed

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the job of consolidating requisitions for spare parts. This situation improved, however, with the transfer of many older men to the M. T. C. making possible the assignment as divisional M. T. O.'s of officers who had made good as train commanders.

Passenger transport within the divisions was largely assigned to individual organization commanders and staff officers and in many cases was driven by favorite orderlies. It can be stated that a good many fine cars, including some with stars on the windshields, were ruined by this practice. Most of these officers insisted on the cars assigned to them being kept clean on the *outside,* but how many ever took the time to look *under* the hood?

Less trouble was encountered in the several corps and armies, for here there existed no prior organization, and the officers appointed as M. T. O.'s were generally officers of rank and ability. Pooling of passenger transport at these headquarters, less only the cars assigned to general and higher staff officers, was soon effected and this system was extended to most of the divisions during the fall of 1918.

The utter fallacy of looking to the several arms of the service for the selection, training and organization of motor transport personnel, was completely demonstrated in France. With the supply train manned by quartermaster personnel, the ammunition train by artillerymen, the ambulances and sanitary train cargo trucks by medical personnel, unbelievable indifference to the simplest motor transport practice was witnessed on every side and was almost totally beyond the control of motor transport officers. I do not believe that efficiency of operation will be possible of attainment until such time as all motor vehicles, excepting only combat and special vehicles, are operated and maintained by a single arm of the service, with all personnel, whether drivers or mechanics, drawn from, trained by, and looking to that arm for their promotion and technical control.

Facilities for Light Ordinary Repairs

While transport breakdowns and the necessity for repairs can be very materially reduced by proper operation, they certainly cannot be eliminated, even under garrison conditions. In the case of an army in the field there will exist a continuous demand for minor adjustments and repairs and the replacement of broken parts, which, if promptly attended to, will with little effort keep a large percentage of vehicles in a serviceable condition, while these same vehicles, if allowed to go on without attention, will soon need not light repairs, but a complete overhaul, necessitating tying up the vehicle for a period of several days.

To make the necessary light repairs within a division requires the presence of a small but completely equipped mobile machine shop, operated by a force of mechanics expert in the several lines of automotive repair and having at their disposal a stock of spare parts sufficient to maintain the division transport during the period of time necessary to obtain new parts from the rear.

This work in the combat zone of the A. E. F. was performed (mostly *without* spare parts) by the very efficient machine shop truck units which were largely responsible for such maintenance as was possible. The name of these mobile units has been changed in the new Army of the United States to that of Repair Sections, and two of these sections, each consisting of an officer and eighteen men, will be responsible for the maintenance of division transport in the future. Each section will be equipped with a machine shop truck, a tire press, a wrecking truck, a spare-parts trailer, a tractor and certain cargo and passenger transportation, and the two sections will have between them a stock of spare parts sufficient to keep serviceable the motor vehicles of a division for a period of thirty days.

Facilities for Overhaul

The repair sections assigned to divisions must at all times retain their mobility, which practically forbids the acceptance of major repair jobs involving several days' work. This larger repair or overhaul work must be taken care of in bigger and better equipped semi-mobile shops situated far enough from the enemy's guns to prevent interference with the supply and troop movements in the forward zones, but not so far in the rear as to prevent damaged vehicles being quickly towed to the park for repair.

The French maintained a large repair park of this description at Bar le Duc, serving from this point the Second French Army in the Verdun Sector, and handling repairs, replacements, and, I believe, the issue of spare parts. Through the entrance gate of this park were towed damaged vehicles to be turned in for extensive repair, the drivers receiving in exchange a serviceable vehicle of the same type and make, with which shortly they rolled out of the exit on the way back to their organizations. The damaged vehicle was repaired and made serviceable and then held in the park for issue as a replacement. Such a system represents a minimum loss of transport to combat organizations but could only be put into effect where operation and maintenance are under the same general direction; otherwise the park would be swamped by the promiscuous dumping upon it of vehicles needing not overhaul, but simply intelligent care.

The first park built by the A. E. F. in the Zone of the Armies was the overhaul park at Langres. During the spring of 1918 this park handled some repair work for divisions in the training areas, but its main functions during this time were the issue of spare parts to the combat troops, the inspection and issue of new transportation assigned to these troops by G. H. Q., and the repair of vehicles salvaged and turned in as unserviceable.

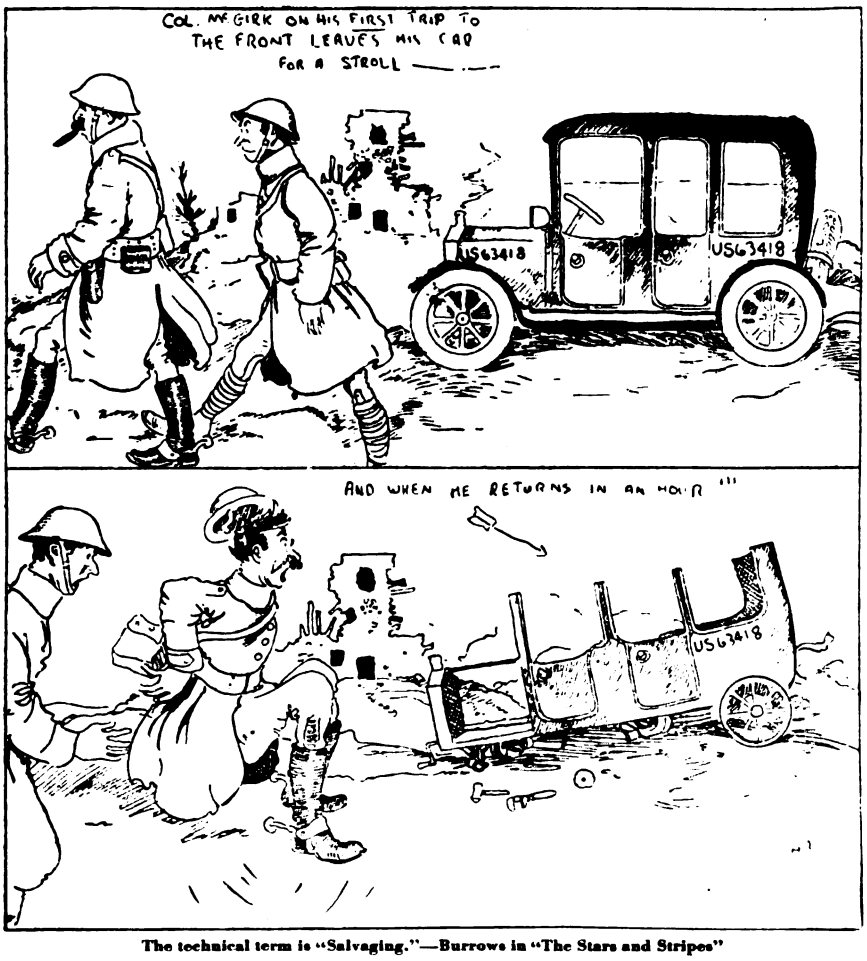
At this time there were only four or five machine shop truck units with the divisions in the line, and none with the troops in the training areas. With no means at hand, therefore, for repair, and with few spare parts available, organizations were continually requesting authority to replace damaged vehicles. This *authority* was readily granted, but organizations soon discovered that there was no replacement. The reason for this was that new organizations were arriving much faster than was motor transportation; naturally all vehicles available for issue were gobbled up on initial assignments. The units demanding replacements did not know this, but soon discovering that they were getting nowhere, they adopted the practice of stripping damaged vehicles of all parts in order to keep other vehicles serviceable. This resulted in wrecks arriving at the overhaul park requiring not overhaul, but entire reconstruction.

This practice, due to the continual lack of spare parts, grew worse during the St. Mihiel and Meuse-Argonne offensives, and no one knows better than the man who has had the misfortune to have his car break down enroute, that vultures never gathered quicker over a fresh kill, or picked bones cleaner, than did the drivers and mechanics in the forward areas locate and strip a damaged car, truck or motorcycle.

During the process of equipping the First Army prior

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to the St. Mihiel offensive, the chief motor transport officer of the army discovered that of 108 machine shop truck units then in France, 79 were in the S. O. S., and as a result of his efforts, 30 units were sent forward for distribution to the organizations of the army. The C.M.T.O. retained under his own control one machine shop truck and two tire presses, and with improvised personnel organized the provisional First Army supply and repair park. This park was first located at Toul, but for the Meuse-Argonne offensive it moved to the vicinity of Thiaucourt. The park was at this time increased to four machine shop truck units, five tire presses and one vulcanizing outfit, and became the point to which all spare parts for the army



The technical term is "Salvaging."—Burrows in "The Stars and Stripes"

were sent for distribution to organizations, and where organizations could send vehicles which they themselves could not repair. The park moved on November 10th to La Frana Ferme, near Nixeville. During the period from October 4th to December 4th this improvised park, partly housed in wrecked barns and partly in the open, handled a total of 841 vehicle repair jobs, and in addition pressed on 4,193 tires, vulcanized 1,875 tubes and 155 casings, repaired 121 radiators and handled 271 welding jobs.

The splendid work of this park is a convincing proof that the overhaul facilities of future armies should be part of the army itself and not an S. O. S. project. Under our new organization there will be an overhaul park (repair battalion) with each corps, in addition to two repair sections for the corps troops. The repair battalion, consisting of 1,238 officers and men, is a semi-mobile plant equipped with knock-down buildings and with machinery mounted on skids for portability. The equipment comprises all tools and machinery necessary for the repair of major units, and the capacity of the park is sufficient for the maintenance of 4,000 vehicles. At this park will be maintained a 90 days' reserve of spare parts for all units of the corps, and as the park has 24 cargo trucks it is possible at all times to move within short notice.

Reconstruction Parks

To care for the total reconstruction of badly damaged vehicles in the A. E. F. there was located at Verneuil, near Nevers, a completely equipped factory capable of building necessary parts of vehicles. This park was also the spare part depot to which all parts were forwarded from the base ports. Just what part this park played in the maintenance of the transport belonging to the combat armies I am not competent to say, for it was an S.O.S. project.

Under the new organization there will be assigned to each army three repair battalions organized into a reconstruction park. A fourth repair battalion will be utilized within each army as an overhaul park for army troops.

The Supply of Spare Parts and Tools

Of the several factors affecting the maintenance of transport which have been previously discussed, there is none that will stand out as clearly in the mind of any man who was responsible for the operation of motor vehicles in the A. E. F. as that of the supply of spare parts and tools. Literally, at times, "there was no such animal" as spare parts, and many a man scoured France, ofttimes vainly, in quest of certain parts required to keep his vehicles running.

Requisitions, sent to the rear in good faith, generally produced about 10 per cent of the needed parts on the day of issue, and to secure a part of the remainder it was necessary to beg, borrow, and steal. From all the testimony offered there were certainly some accomplished thieves in the army, especially in the matter of transport.

No more vivid description of existing conditions can be written than that described in a verse originally published in the *Stars and Stripes*, written by a sergeant in the M. T. C.:

The Absent Quad

The Quad truck waits without, my Lord!
  Without what, Captain Bunk?
Without the steering arms, my Lord!
  Without a lot of junk;
Without a vulcanizing patch,
  Without a nut or screw;
She's minus top and wheels and valves,
  She's shy a body, too;
Without a spring, a brake, a yoke,
  Without a horn to blare—
Good gracious me, it beats the Dutch,
  How much there isn't there!

We took her to the park repair,
  As perfect as could be,
Just wanted to adjust some screws,
  And now—ah! woe is me.
They swiped the lining, brake (ten feet),

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They stripped the casings clean,
They monkeyed with her primer—
Oh, they acted awful mean!
But one thing saves the day, my Lord!
Our records can declare,
That though we didn't get a Quad,
The U. S. number's there.

Due to the great number of vehicle makes represented, and to the shortage of spare parts, it was not possible to develop a system of automatic supply of parts to the organizations of the army, but all supplies were issued only upon requisitions, which were forwarded through the C. M. T. O. of the army to the spare part depot at Langres. Such of the parts called for as were available were for a time forwarded direct to divisions by truck from the depot, but later each division was given a "drawing day" and on that day sent its own trucks to Langres. Either system would have been satisfactory had a stock of spare parts existed, though Langres was so far to the rear that the trucks were forced to make an unnecessarily long trip. After the establishment of the First Army Supply and Repair Park, spare parts for the army were forwarded to this park, where they were drawn by the organizations for whom intended.

One of the greatest handicaps in the issue of spare parts was the shortage of competent personnel in the supply division. Only 50 qualified spare parts men had arrived in the advance section by the last of October, 1918, and the few who were available were too often used for other than supply work to meet the almost continual emergencies existing through the summer. The same handicap applied equally to repair work and this at a time when great numbers of capable automotive mechanics were serving in the infantry.

Undoubtedly, however, had there been a really adequate supply of spare parts and tools from the United States, an organization, improvised perhaps, would have been effected to handle the distribution in the A. E. F. Much of this shortage was directly chargeable to the small amount of ocean tonnage allotted by the Transport Service to spare parts and supplies, in comparison to the amounts asked for. In addition there does not appear to have been very good co-operation and liaison between the motor transport headquarters in Tours and in Washington.

The automatic requisitions sent to the Chief of the Motor Transport Corps from the A. E. F., afforded ample information as early as August, 1918, as to specific serious shortages of tools and parts, but, though the system of automatics as furnished by the A. E. F. was apparently approved in Washington, orders for purchase and production in accordance therewith were not promptly placed, nor was the D. M. T. C. at Tours notified that the automatics submitted were not considered satisfactory, and that they were not being complied with. Instead, the authorities in Washington apparently developed a system of supply sets of spare parts based on the experience of the Punitive Expedition into Mexico, and forwarded a certain number of these sets for every 100 vehicles floated.

Between July and November 20,505 tons of spare parts and tools were floated out of 56,000 tons asked for, but, in spite of requisitions and protests from G. H. Q. of the A. E. F., nearly half of the tonnage floated consisted of certain solid tires and other supplies of which there already existed a stock in France sufficient to operate certain of the trucks for several years, while at the same time no attention was paid to requisitions for such supplies as Cadillac, Dodge and Ford tires, which were urgently needed.

Thousands of boxes of "supply sets" for different makes of vehicles were shipped to France, each box containing numerous kinds of spare parts on a ratio determined by experience tables prepared in the United States. The actual call for spare parts did not conform to this experience table and the result was, that to obtain certain needed parts it was necessary to open a large number of boxes to obtain a sufficient number of the particular article desired. Thus, heavy boxes had to be handled and opened, the particular part in question removed and the box closed and replaced in storage. Take for example the item of wrist pins for Packard trucks. There were five in each box, necessitating, in case 500 were required, that 100 boxes be opened for this article alone.

Another factor in the shortage of spares and tools among the combat forces of the A. E. F., lay in the development of the repair service in the S. O. S. which resulted in the first tools, accessories and parts being held at Verneuil and other points 300 miles in the rear. Few vehicles forwarded from the assembling parks had the necessary equipment of hand tools; the records show that over 20,000 vehicles were without tools.

Still another factor in the shortage of parts lay in the cumbersome purchasing system employed in the United States. Records in the War Department show that after requisitions for parts had been forwarded to the Purchase, Storage and Transport Branch of the General Staff for purchase, an average of 53 days elapsed before orders were placed with the manufacturer, and that after orders had been executed they often lay for days on the manufacturers' shipping platform, waiting for bill-of-lading.

Such a rigid system made it impossible to meet emergency demands for specific parts. As an example of this in the First Army, take the case of the Cadillac car. Three parts on this splendid machine gave trouble, these being the timing chains, the front springs and the wheel bearings. A shortage of these parts soon developed, with little or no apparent attempt made from the United States to correct the ratio of parts being shipped. As a result it became necessary to salvage from the First Army several fine cars which had nothing the matter with them excepting the lack of the above parts. Apparently, the Cadillac Motor Car Company received information as to these particular items of breakage only after the Armistice.

Any system for the supply of parts and tools for an army in the field to be effective, must be as automatic as the supply of rations, and it is apparent that it must be highly flexible to permit quickly changing the ratio of the different parts supplied to conform to actual requirements, which naturally will vary in different theatres of operations depending upon the roads and conditions of service. Further, the actual conditions governing the forwarding of parts to the various organizations require that but a single *kind* of part be shipped in each container to facilitate storage and issue, and that an adequate reserve of spares and tools be maintained in each corps and army.

This last essential is so evident as to require no discussion, and is of course to be implied wherever it affects the six preceding essentials.

The late war marked our first considerable use of gasoline driven vehicles for supply and combat purposes. With little or no previous experience to fall back on and in the confusion attending the organization of a great army in a limited period of time, it is small wonder that in both operation and maintenance much faulty practice should have developed. The real wonder is that we were able to do as well as we did. Out of the varied experience of many men, ranging from the depots in the United States to the front in France, it should now be possible, however, to develop a proper theory covering the use and upkeep of this new means of transport.

(Continued on page 518)

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Fore and Aft of the Infantry

The 6th Engineers in the American Offensives of 1918

By

Donald Bennett Adams and **Albert Eli Crane**

Former Major, 6th Engineers, U. S. A. — Former Captain, 6th Engineers, U. S. A.

[*Note.* The following contribution by Major Adams and Captain Crane represents a type of article of which we would gladly see more in this journal. As a personal experience it is most interesting, and as an account of the things that engineer troops are actually called upon to do in "open warfare," it is most instructive. The apt title chosen well epitomizes the functions of engineers in the attack.

The period covered by this account, which saw the suppression of the Marne Salient and the Meuse-Argonne Offensive, witnessed the greatest activity, the largest numbers engaged, and the most notable achievements in the history of American arms. In these great events none of the American combat divisions was more actively engaged or acquitted itself with greater credit than the 3rd Division, "The Rock of the Marne." The authors give an entertaining picture of the part played by the 6th Engineers in the operations of the division. These activities are typical of those of all engineers with the combat divisions during these great offensives.—ED.]

THE service rendered by the engineers to the combatant forces might be divided into three parts. The first would cover the immense amount of work done in the S. O. S. areas, and would include everything from the building of ports to the establishment of rest areas for the exhausted units. The second might properly include the service with forces holding "quiet" sectors—position warfare. The third would cover the service performed under active combat conditions, where positions are held momentarily. What follows is taken from personal experience in the third class of service, and of course is confined to personal point of view, perhaps limited. These experiences may be of some interest and may perhaps clarify just what will and can be done in periods of confusion, high tension, at the best never out of artillery fire, and at the worst, under rifle fire.

In the ordinary course of events there is work to be done by the engineers previous to every attack. This always includes removing every obstacle which might impede the advance of the infantry and artillery. First of all, the opportunity presented in the usual lull before the attack must be utilized to assure the successful advance of those units lying immediately behind the front line. It often happens that one of these units actually forms the attacking force. At any rate the advance of all units lying to a depth equal at least to the limit of direct hostile observation must be made easy and certain.

During the night preceding an attack all roads in the sector, leading to the front, must be made passable for transportation. Bodies of horses and men must be disposed of, shell holes must be filled, or, if the road has been mined, a new piece of road must be built around the mine, or the hole bridged. Naturally a road is always mined at a fill, making the obstacle as complete as possible and the repair as difficult as possible. On the road leading north into Fismes—on the Vesle—a fill was blown out making necessary a trestle bridge not less than 20 feet long and 15 feet high.

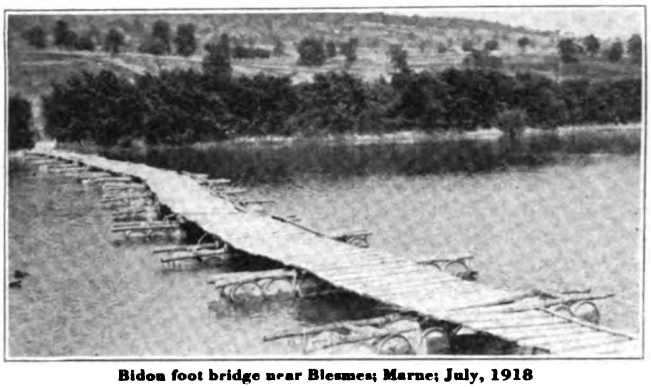
In the advance in front of the Montfaucon, in the Meuse-Argonne campaign, it was known that when the Third Division should make their advance to take over the sector, the roads would barely take care of the horse and motor transportation. The simultaneous advance of the whole division excluded the infantry and machine gun units from the roads, and furthermore, these units were to advance beyond the points where large bodies could safely move on the roads. Starting at a point back of even balloon observation, paths for each of the advancing columns were cleared through the woods by the engineers. Thus the two infantry brigade columns and machine guns, arriving at a point where to be observed was dangerous, and where speed was essential, left the road free and open for wheel transportation and, led by engineer guides, advanced quickly and safely over paths marked by tapes. This advance was particularly successful and was made under cover up to within a short distance of the front, where there existed no cover of any kind. In making the paths, all obstacles such as stones and stumps were removed, small swamps and streams were bridged, some parts strengthened with corduroy and others merely drained. The speed and ease with which the advance was made and the manner in which the hastily constructed paths came up to all requirements, proved the entire merit of the scheme and justified the effort put forth.

The engineer, in assisting the advance of the infantry and artillery, encounters the usual artificial obstacles—almost always wire, and the multitude of natural obstacles such as swamps, rivers and vegetation. It is in overcoming the latter class, under fire, that the engineer finds his biggest job.

A few days after the Boche attack on the Marne, in July, 1918, the Sixth Engineers, attached to the Third Division, were called upon to get the infantry across the river opposite Mezy. The American side of the river was fairly flat with a gentle slope starting about a mile back. The Boche side was flat for only a few hundred meters and then rose abruptly, so that machine guns above could command all operations on the river. A company was detailed to rush a foot bridge across at this point. Furnishing their own covering party, the engineers forced the Germans back from the opposite side of the river. Then a bridge of gasoline "bidons" was thrown across under machine gun fire from the slope above. A deserted Boche ponton furnished the ferry for the landing party, which anchored the bridge to the opposite shore and held off the enemy. The bridge provided the means by which the infantry could begin their advance, whereupon the engineers immediately salvaged sufficient German ponton material to construct a parallel bridge sufficient in strength to carry the infantry supply and ammunition trains. This second bridge was put in operation in about 12 hours after the infantry attack had driven the Germans from the heights. Two companies of engineers then went to work on a more permanent bridge for the supply trains. With one company working from each bank, a bridge supported by piles, cribs and trestles was completed in 70 hours. This bridge could carry live loads up to ten tons.

During the advance to the Vesle, a large amount of road repairing and bridge building was done, but the next work in front of the infantry was done at the Vesle itself.

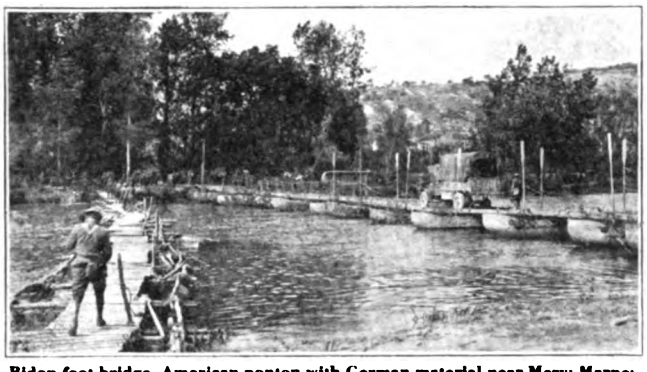
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Bidon foot bridge near Blesmes; Marne; July, 1918



German ponton wagons; Marne; July, 1918



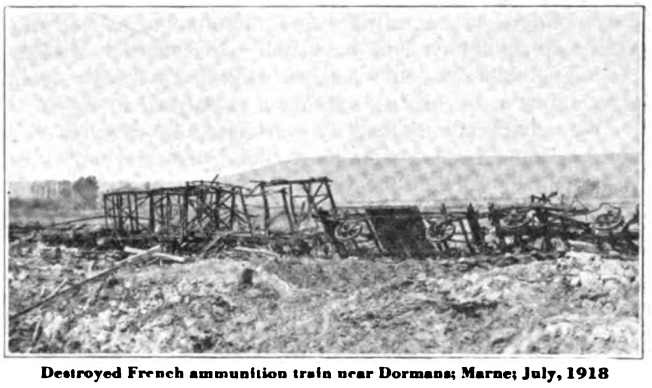
Bidon foot bridge, American ponton with German material near Mezy; Marne; July, 1918



Trestle bridge near Jaulgonne; 6th U. S. Engineers; Marne; July, 1918



Trestle and crib bridge; A Co., 6th U. S. Engrs.; near Mezy; Marne; July, 1918



Destroyed French ammunition train near Dormans; Marne; July, 1918



American ponton, German material; Jaulgonne; Marne; July, 1918



Direct hit on American tank; Meuse-Argonne; October, 1918

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The division sector extended west from Fismes, joining the French at Villette. One company was ordered to provide a means of carrying the attack across the Vesle, the river at this point being about 20 feet wide, six or eight feet deep, and sluggish with abruptly sloping banks. One day and a night were consumed in making up the material for a "bidon" bridge, and the same night a hasty reconnaissance was made of the river. The bridge, completely built, was taken into Fismes on a truck under heavy artillery fire and then carried on the shoulders of the men along the main road just back of the front line. This road had been mined and was too close to the river to be safe



German entanglements; 6th U. S. Engineers encamped in woods in background; near Madelaine Ferme; Meuse-Argonne; Oct., 1918

for transportation. The bridge was carried to a position on front line and the infantry advance to the river prepared.

Owing to the difficulty in forcing ahead the covering party of infantry, the artillery had ceased to play on the opposite bank when the advance started. First went a wave of infantrymen, instructed to lie down on the bank on each side of the chosen position for the bridge. The bridge followed on the shoulders of the engineers, who were obliged to descend into and climb out of a precipitous railroad cut which had been well wired by the Germans. In doing this rifles and helmets continually struck against the empty metal bidons, making a great deal of noise.

We advise any reader who attempts to carry a bidon bridge into No-Man's Land to build the carrying pieces long enough so that the bidons cannot possibly be struck by rifles or helmets. The clang of a helmet on an empty bidon in No-Man's Land makes more noise than a brigade of artillery in action, or at least so it seems to those carrying the bidons. But nevertheless the bridge was slipped into place in less than fifteen minutes, securely anchored to the opposite bank, and made safe for passage. A bridge guard was left, and the outfit retired without having drawn any fire.

Further reconnaissance the same night furnished an interesting experience. Advancing along an old trail which the Germans had wired on both sides, a party of five arrived at the river bank and found the supports of an old bridge still in place, but with the flooring removed. On the opposite bank, the heads of a Boche outpost could just be distinguished. Such a mark could not be passed up, so the party indulged in a little rifle and pistol practice. Naturally, all the outposts in the sector opened up and the party was fortunate in getting away unharmed. A few nights later another party attempted to plank over the bridge, but suffered several casualties in the unsuccessful attempt, due to an enemy machine gun which commanded the path. The next attempt was made in broad daylight. Concentrated fire was diverted by an infantry attack and enough planks were placed by two engineer sergeants to allow the infantry to pass, although the bridge was covered by hostile machine guns.

Another reconnaissance in this sector proved the aptness of the title "No-Man's Land." An engineer officer was given an automatic rifle party to assist him in reconnoitering an old mill site between the front lines and opposite the junction of the French and American forces. While advancing along a narrow trail, the party was fired on. The riflemen immediately sought the protection of the ground and replied briskly to the enemy's fire. The only targets were the flashes of rifles and machine guns, and no one knew whether he was firing at French, German or American. After an extravagant waste of ammunition, the party withdrew without accomplishing its mission.

As to artificial obstacles, it was found that after several days in a position, the infantry liked wire along their immediate front, feeling its protection and confidently advancing through the lanes left in the wire, especially if the lanes were widened just before the attack. On the other hand, when the infantryman is advancing daily, he does not relish the idea of advancing through strange wire. It must be remembered that the engineer soldier was fed on barbed wire, that he appreciated its full value as an obstacle to the enemy. To the infantry, wire was primarily an obstacle to their advance, since the wire best remembered by him was that of the enemy.

In the Meuse-Argonne a belt of American wire was strung across the road just north of Cunel. The infantry from the commanding officer down, were so troubled by this obstacle, that a compromise was made and a single strand of wire used. In the weeks previous to the second battle of the Marne, the engineers in one regimental sector laid out an elaborate system of entanglements. But we received no encouragement from the infantry, and when July 15th arrived the wire had only been fairly started.

Just before the battle of St. Mihiel, the Commanding General of the Third Division gave to the Sixth Engineers the problem of finding a method of passing troops quickly over or through wire. The method devised was a mat of chicken wire, which was carried in a roll and pushed out over the entanglement as a carpet. On this the infantry could pass over the wire in a column of twos. The method



Road repair work; F Co., 6th U. S. Engrs.; Haucourt; Meuse-Argonne; Oct., 1918

was developed by the infantry as a drill, but as far as we know, it was not used in an attack.

In the fall of 1918, when the effective strength of certain divisions had been diminished, it was found necessary at times to use the engineers as infantry attacking troops. Arriving at the front, prepared to consolidate a position when taken by the infantry, if the infantry has met with a reverse, the engineers must, if there is a bare possibility, take the position and consolidate it as well. Following is an example:

On October 19, 1918, two companies of the Sixth Engineers were ordered to follow the infantry in an attack on

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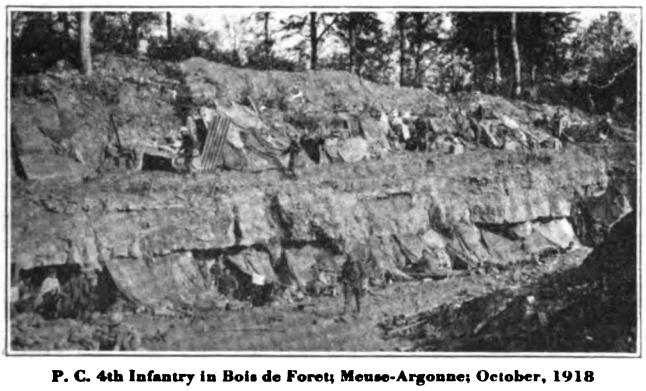
a small woods north of Cunel, the attack to take place the following morning. Fortunately the two engineer company commanders were ordered to division headquarters at the same time as the infantry officers, and were told the details of the affair.

The engineers, in their trenches as reserves, were somewhat delayed by shell fire at the start, but at two in the morning were able to draw wire, picks and shovels and to start forward. A thick mist and drizzling rain which held the gas in the woods also made the approach difficult. But finally arriving at a point about two hundred yards back of the front line, they dug in to wait for the zero hour. Shell fire was incessant, but rather few casualties resulted.

At the zero hour the engineers with their loads advanced in platoon columns and soon arrived at the jump-off trench on the edge of a small wood. Here it was found that only a handful of infantry had lived to cross the open space which lay between the jump-off trench and the objective, a long narrow wood perpendicular to the front. A half dozen of the infantry had crossed over and could be seen across the space, about fifty yards distant. The open space was covered at each end by machine gun nests, which neither the artillery barrage nor the attacking infantry had disturbed.

It was plainly "up to the engineers" to go on and try to take the wood. One company was despatched in single file at the most likely place and succeeded in crossing with few casualties, although at least one Boche machine gun was not over 75 yards away.

As soon as one platoon had crossed, it immediately advanced on the closest machine gun nests, and succeeded in cleaning them out, taking 40 prisoners. The platoon commander, Lt. Knox B. Birsey, was killed. But the crossing was made safer for the remaining men, and once over and under cover they reformed and prepared to advance into the woods. The plan of the Commanding General for the infantry was to be followed, an infantry officer who had crossed offering to bring up men to protect the flanks as the engineers went forward.



P. C. 4th Infantry in Bois de Foret; Meuse-Argonne; October, 1918

The advance of the Engineers carried them forward through the narrow wood for a distance of half a mile, in spite of a demoralizing machine gun fire directed at the woods from both sides. Part of a third engineer company had arrived in the woods, and had been rather badly used, its captain, C. D. Harris, being killed, and most of its other officers wounded.

It soon developed that the Boches, were entering the woods behind the engineers, so the line was faced to rear and the engineers fought themselves out back across the open again to the jump-off trench.

Two attempts to take the woods having failed, the engineers were ordered by the infantry regimental commander to form again, take the woods and hold it. Machine gun units were detailed to accompany the engineers and infantrymen filled out the depleted ranks of the engineers, who now formed as two companies. The reorganization had been actually carried out under machine gun fire from a point about six hundred yards distant.

Again the engineers started across the open, the first company encountering a line of Boche skirmishers. But this time the wood was taken throughout its entire length, and a heavy counter attack from the front was beaten off with the aid of the machine gunners.



Unexploded bomb; Fossoy; Marne; July, 1918

During the night the men dug in in groups of two to four at about 50-yard intervals along the edge of the wood. The following day an American advance on both sides took the commanding hills and straightened out the line. A fresh engineer company came up the second night, bringing tools, and wiring the woods against another frontal attack. Six days from the time the engineers entered the wood, the division was relieved, and went to the rear for a well-earned rest.

In general, the combatant engineer must be able to accomplish any sort of a technical job, and must be prepared to act as infantry when occasion demands. The ideal engineer company contains a large proportion of specialists, and invariably these men are the first casualties. Then new men must be developed to furnish the special details constantly required by the work at hand. A replacement who had been transferred from the infantry to the engineers gave his opinion of the sappers thus:

"Well, sir, it's like this. When I was a doughboy we would fight a little and that was very bad, but after it was over we had plenty of time to sleep and rest. Now in this engineer outfit we fought our way in here just like infantry, but now you have got us out here working like the devil all the time and we are just coaxing the Hun to shoot at us. I haven't had any time to sleep at all. Sir, I'm off the outfit, I want to go back to the infantry."

Our mission was to assist the advance of the infantry and artillery, and the measure in which we carried out the mission was limited only by our experience, ingenuity and physical ability. The engineer officer sins most who lets opportunity slip by unnoticed. He can not be smug and contented as long as one single combatant within his area is in trouble, and he must find the trouble. He must offer aid to the limit of his resources. He must anticipate situations and be ready to meet them. He must cautiously advise, and sometimes suffer for his zeal. But whether he digs an emplacement for the artillery or replaces the infantry in an attack, he must remember that in carrying out his mission he is one vital part of a huge machine, and one part which must function so well that it can be forgotten, so long as it continues to function.

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"Mad Anthony" Wayne's Campaign Against the Indians in Ohio

1792-1794

By

H. L. Robb

Captain, Corps of Engineers

[*Note.* To the general reader this exceedingly well written account will be of interest as a record of a very important epoch in our national history, and of one of the decisive battles fought on the American continent.

For the military man this little sketch literally teems with the most valuable and important military lessons. It proves that lack of preparation, carelessness and indifference are sure to meet disaster, and that proper training and discipline, thorough preparation and skillful leadership are the essentials of success.

The success of General Wayne in this campaign stamps him as a military leader of the highest rank, and entitles him to the admiration and gratitude of his country. He took his duty seriously, prepared for it thoroughly, neglected no precautions, and when he finally struck, the force of his blow was irresistible, and the results immediate and far-reaching.—ED.]

THOUGH now nearly forgotten, and given only the most casual mention by the historian, General Anthony Wayne's campaign against the Indians in Ohio, constitutes one of the most inspiring and instructive chapters in our military history. A study of it reveals the display of competent generalship, and the application of sound military principles to a difficult problem, by a leader whom we have been taught to consider a reckless fire-eater, rather than a man given to painstaking preparations and the exercise of judgment and proper caution.

The following sketch of events preceding Wayne's campaign is given for the purpose of illustrating the relation of this affair to our national history.

In 1788, the first permanent settlement in Ohio was established near the mouth of the Muskingum river by a band of settlers, under the leadership of General Rufus Putnam. Friction with the Indians ensued, and a large number of lives were lost in numerous encounters between the settlers and the Indians. The larger part of the small regular army, then consisting of about 1,200 infantry, and a battalion of artillery, poorly outfitted and poorly paid, was sent to the vicinity of the settlement for the protection of the settlers.

General Joseph Harmar, a Revolutionary officer of excellent worth, was in command of the army. Harmar led an expedition against the Indians, and was defeated with considerable loss near what is now Fort Wayne, Indiana, on October 22, 1790. Although Harmar was personally exonerated, the command of the next expedition was given to General Arthur St. Clair. Preparations were begun for another punitive expedition in September, 1791. The new expedition was organized hurriedly and moved against the Indians in October. St. Clair was taken ill, measures of security were practically neglected, the militia deserted in large numbers, and as a final blunder, an entire regiment of regulars, under the command of Colonel Hamtramck, the most efficient officer in the expedition, was detached in the face of the enemy for the purpose of capturing some of the deserters. The finish of this ill-fated adventure came on the 4th of November, 1791. The army had camped for the night in two parties, separated by a creek. The militia forces were placed in the most exposed position. At dawn the savages fell upon the militia camp, with appalling whoops and yells, combined with the efficient use of the most modern fire-arms, which had been supplied to them by the British agents. The militia broke and ran, plunging pell-mell into the assembling force on the opposite side of the creek, throwing the whole force into confusion. The Indians, in the meantime, surrounded the entire camp and from all sides poured a murderous fire in the mass.

The panic-stricken men huddled together for protection and the slaughter was terrible. St. Clair, aroused from his sick bed, though so weak that he was unable to mount a horse without assistance, dashed around trying to arouse his men. In desperation the men finally attempted to charge their enemy and fight their way out. St. Clair at the head of one of these charges finally opened a gap through which the survivors poured in haste. The Indians were too busy pillaging the camp to pursue them far, and thus out of a total of about 1,400 engaged, 600 escaped, leaving 800 dead and wounded to the mercy of the savages.

The government was badly demoralized by St. Clair's defeat. The United States would have been glad to make peace with the Indians on almost any honorable terms. The nation was very poor and loath to undertake the heavy expenditure required for a real campaign. There was little national glory to be won even by a successful Indian war, and another defeat would have been a serious disaster. Every effort was therefore made to conciliate the savages but they, encouraged and supported by the British agents in Ohio, maintained a scornful and hostile attitude.

In the meantime Congress was persuaded to authorize an increase of the army, and money was provided for a new expedition, the head of which was to be appointed by President Washington. A nucleus for the army existed in the remnants of St. Clair's defeated army. One entire regiment of regulars had not been engaged in the final crushing defeat, as we have seen. The officers had, however, been either killed or, like St. Clair, had resigned in disgrace.

The problem of selecting a leader for the army was therefore considered at length by Washington. Most of the prominent Revolutionary leaders were either dead or too old for such strenuous service as was involved in the coming campaign. Lee, Morgan, and Wayne, appear to have been those considered most seriously. Of Wayne, Washington has left a memorandum of his opinion. He considered Wayne "vain, susceptible to flattery, brave almost to the point of rashness," and feared that he was "no economist." Nevertheless, "Mad Anthony" was undoubtedly the man for the task. He had the record of being one of the most successful leaders of the Revolution. In addition, he had had some experience in Indian warfare.

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having led an expedition against the Creek Indians in Georgia at the close of the Revolution. He was an engineer by training, and a soldier by preference. At the time of his appointment, Wayne was about 47 years of age, and was in the prime of life, health and vigor. His personality and record were such as to inspire confidence in the men under him as well as in the country at large.

Immediately following his appointment, in April, 1792, Wayne proceeded to Pittsburgh, Pa., and established his headquarters at that place. He had made the stipulation, in accepting the commission, that he should not be required to move against the Indians until he was ready. He proposed therefore to receive recruits, and organize his force at or near Pittsburgh.

The organization authorized was one suggested by Baron Steuben, and is described in detail by General Upton in his Military Policy of the United States. Briefly, it was to be called the Legion of the United States. The legion was to be sub-divided into 4 sub-legions, each to be commanded by a brigadier-general, to have a strength of 1280 men; each sub-legion was organized into the following units:

1 troop of cavalry or dragoons.....strength	80
1 company of artillery.....strength	60
4 rifle companies, at 95 men.....strength	380
8 infantry companies, at 95 men.....strength	760
Total.....	1280

4 sub-legions at 1,280 men, grand total authorized, 5,120

This plan of organization was apparently carried out, but the total number of men was never more than about half that authorized, due to desertions and illness.

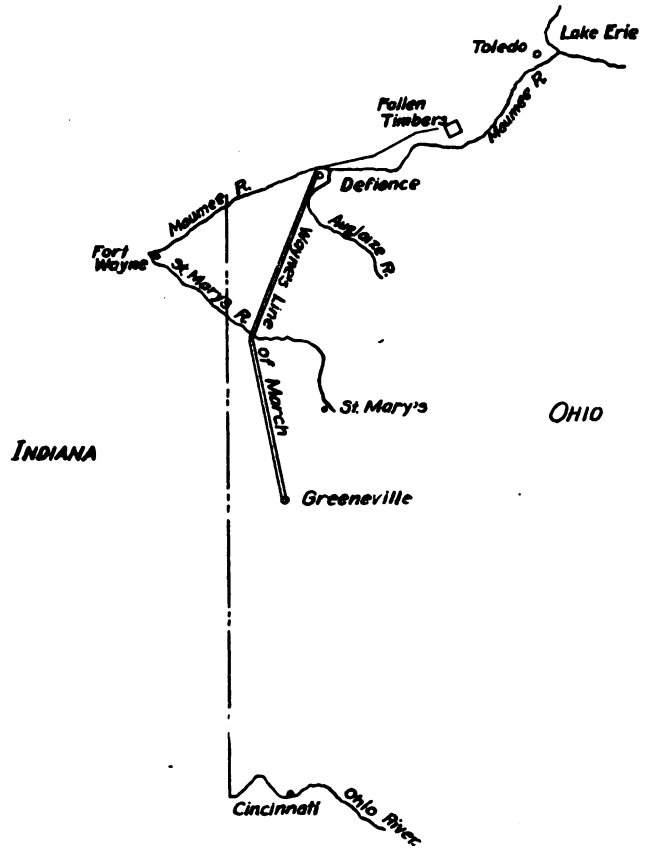
The burden of organization was at the start borne almost entirely by Wayne alone. In addition he of necessity had actually to conduct, personally, all drills both of men and officers. There is little record of the problems he faced at this time, but they must have been enormous, yet Wayne appears to have carried the burden with patience and self-confidence.

Recruits were shipped to him in large numbers, but many of them became panic-stricken as they neared Pittsburgh and deserted. Of Wayne's recruits one unfriendly observer remarks that they were "purchased from the prisons, wheel-barrows and brothels of the nation at foolishly low wages," and that taking them as a whole they were men who had "enlisted because they could no longer live unhung any other way." This estimate, undoubtedly a very harsh one, seems to be the original black eye, under which the much maligned regular soldier has suffered for many years. The problem of transforming these men into soldiers was probably as difficult a problem as any commander has had to face. Many of them were mere boys or weaklings, unaccustomed to handling the ponderous firearms of the period. Nevertheless, this group of men was gradually transformed into a disciplined army. Both officers and men grew into their tasks, and those who did not agree with the commander were eliminated from the commissioned personnel.

The points that were emphasized in this training period were: (1) the use of the rifle, (2) instruction in guard duty and (3) endless practice in charging, accompanied by blood-curdling whoops.

By March, 1793, Wayne was able to report that the morale and discipline of his command was at a high pitch. The men had acquired a confidence in themselves and their commander, which they never lost. In May, 1793, the Legion moved down the Ohio river by boat to Cincinnati, and established a camp about a mile from the city. Here they remained until October, while negotiations were being carried on by the government with the Indians in futile efforts to effect a settlement. The Secretary of War continually warned Wayne that he must be cautious and hazard nothing. This injunction was scrupulously observed by the general. His conduct and careful obedience to the governmental restrictions were not such common virtues at that time, and Wayne won the commendation of Washington, and the implicit confidence of the government by the restraint he practiced throughout the campaign.

On October 7, 1793, the Legion moved to the present site of Greenville, Ohio, where a fortified camp was constructed, and the army went into winter quarters. The



position of the Legion here was both a threat to the Indians and a protecting barrier for the settlers. During the winter, a fort was built on the site of St. Clair's defeat and called Fort Recovery. These fortifications were planned and superintended in part by Wayne himself. A sketch of the fortified camp at Greenville is shown for the purpose of illustrating how well organized the expedition was, and also to indicate somewhat of Wayne's skill as a military engineer.

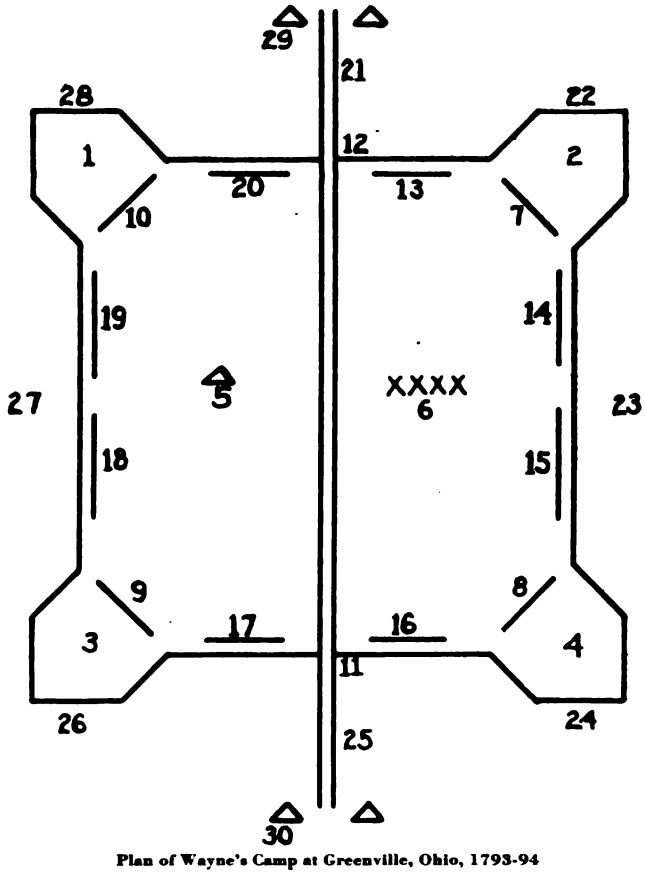
During the winter Wayne caused a number of roads to be built through the forests, leading in different directions from Greenville, for the purpose of deceiving the savages as to his intentions. The savages were in the meantime keeping a close watch on Wayne, and all his movements were reported to the British agents in Northern Ohio. On June 30, 1794, the Indians made a savage attack on Fort Recovery, but were forced to withdraw after suffering some loss.

Wayne was now preparing to move against the savages, but was delayed by lack of supplies until the latter part of July. On July 26, 1794, he was joined by Major General Scott, an old Indian fighter, in command of about 1,200 mounted Kentucky militia. A number of experi-

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enced Indian fighters and scouts had been induced to join the expedition also, and were of great service to the army.

On July 28th, the Legion left their camp at Greenville and instead of moving to the northwest towards what is now Fort Wayne, or the northeast towards Toledo, as the Indians had been induced to believe they would, a middle



Plan of Wayne's Camp at Greenville, Ohio, 1793-94

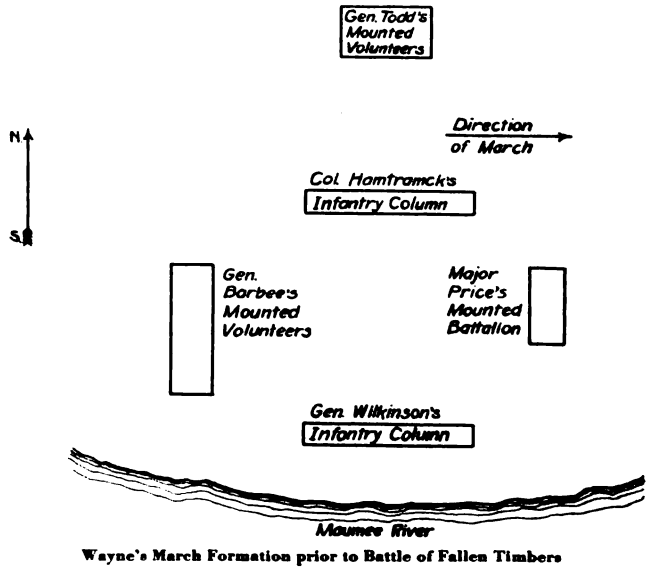
1. Lt. Massie's Bastion
2. Lt. Pop 's Bastion
3. Capt. Porter's Bastion
4. Capt. Ford's Bastion
5. Headquarters
6. Park of Artillery
7. 2nd Troop of Dragoons
8. 1st Troop of Dragoons
9. 4th Troop of Dragoons
10. 3rd Troop of Dragoons
11-12. Gateways
13-14. 3rd Sub-Legion
15-16. 1st Sub-Legion
17-18. 2nd Sub-Legion
19-20. 4th Sub-Legion
21-28. Picket Guards
29. Advance Guard
30. Rear Guard

course was chosen leading almost directly north to Defiance, Ohio. In eleven days the army marched 76 miles through a heavy forest, constructed a bridge 210 feet long across a swamp, built a fort at the crossing of the St. Mary's river, and cleared a road. Throughout the march no precaution for the safety of the command was neglected. The command marched in open order with a strong "front guard," and spies and scouts were kept well out to the front and flanks. These spies and scouts were able to capture, almost at will, individual Indians, and from the captives so made, much information was secured. Wayne was determined that he would not suffer the fate of Braddock and St. Clair. He showed his generalship by taking advantage of the services of the numerous white Indian fighters who were at home in the wilderness. On this march Wayne was severely injured by a falling tree while he was endeavoring to speed up the construction of the fort at the crossing of the St. Mary's river. He did not, however, allow his injury to delay the march for a moment. He had planned to plant himself in the heart of the Indian country before the savages knew that he had left his camp at Greenville. He did not succeed in this entirely, as a deserter gave warning of his approach, but the rapidity of his march impressed the Indians to such an extent that they nick-named him the "Whirlwind" and the "Blacksnake."

The Legion arrived at the junction of the Au Glaize and Maumee rivers on August 8th, 1794. The Indian inhabitants of the village at that point fled at the approach of the army. Here a week was spent in constructing a strong log stockade with four blockhouses as bastions. This fort was named Fort Defiance. A small garrison was left in the fort and on the 15th of August the army moved out again, marching down the north bank of the Maumee, and on the 18th, arrived at a point called Roche du Bout. The 19th was spent in constructing a rough stockade for the protection of all stores and baggage, and in making a reconnaissance of the Indian forces. The enemy was found to be encamped in a thick woods in the rear of the British fort at the rapids of the Maumee.

Wayne had previously dispatched a messenger to the Indians with a final offer of peace. This messenger returned with the answer that "if you will remain at Fort Defiance for ten days we will let you know whether we will be for peace or war." This insolent answer was not a correct representation of all the Indian sentiment. One of their most prominent chiefs, Little Turtle, called the attention of his fellow savages to the immense difference in the conduct of Wayne's expedition as compared with those of Harmar and St. Clair; he declared that "something whispered him" that the outcome of this coming encounter would be different than the previous ones had been. The hot-heads were in control, however, and Little Turtle's advice was rejected.

On the 20th of August, 1794, the Legion marched from their camp at 8 a. m. A battalion of selected men, from the mounted Kentuckians under Major Price, marched well to the front; a brigade of mounted volunteers under General Todd of the Kentucky militia, covered the left flank; the right rested on the river; and the remaining brigade of mounted men under General Barbee brought up the rear. The main body of the Legion advanced in two columns under General James Wilkinson and Colonel Hamtramck. The Legion advanced slowly throughout the forest until 11 a. m., when the advanced battalion was greeted



Wayne's March Formation prior to Battle of Fallen Timbers

with a heavy fire, thrown into confusion, and forced to retire on the main body in disorder. Wayne was prepared for just this situation, and at the sound of the first firing caused the Legion to be deployed in two lines. General Scott, with the two brigades of mounted men, was ordered to take a circuitous route and strike the enemy on their right flank; the Legionary cavalry, under Captain Camp-

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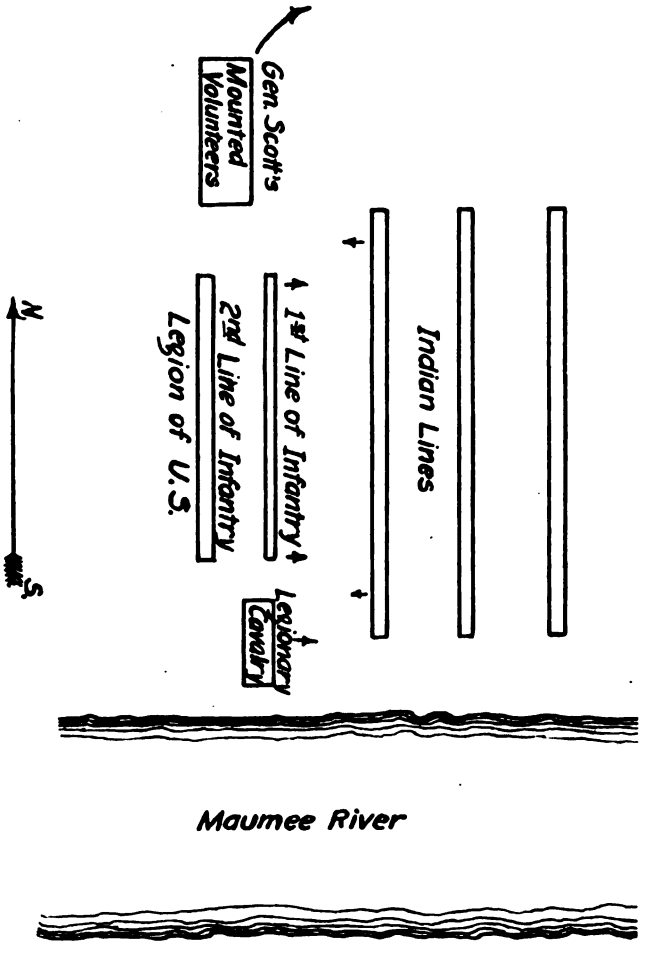
bell, was directed to charge the enemy's left. The front line of infantry was ordered to charge with rifles at the trail, and to rouse the Indians from their cover in a mass of fallen timber, at the point of the bayonet, reserving their fire until this had been done. The second line was ordered to follow and support the first.

The Indians were formed in three lines, at right angles to the river, and were well covered by a mass of fallen timber, as stated before. They directed a heavy fire on the Legionary troops while they were forming for the attack, and endeavored to repeat their tactics of the battle with St. Clair's army, when they had so successfully surrounded a force larger than their own. But Wayne was too quick for this to succeed. On the Legion's right the cavalry charged with "broad swords swinging," the horses jumping over the fallen trees, and rammed their way pell-mell into the savage ranks. In the center the front line of infantry advanced with equal impetuosity and vigor; the Indians were able to deliver only one volley before, with a shout, the soldiers were upon them. The savages broke and fled; as they fled the infantry fired at their backs; if they attempted to halt the infantry pounced upon them with the bayonet. So complete was the success of the first charge, that only the cavalry and the first line of infantry were able to take part in the actual fight. The Indians were pursued through the woods to the very walls of the British fort, where they had taken shelter. The entire action lasted only 40 minutes. Less than a thousand Americans actually took part. The number of the enemy was about 2,000, including about 400 whites, Canadians, and renegades. The American loss was 107 men killed and wounded, the enemy loss was about twice that many.

This battle was the most complete and important victory gained over the period of 40 years' warfare to which it put an end, and the only one of any importance in which the Indians lost more than their foe. The results of the battle were far-reaching; the war spirit of the Northwestern Indians was subdued, as well as growing restiveness of the many other frontier tribes in New York and in the South, who had been watching the progress of the American army in Ohio. The Indians learned that no great reliance could be placed on British protection, the superior power of America was at last made manifest to them and they came forward to sue for peace. The voice of the anti-war faction which had risen to such heights as to embitter the life of Washington, was stilled for a time. Great Britain was induced to sign a treaty confirming American rights in the Northwest.

The concluding events of Wayne's campaign are of no special military importance. He laid waste the Indian country along the Maumee, destroyed even the British agents' houses and fields up to the very walls of the British fort at the rapids of the Maumee, while the British commander was forced to look on, powerless to stop him. The army then returned to Defiance and proceeded to Fort Wayne, Indiana, where that fort was then constructed. The following summer the Indians signed a formal treaty of peace at Greenville.

The weaknesses of St. Clair's expedition are a lesson suitable for embodiment in a military primer, while the strength of Wayne is only emphasized by a statement of these weaknesses. The principal weakness or fault of the St. Clair expedition was the choice of the leader. For this Washington was largely to blame, as much as he is to be praised for the choice of Wayne. St. Clair was elderly, in poor health, had a reputation in the Revolution which, at best, indicated only mediocrity, and a propensity to failure. The poor quality of his troops was a second flaw, though under a lengthy training these same men in many cases became real soldiers. The third and principal error made, was in the presumption that an army could be organized and become effective in the short space of two months or less, which was all St. Clair was given for his task. The final massacre of St. Clair's force even then was due to the criminal lack of any measures for information and security. No scouts were sent out, no



Wayne's Formation for Battle

attempt was made to learn anything of the enemy's whereabouts, and even the camps were guarded by only a few sentinels, apparently posted close to edges of the camps.

For Wayne, we can have only admiration for his competence. He accepted the leadership of what was popularly regarded as a hopeless undertaking, and carried it through to completion and success. His success was built on the solid foundation of adequate preparation and able leadership. For the two years preceding the battle of Fallen Timbers, the Legion was undergoing a steady training in the fundamentals of the soldier's profession. From the beginning, an information and security service was in force. The aid of the frontiersmen was enlisted to keep the army informed of the doings of the savage enemy. On the march, the same measures that would be adopted today under similar circumstances, were adopted to preserve the army from ambush. When the army halted, they "dug in" and prepared to hold the objective gained. The men in ranks saw and understood all these things and by so doing, gained that intangible but priceless asset of an army, morale, without which they would have been lost, but with which they were able to crumple, at one blow, the Indian foes of the Northwest.

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Colonel Mason M. Patrick, Corps of Engineers, Appointed Chief of the Army Air Service

Col. Mason M. Patrick, Corps of Engineers, whose portrait appears as the frontispiece of this issue, was on October 4, 1921, appointed Chief of the Army Air Service, with the rank of Major General.

The appointment is a recognition of the conspicuously efficient service of General Patrick as Chief of the Air Service of the A. E. F., and will be a cause of gratification to the engineering profession generally.

Mason M. Patrick was born in West Virginia, December 13, 1863. He was appointed to the Military Academy from his native State in 1882, graduating No. 2 in class of 1886.

On graduation, General Patrick was assigned to the Corps of Engineers, in which he rose to the rank of colonel on March 24, 1916.

In his service as an officer of the Corps of Engineers, General Patrick enjoyed a widely varied experience, both civil and military, which fitted him to perform with conspicuous success the important duties which devolved upon him during the World War. At various times he served as District Engineer Officer at Norfolk, Va.; Wilmington, N. C.; Detroit, Mich.; Cincinnati, Ohio; Memphis, Tenn.; in charge of the U. S. Lake Survey; Secretary of the Mississippi River Commission; Division Engineer; raising the wreck of the *Maine;* instructor at West Point; assistant in the Office of the Chief of Engineers; Commanding Officer Post of Washington Barracks; commanding the 2d Battalion of Engineers, Chief Engineer of the Army of Cuban Pacification, commanding 1st Regiment of Engineers.

When the U. S. entered the World War, General Patrick was one of the first to proceed to France, sailing August 7, 1917, from New York, as colonel of the famous 1st Engineers, which regiment he had organized and trained.

Shortly after his arrival in France, Colonel Patrick was promoted to the rank of brigadier general. He was successively appointed to the positions of Chief Engineer of the Lines of Communication, Commanding General of the Lines of Communication, and Director of Construction and Forestry. In this latter capacity he was charged with the direction of all engineer construction in the A. E. F.

General Patrick's chief contribution to the winning of the war was as Chief of the Air Service, A. E. F., to which position he was appointed on May 29, 1918, and shortly thereafter promoted to the rank of major general. In the face of extraordinary difficulties he thoroughly reorganized the Air Service, placing it on an efficient working basis. In addition to his regular duties he served on various important boards and commissions, including the Inter-allied Aviation Committee and Munitions Council.

In recognition of his many and conspicuous services General Patrick was awarded the distinguished service medal and was likewise awarded decorations by England, France, Italy, and Belgium.

His last assignment to duty with the Corps of Engineers was as Commanding Officer of the Engineer School, U. S. Army, and the post of Camp Humphreys, Va. Since the inception of the Society of American Military Engineers, the interest and enthusiasm of General Patrick have been an important factor in its development.

Subsidence of River Banks

By

H. McL. Harding

MR. H. McL. Harding, Consulting Engineer, City of Natchez, Mississippi, has furnished a very interesting paper, of which the present article is an abstract, on the subsidence of river banks, as affecting terminal and other waterfront improvements. It is regretted that limitations of space prevent the publication of the paper in full.

After an investigation and study of waterfront conditions at a number of cities on the Mississippi and Ohio Rivers, the author concludes:

First. The river bank and levees may subside, as a consequence of the transportation of the subsoil by the flow of underground water, at points where the bank is not eroding, and even where accretion is taking place. The underground flow may be due to springs, lakes, or natural drainage.

Second. The underground water, whatever its source, on reaching a wholly or partly impervious stratum of clay or rock, may flow above this stratum in a narrow course, causing a gully in the banks or a bayou; or may spread fanwise, and convey away earth and sand, leaving voids and cavities in the soil above the impervious stratum. Supporting columns of material, which have resisted the slow moving water, may remain. There may be several impervious layers with softer material between them, and consequently separate underground streams at different elevations.

Third. When the underground flow is small, or at a great depth, a long period of time may be required to produce a marked subsidence. The earth may arch so as to prevent, for the time being, any settlement.

Fourth. A rise in the river will fill the voids and cavities with water both from the river itself and from the underground flow from the land. So long as the rise lasts, no settlement results. However, the layers of soft earth become saturated, and their weight increased. When the flood recedes, the underground flow is augmented in volume and velocity, more material is transported, the voids increase, and then comes the subsidence of the surface, gener-

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ally following a falling river stage. When the supporting earth columns or arches are slowly removed, the surface subsidence is gradual; otherwise it may be quite rapid, often several feet in twelve hours or less. Much depends on the character of the soft strata. It may be gumbo clay, which, while ordinarily resistant, becomes fluid when saturated with water, and then flows or is squeezed out.

Bank subsidence is therefore due to underground flow or drainage from the rear, either alone or in combination with water from the river discharged during a falling stage. The river water cannot be kept out of the subsoil if there is underground flow from the land. The subsidence in swamps due to subsoil movements requires a different treatment.

The author cites a case where the bank consisted of a stratum of impervious blue clay (erroneously called soapstone) overlaid with gravel, sand and marl. The blue clay stratum extended about 13 feet above local river datum, and had a depth of more than 80 feet. Above the clay was first a layer of gravel containing about 40 per cent sand, then a layer of sand, and finally of marl. The total depth of the overlying material was from 20 to 30 feet. The bank extended back from the river several hundred feet to high bluffs. Buildings and accessories of a municipal public utility occupied a frontage of about 600 feet along the river. There had been a spring flowing to the river in considerable volume through the northern end of the property, but it had been stopped by filling and revetment. The flow of underground water through the central and southern portion of the frontage, which was previously only a small seepage, then greatly increased, and the bank undermined and fell away. Various attempts were made to check the sloughing, by cinder filling, brush, concrete walls to keep out river water, etc., but with no good result. The protective works were undermined by the ground water coming from the land.

In another case, in a different locality, settlement of the levee and the land in rear of it was experienced on a frontage where a foreshore was being deposited in front of the bank, and where no erosion or sloughing of the bank was experienced. A large drain was constructed for diverting the drainage from the southern part of the city frontage to a point beyond the city limits. Since its construction there has been no change in the elevation of the levee in this section, but in the northern portion, where no drain has been provided, there is still a continual subsidence.

After giving other instances, the author recommends the following corrective measures:

First. That borings be made to determine the existence of impervious strata and their depths, and to determine the presence or absence of underground flow. These borings should be on a line in rear of the area, and on lines perpendicular to the banks at its limits. They should extend to impervious material, which is generally found at no great depth.

Second. If water is found at a reasonable distance below the surface it should be diverted by drains into the river, so that it will not flow under the area affected. The drains may be porous drain pipes with open joints, laid in broken stone. They should extend along the rear of the area to be protected, and have suitable outlets to the river.

Third. Lines of stakes, parallel and perpendicular to the river, should be set and their elevations taken to determine surface movement and subsidence.

The author explains that the above is only a general outline of the necessary procedure.

Discussion

Charles L. Potter

Colonel, Corps of Engineers

I have read with interest Mr. Harding's article and particularly his suggested method of investigation and treatment. The method of investigation is sound. His method of treatment (drainage) is good, in the cases where it can be applied. In some cases, however, it is impossible to apply such methods.

It is also not always practicable to determine that a locality needs treatment. At Helena, Ark., some years ago, a section back from the river bank subsided bodily. On this bank there is the usual bank revetment, consisting of a wide willow mat up to about low water, and a loose rock pavement above. It is true that borings would have shown an underlying stratum of sand; but the fact that the bank revetment had remained unchanged for years, would have indicated that this locality would be safe for structures of moderate weight. When the sudden subsidence occurred, there was no movement in the bank. This would indicate that the undermining occurred entirely away from the immediate bank. It is inconceivable that sand, away from the bank, could be moved toward the river and leave the bank fully supported. It was the view of the Mississippi Commission that the sand was carried away laterally and not toward the river. In this case exploration would have indicated no real danger; and treatment, if any had been undertaken, would probably not have been carried out in the right direction.

Another case, which the commission is now studying, is at Memphis. At this place the city has built a terminal at the top of a high bluff and connected by an incline with a floating barge at the river. It is not a case of locating a terminal, but of trying to save an existing structure. The river bank slopes to about high water (35 to 45 feet on the Memphis gage) where it is surmounted by a nearly vertical bluff 50 to 60 feet high. Borings at the foot of this bluff show no impervious stratum for 60 feet (30 feet above to 30 feet below the zero of the gage). It is practically all sand. Slight cavings from the bluff at high water indicated that they might be due to direct action of the river on the underlying sand. But some distance up river the Frisco tracks leading to the terminal have been damaged, and their connection with the terminal threatened, by such decided caving that it cannot be believed that it is due to the action of the river. This stratum of sand is found in wells in the lower parts of the city—quite a slope back from the bluff makes a back portion of the city lower than at the bluff—and it is invariably found to be water bearing.

Many years ago the Mississippi River Commission reveted this bank to the extent of an underwater mat. This mattress work has remained unchanged, even opposite the deep caving threatening the Frisco tracks. The sloughing occurs above low water. The upper bank paving was not added, since the low water line was nearly up to the bluff when the mats were put in. The bluff has since gradually receded until there is now a fair slope from low to high water. The commission has decided to pave the upper bank for some distance either side of the terminal with concrete, providing for carrying away of the water along the lower edge of the concrete by an open gravel-filled ditch. This, if it stands, will prevent direct action of the river on the sand stratum. If the water in the sand has not too much head (and it should not, since it is not held in any other direction so far as is known) it is believed

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Student Military Training

An Address by

The Honorable John W. Weeks
Secretary of War

Presented at Lehigh University, October 8, 1921, by Major General James G. Harbord, Deputy Chief of Staff, on behalf of the Secretary of War.

THIS is a day set apart at Lehigh University for the expression of a tribute of appreciation and gratitude to those to whom the University owes its origin and its upbuilding in the fifty-five years of its existence.

Lehigh University has been and is noted for its promotion of matters of national public service. I am therefore glad to have this opportunity to speak on the subject of Student Military Training here, because the time has now arrived when it is possible to speak of military training in the schools and colleges as a part of a comprehensive program of national defense. I am particularly glad to speak on this subject at Lehigh University because Doctor Drinker has not only been one of the pioneers in developing student military training but through his leadership he has had no small part in organizing and developing the public opinion that has finally crystallized into a settled national military policy.

In my capacity as Secretary of War I am officially disposed to emphasize the importance of student military training from the standpoint of its value to the national defense. It means an assured supply of highly intelligent reserve officers. It means that the requirements of national service are to have proper consideration in the education of our future thinkers and men of affairs. It means that a new public value is being developed in the graduates of our schools and colleges. It means a more intelligent public opinion with reference to military economics and international affairs. This alone will justify student military training in the minds of all patriotic citizens.

But student military training does not involve a sacrifice for the public good without return to the individual. It has a positive educational value for each student. Our most eminent educators have agreed that, aside from its physical benefits, time devoted to the military studies in the R. O. T. C., is fully entitled to credit in the general scheme of mental culture. The student of engineering will be a better civil engineer for some knowledge of the military applications of his profession to the nation. In subjecting themselves to the discipline which is essential to military teamwork, young men soon learn the real secret of modern civilization which depends upon the combined action of human beings to common ends.

There is also a distinct moral advantage in the contemplation of patriotic service to the nation and in preparing to meet its obligations. But perhaps the greatest benefit of military training is found in the opportunity it gives a young man to develop his gift of leadership and to acquire a sense of its responsibility. No man can prepare himself to serve his country in war without making himself more valuable for all of the relations of civil life. The student who avails himself of the opportunity offered by the military department of this University will graduate a better man for himself, for his family and for his country. He will go out better prepared for peace as well as for war.

The progress of military training in our schools and colleges is already most encouraging. At the close of the past academic year, the total enrollment in the Reserve Officers' Training Corps was 90,811. There were 227 Senior Units with 5,025 students enrolled in the Advanced Courses and 39,228 students enrolled in the Basic Courses. There were 116 Junior Units with an enrollment of 46,558. Of these Junior Units, 51 with an enrollment of 34,472 were organized in the High Schools of the country. Of the 5,025 students in the Advanced Courses, 1,069 qualified for commissions in the Officers' Reserve Corps at the close of the academic year.

I am particularly impressed by the record of Lehigh University during the past year. The total enrollment in the University's R. O. T. C. was 545. It is expected that this year's enrollment will be about 700, with at least 70 in the Advanced Courses. Lehigh sent 17 advanced students and 130 basic students to this year's R. O. T. C. Camp at Plattsburgh. I am informed that the Lehigh students had a higher average of marks than those of any other institution represented at the camp. This gave Lehigh the Efficiency Cup. The Seventh Company composed exclusively of Lehigh men was officially rated as the best company at the camp. The Eighth Company with a fifty per cent membership of Lehigh men, was rated as the second best company in the camp. The Lehigh Rifle Team won the Intercollegiate rifle match and with it the honor of representing the R. O. T. C. Units of the 1st, 2nd and 3rd Corps Areas in the National Matches at Camp Perry.

It is my good fortune to be the first Secretary of War who has been able to announce the establishment in time of peace of a national defense organization sanctioned by the Congress and defined by the President of the United States. It has always been understood that in the event of serious national emergency we would expand a small professional peace Army into a great non-professional War Army. The defect of this policy in the past has been that we have always deferred the organization of this national War Army until danger has actually come. Our new national defense law does not change the type of this traditional American institution. It simply prescribes that the defect be corrected—that our traditional Citizen Army be organized in time of peace so that the actual units which may be required upon mobilization shall be permanently constituted and localized. This is the realization of Washington's words to Congress in 1790, when

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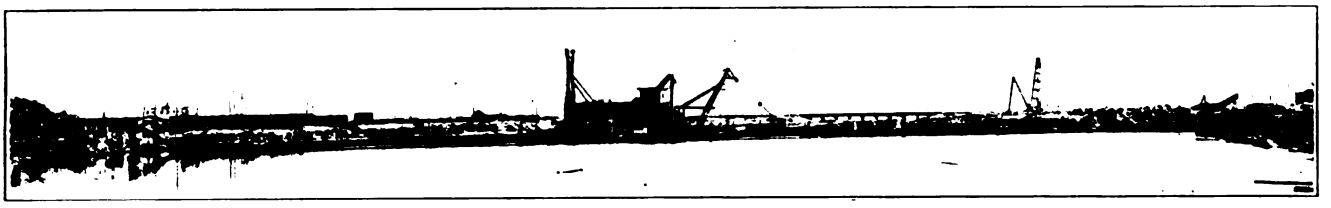


Fig. 2, 36-inch siphon assembled ready for lowering

Inverted Siphon in Sewer System

By

Burt Harmon
Captain, Engineer Reserve Corps
Formerly Junior Engineer, Engineer Department at Large

Note.—In a letter accompanying this article the U. S. District Engineer at Los Angeles (Maj. E. D. Ardery) says:
"There is enclosed an illustrated paper on a sewer siphon written by Capt. Burt Harmon, Engineer O. R. C., who, as Junior Engineer of the Engineer Department at Large, was in local charge of the Silt Diversion Works for the protection of Los Angeles and Long Beach harbors, California, and who designed and installed the necessary alterations in the Long Beach sewer system where crossed by the new river channel.
"The 36-inch siphon was installed at the same time as the 27-inch pipe, not only because the United States desired to complete its share of the work pertaining to the diversion project, but also because in heavy rains enough storm water finds its way into the sewer to exceed greatly the capacity of the 27-inch pipe, in which cases it, for brief periods, overtops the wooden partitions and uses the other pipe also
"While standard practice would indicate a minimum slope of about one per thousand for a 36-inch sewer, and perhaps one and a half per thousand for a 27-inch sewer, the 27-inch side of the siphon described above is operating successfully with a slope of about one in twelve hundred."—ED.

AN inverted sewer siphon that may be of interest to engineers by reason of its length and exceptionally flat grade was built during 1920 by the United States Engineer Department at Long Beach, Calif. The siphon, as part of an existing sewer, was made necessary by the construction of silt diversion works for the protection of Los Angeles and Long Beach harbors.

The silt diversion channel has a bottom width of 530 feet and a depth of 14 feet, with side slopes of one on one and a half. It passes through the industrial district of Long Beach and intersects several branches of the former sewer system, including the 48-inch outfall sewer to which all the others were tributary through pumping plants. To avoid unnecessary channel crossings all the smaller sewers are intercepted by a new one paralleling the channel and emptying into a sump, from which the sewage is pumped into the outfall sewer before it crosses the channel.

The problem before the designers was to provide a structure that would (1) maintain a scouring velocity with the present minimum flow in the outfall—approximately one-eighth its total capacity—and (2) be sufficiently elastic to provide for future increase in flow up to the ultimate capacity of the outfall. As the sewer is below flood height, a bridge was considered impracticable. Pumping was obviously undesirable. The only alternative was a siphon.

The siphon as constructed (Fig. 1), consists of two welded steel pipes 27 and 36 inches in diameter, laid 7 feet below the bottom of the channel. The horizontal distance between manholes is 611.4 feet, and the total length of the siphon pipes is 619.1 feet, of which 32 feet at each end is inclined (Fig. 2) on a grade of 2 horizontal to 1 vertical. The total fall is 0.50 foot. This very flat grade required that the intake be so constructed as to cause as little obstruction to the flow as possible. For this reason no gates were placed at either end of the siphon, the diversion from the 48-inch pipe to the siphon pipes being made by curved wooden partitions in the manholes.

The invert through the manhole is semicircular, and so designed that when the natural flow in the 48-inch sewer is just equal to the capacity of the 27-inch pipe under the head available, without increase by backwater, the area of the cross-section of the stream is the same at all points between the end of the 48-inch pipe and the beginning of the siphon proper. The same method was followed in designing the 36-inch side. The upper sides of the inclined pipes were prolonged into the manhole so that the floating material will enter them without colliding against a vertical wall. The discharge manhole follows the lines of the intake.



Fig. 1. Intake manhole showing siphon pipes in position prior to completion of channel bank

It is estimated that the 27-inch pipe alone will care for the increase in flow for perhaps two years without creating an undue amount of backwater in the approaching sewer. The diversion partitions will then be replaced by others already prepared to confine the flow to the 36-inch pipe, the sewage being by-passed into the channel while the change is being made. When the capacity of the 36-inch pipe shall have been reached, the second partition will be removed and the flow passed through both pipes, the capacity of the two being approximately that of the 48-inch outfall.

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The method of placing the pipes is shown in Fig. 3. The pipe was built in 50-foot sections with flange couplings. A trench was dredged across the channel, and a trestle with bents 50 feet apart driven along it. Screws 1½ inch in diameter and 18 feet in length, with the lower end bent into a hook, were placed through the caps of the trestle over the center line of each pipe. The pipe was assembled suspended by slings from these screws. It was then lowered by turning the nuts on the screws simultaneously, the pipe being filled with water from the city mains as it was submerged. When both pipes were in place, they were covered with earth to a depth of 1 foot, and the trench then filled with broken concrete to the level of the channel bottom. This fill was permitted to settle for about six weeks, when the screws were removed and the piles cut off near the top of the concrete fill, the stumps being left for additional security.



Fig. 3. 36-inch siphon being lowered

The siphon has been in operation for eleven months without either lodgment of floating matter in the manholes or indications of deposit of sediment in the pipe.

Superiority of the American Automatic Pistol

A singular corroboration of the claim that the American .45 caliber automatic pistol furnished by the Ordnance Department during the World War was far superior to similar hand weapons in use by other armies is found in two incidents related in the *Cavalry Journal* for July, 1921.

The first is a reprint from the French *Revue de Cavalerie* of May-June, 1921, in which Colonel Loir recounts an encounter between a French and a German patrol. The German patrol of six troopers under command of a commissioned officer was surprised by the French patrol and immediately abandoned its leader, hotly chased by the French patrol except for the non-commissioned officer in charge who remained behind to enter into single combat with the German officer. As the French patrol followed in pursuit of the Boche, they passed in file at a gallop in front of the German officer, and according to Colonel Loir:

The latter fired and hit three horses with three shots at a distance of 30 paces. The French non-commissioned officer, armed with his lance, galloped down upon him and charged him. The officer fired a fourth round, which left a very visible mark on the leather leggin of the non-commissioned officer, and springing aside he avoided the lance. The non-commissioned officer threw his horse about and charged the second time. The officer fired a fifth round, which glanced along the thumb of the lancer's bridle hand, again bounded back, and a second time avoided the shock. With admirable obstinacy, the non-commissioned officer a third time came back to the charge. The officer fired a sixth ball, which, like the five others, found its mark and hit the horse in the point of the shoulder, passed under the skin, and lodged under the saddle, where we found it some days later. A third time he avoided the shock. Undaunted, always master of his horse, and retaining his presence of mind, the non-commissioned officer again made an about and charged for the fourth time. The German then lost his head, believed that he had no more cartridges (he had two more), turned and bolted. Naturally he was struck at once to the ground by a blow of the lance in the back.

The fate of this German officer, armed with a German pistol, who, in spite of the fact that he registered six hits out of six shots with a weapon whose efficiency he backed with his life, was eventually struck through the back with a lance is in striking contrast to the incident related by Capt. Ernest N. Harmon concerning the part played by the Second Cavalry in the St. Mihiel offensive in September, 1918. In proceeding toward Vigneulles he states:

The men were falling back to the cross-roads in good order, when suddenly a machine gun opened up on the column from a small trail leading from the main road on the right. This was on our unprotected flank. The Germans had allowed our patrols to go by and had brought their guns to the edge of the woods as the column started back. All the men opened fire on the machine-gun crew with their pistols as they passed. All rules as to flank men only firing from column of fours were forgotten. All men fired, with the effect that the crew of three men were all killed. Of course, the horses broke into a gallop. The head of the column, being without a leader, dashed past the cross-roads before an officer could get in front. A second machine gun opened fire from the left. The crew hardly fired before they were all killed by the fire of the troops as they passed. Both guns were about twenty yards off the road. The time of firing was short. However, the only reason many of our men were not killed is the fact that the aim was low as for infantry and our column was moving so fast. No commands to fire were given our men; the firing was done from a sense of self-preservation, and was effective. After this incident the men had all the confidence in the world in their pistols.—*Army Ordnance.*

Robert's Rules of Order

How many engineers know that the author of "Robert's Rules of Order" is one of their own profession, that he is a civil engineer and a retired member of the Corps of Engineers of the United States Army and at one time Chief of Engineers, holding the rank of brigadier general? This man, now in his eighty-fourth year, is living a vigorous life at his home in Oswego, N. Y. His book was published in 1876 and was immediately accepted as the standard authority on parliamentary law. The sales have increased yearly so that to date over 650,000 copies have been sold. A new book by General Robert appears this month entitled "Parliamentary Practices" and still another will be published next year called "Parliamentary Law."—*New York Times.*

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The Greek Offensive of July, 1921

By

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[NOTE.—In view of the confusing and often highly inaccurate and unreliable accounts of the Turko-Grecian War which have appeared from time to time in the public press, this informing account of an important phase of the Greek operations by an eye witness, who is also a trained soldier, will be of interest even to the non-military reader.
Major Shallenberger observes, but he also interprets that which he observes in the light of previous experiences of warfare.
We are especially gratified at his testimony as to the conduct of the troops toward prisoners and enemy civilians, proving that war may be conducted in a humane manner, and that brutality to the helpless is not essential to the success of military operations As the evidence on this point is direct and first hand, we have no reasons to doubt the truth of it.—ED.]

General Scheme of the Offensive

DURING the month of June the Greek staff had organized five regiments from reservists, who were used to replace the divisions which were holding defensive sectors and engaged in the duty of guarding the occupied area and line of communication work. The 11th Division had been withdrawn from the Ismid sector and moved to the Brusa sector, the 12th Division had been sent over from Turkish Thrace, having been relieved by two regiments of reservists. By this operation the Greek general staff had available for the offensive eleven divisions, which were organized as follows:

First Corps—
1st Division.
2d Division.

Second Corps—
5th Division.
13th Division.

Third Corps—
7th Division.
10th Division.

Northern Group—
3d Division.
11th Division.

Acting Directly Under Army Orders—
9th Division.
12th Division.
4th Division.
1st Cavalry Brigade.

Army Troops—
One Regiment of heavy artillery, 120-mm. guns.
Two groups, 6-inch howitzers.
2d, 3d and 4th squadrons aeroplanes (24 planes).
One squadron from the navy (5 planes).

Total combatant force for operations, 150,000 men, 271 guns, 29 planes.

The Turkish force opposing the Greek troops consisted of fifteen known infantry divisions, and possibly two others, plus three cavalry divisions. These were organized into five groups of three divisions each, a total combatant force of 80,000 men and about 140 guns.

The Greek plan of action had for its objective the occupation of a line beyond the railway running from Bilejik through Eske-Shehr to Afium Kara-Hissar. The Turks had so strongly fortified the defile running from Bilejik to In-Eunu that to attempt to again pass by that route was not attractive. The route through Kutahia was, therefore, decided upon. The Greeks then purposely allowed the information to leak out that they were going to march from Ushak through Kutahia or Eske-Shehr. Newspaper reporters and foreign observers found this information everywhere, so that it soon became common all through the Orient that the Greeks were going to follow this route in the next offensive. The Turks made use of this information and commenced the fortification of Kutahia, facing their fortifications to resist the movement from Ushak.

In the first days of July the Greeks announced that they were going to attack, and assembled seven divisions and the cavalry brigade at Ushak. They made no attempt at concealing them, and allowed the Turkish aviators to come over and observe and photograph them. At the same time they assembled four divisions at Brasa, which were apparently to march against In-Eunu.

On July 8, the 9th Division marched from Ushak via Gediz on Kutahia in four columns, each column made long for the purpose of deception, and the 11th and 3d Divisions commenced to march in the direction of In-Eunu. On the same date the 3d Corps, consisting of the 7th and 10th Divisions, which had been secretly moved to Southwest of Brusa, commenced to march on Kutahia by the trails passing over and to the west of Mt. Olympus. The bulk of the army, that is the remaining six divisions and the cavalry brigade, were marched in two night marches from Ushak to Toulum Bonar. During this time the Turkish aviators were not allowed to approach the Greek lines and all movement was kept secret. On July 10 the Greeks issued the first communique which announced the progress of columns moving north from Ushak and those moving east from Brasa. No mention was made of the other forces. On July 10, the 1st and 2d Corps moved north from Toulum Bonar, having as the objective the left flank of the Turkish position which they were to take by envelopment, while the 3d Corps from Brusa was to turn the Turkish right flank. On this same date the 12th and 4th Divisions marched against Afium-Kara Hissar. The cavalry brigade marched between the two forces.

It is thus seen that the operations against Kutahia were to be that of a maneuver in which the Greeks, by giving out false information, caused the Turks to take up positions which could be turned by their columns moving from unexpected directions.

It was very evident that the Greeks had carefully prepared for this offensive in every detail Whether the credit belongs to the King and the Great General Staff, headed by General Dousmanis, or to General Papoulos and his staff, is difficult to say, but every feature seemed well prepared. About 1,500 trucks had been assembled at Toulum Bonar, Ushak and Brusa which were the advance bases, to insure

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supply, also about 2,000 camels had been requisitioned, and several thousand ox-carts. The sanitary service had prepared hospitals at these three bases and sanitary trains to handle the wounded. Every department was functioning well and calmly.

The Battle of Kutahia

The troops advanced against the Kutahia defenses without much resistance until the 14th, on which date the covering troops were encountered and real fighting commenced. Before this time, however, columns marching against Afium Kara-Hissar found little resistance and occupied the town on the 13th. A small battle was fought on the 12th on the positions west of the town. When it was seen that little resistance was to be encountered the 12th Division did not enter the town, but turned at once to the north, moving in general east of the railroad. The 4th Division occupied the town and remained there because the Turks attempted to counter-attack and retake the town, but were driven off and fled to the north. After that there was little action in that sector. The cavalry brigade moved to the right of the 12th Division, and marched throughout the rest of the operations on its right flank.

On July 15, the left flank of the Turkish positions was assaulted by the 1st and 2d Corps with success, the 5th Division completely passed the flank and secured a foot-hold on a commanding position well in rear. On the 16th the Turks attempted to drive back the 5th Division by a counter attack made with three of their divisions. This counter attack was repulsed only after very severe fighting, in which the 5th Division had about a thousand casualties, but they remained masters of the position, which completely turned the left flank of the Turkish defenses. On the same day the 3d Corps, in an all-day battle, captured the positions on the Turkish right and progressed in the direction of Kutahia. The divisions in front pressed the attack only lightly. Thus on the 16th the Turk found both his flanks turned, and decided to give up the whole of the position. He commenced the retirement of his entire force in the afternoon of that day, and by midnight the last of the Turkish troops had passed out of Kutahia. The 10th Greek division entered the town the next day at noon, followed closely by the 9th Division.

As soon as it was seen that the Turkish lines had been turned, the 2d Corps received orders to change direction, and marched against Siedi Ghazi. This they commenced on the 17th.

The Turkish evacuation was extremely well executed. It was accomplished quickly and completely. Very few prisoners or matériel fell into Greek hands. The 3d Corps captured four guns, and eight guns were abandoned by the Turks during the pursuit. It is not believed that the number of prisoners taken would reach a thousand. During the 15th and 16th between 2,500 and 3,000 Turkish wounded passed through Kutahia, while probably one thousand passed by other routes. The Greek casualties in this battle amounted to a little over 3,000. Thus the battle casualties were about equal, with a slight advantage to the Greeks. However, during the retreat the Turkish soldiers took occasion to desert in great numbers. The inhabitants of Kutahia and other villages stated that this was done by wholesale. The town of Kutahia did not suffer at all from the operation.

While no decisive result was arrived at on the field of battle, a serious shock was given the morale of the Kemalist troops, for Kemal had assembled here his best divisions, which thought by reason of their strong position to stop the Greek troops. The Greeks took this position all too easily for the Turk to receive any credit in its defense, and his precipitous evacuation caused his organizations to break up, giving discontented soldiers an opportunity to run away.

The Greeks pursued the Turkish columns as rapidly as possible, but only unimportant rear-guard actions were fought until the entry into Eske-Shehr.

The Battle of Eske-Shehr

On the afternoon of July 19, the Greek 3d Corps moved to the attack of the position in front of Eske-Shehr, but found it unoccupied and entered the city that night at 8 [illegible]. The town of In-Eunu was occupied that afternoon [illegible] p. m. Thus the whole Turkish garrison from that [illegible] p. [illegible] gone. The inhabitants stated that they had about 4 [illegible] evacuation on July 17, the day of the fall [illegible] troops left Eske-Shehr by train at 5 district had [illegible] visions pushed on beyond commenced the eva[illegible] the city still occu- of Kutahia. The last [illegible] the two divi- p. m. the 19th. as to have

On July 20, the 7th and 10th Div[illegible] Division the city and found the hills surrounding [illegible] etween pied by the Turks, and orders were given to [illegible] ayed sions to take the heights on the following day, so [illegible] ar- a covering position. Thus on the 21st, the 10th [illegible] 0th was prepared to attack the heights east of the city, b[illegible] the railroad and the main road, but its attack was de[illegible] until the afternoon because the cavalry brigade which [illegible] rived that morning was to take part on the right of the 1[illegible] Division, and it was not yet in position for attack. The 7t[illegible] Division was awaiting the attack of the 10th Division before pushing farther up the railroad and up the Boz-Dagh. The 9th Division had been assigned to the 3d Corps as reserve, and was halted a short distance west of the city. The Greek 1st Corps had crossed the Turkoman-Dagh, and was facing the heights of the Sultan-Dagh. The Greek 2d Corps was approaching Seidi-Ghazi.

The Turks had evidently prepared to surprise the Greeks by a strong counter-offensive, hoping to entrap a large number in Eske-Shehr and roll up the balance of them in the mountainous country. The Turk had concentrated his entire force in the hills facing the Greek lines, and commenced a strong counter-offensive all along this line, between 10 and 11 o'clock on this day, July 21. The Turkish troops were disposed as follows: The 1st Division, 3d Caucasus, 11th Division and 3d Cavalry Division to the north of Eske-Shehr, at the foot of Boz-Dagh; the 24th, 4th and 41st Divisions in the hills east of Eske-Shehr; the 61st, 23d and 5th Caucasus Divisions on the Sultan-Dagh, facing west; the 12th Corps in position west of Seidi-Ghazi. The Greek staff counted two other divisions and two cavalry divisions as present, but their positions were unknown to the writer. They probably were in reserve. The strongest efforts were made against the Greek left, which the Turk hoped to envelop and cut off the retreat in the direction of In-Eunu, and against the center, which he wished to pierce, thereby cutting the only other route leading from Eske-Shehr.

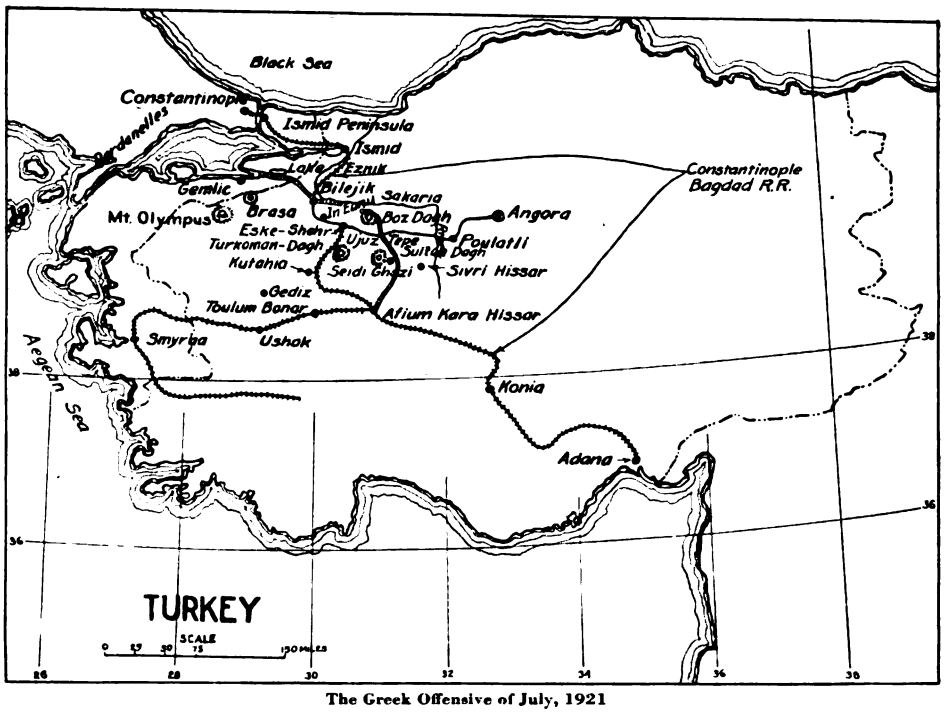
The scheme was bold, but a good one, and was a surprise to the Greeks. But the Turk unfortunately found the Greek quite ready for a fight, since they themselves were everywhere preparing to attack on that day, and consequently all troops were well in hand. The Turkish attack drove back the advanced detachments, but as soon as the Greek main forces were deployed the attack was everywhere checked and the Greeks themselves immediately took the offensive and soon had the Turks on the run. The Turk in his endeavor to push through his part of the attack had committed all of his forces to the action and when the Greeks began to push him back he seemed to have no reserves to cover his

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withdrawal. Thus late in the afternoon his lines completely gave way and his troops fled from the field in all directions and in great disorder. The Greek columns were immediately ordered to pursue, which they did all night long, so that by morning the Greeks had advanced their lines everywhere about 20 kilometers, the Turk having been unable to offer any resistance. The Greek lines were pushed forward the next day again without resistance, until present line was occupied, which was the line the Greeks wanted for the defense of that area.

The booty from this battle was considerable, 40 guns were taken, and over 5,000 prisoners. The Turkish killed and wounded were conservatively estimated at 5,000. The 23d, 41st and 3d Caucasus Divisions suffered particularly severely. The Greek cavalry brigade found occasion to charge the 41st Division, mounted, and killed over 400 with the sabre. The commander and staff of that division were captured. The Chief of Artillery of the 23d Division was captured, together with 1,500 men from that division. The Turkish 11th Division attempted to move down the railway toward Eske-Shehr and was caught in flank by the artillery fire of the Greek 10th Division, which caused the Turkish 11th Division to withdraw without playing much of a part. The Turkish troops in front of the Greek 1st and 2d Divisions suffered very heavy casualties, the extent of which is not exactly known.

The result of the whole battle was a very serious defeat for the Kemalist Army, and gave the Greeks their much-desired opportunity to deal the Kemalists a good blow. The casualties on the Greek side were comparatively light, numbering a little over a thousand in all.



The Greek Offensive of July, 1921

General Results of the Offensive

On July 23 operations ceased, leaving the Greeks in possession of a strong line about 50 kilometers to the east of Eske-Shehr. This completed the operation which had Eske-Shehr for its final objective. The Greek lines now commenced on the Sea of Marmora near Gemlik and extended to Lake Iznik-Guel and Bilejik, thence following the heights east of the railroad and crest of Boz-Dagh, crossing the railroad to Angora at Ujuz-Tepe, south along a series of heights about 140 kilometers east of Seidi-Ghazi to Afium-Kra Hissar.

The Greeks captured in all 50 guns of various calibers, a large quantity of rifles, and about 6,000 prisoners. This number will be probably increased when the final count is taken, since the number of prisoners and deserters was increasing daily and pieces of artillery were being found abandoned in various places.

The most important result was a serious blow dealt to the prestige of the Kemalist movement and to the morale of the troops. His army, which had been so much vaunted by the French and Italian press, was unable to offer any serious resistance to the Greek troops. When one considers the rapidity of the Greek advance one cannot help but admit that the Greek movement was rather brilliant. The various strongholds of the Kemalists fell in very rapid succession. For example, the real movement commenced on July 10; on July 13 Afium Kara Hissar fell; on July 17 Kutahia fell; on July 19 Eske-Shehr fell; on July 21 the entire Kemalist army was given a decisive defeat. Thus in eleven days all of the Kemalists' strongholds had fallen, and the Greek troops had made an advance of 200 kilometers by the shortest line.

The remnants of the Kemalist Army were concentrating at Sivri-Hissar and in the heights north of the railroads. The next real line of defense, which is the defense of Angora, is that of Poulatli, behind the Sakaria River. From airplane reconnaissance and other sources it would seem that Kemal has there about 40,000 men, which is what remains of his army of 80,000 at the commencement of operations.

Observations

The most striking feature of the operations was the mobility of the Greek divisions and their great marching powers. The Greek divisions were about 13,000 strong, but all of their transportation was so arranged that no roads were necessary for their advance. All of the divisional transportation was on the backs of burros, mules or camels. By this means the divisions were able to march and maneuver over mountain ranges and in places which seemed incredible; for example, the 7th Division, which became the left flank division, throughout its entire march on Eske-Shehr of over 300 kilometers by the map, but actually over 400 kilometers, never had a road worthy of the name, and many times the division would have to pass in single file over the trails. In spite of these difficulties, it was always in its place and even in advance of the line. I, myself, on July 19, saw this division advance 50 kilometers in the face of the enemy. Other divisions, such as the 12th, made remarkable records in marching, but I did not personally witness them.

It was by means of the mobility of its divisions that the Greeks were always able to envelop or out-flank the Turks, and the Turks were so fearful as to their line of retreat that the least threat at it always caused them to give way.

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Both sides evidenced good fighting qualities in battle. The Greeks always attacked with great zeal. The Turk also showed every evidence of being a very brave and clean fighter. The greatest fault of the Kemalist army was its lack of real organization. There seemed to be no bottom to it.

The artillery did not play such an important part in this operation. Only at Kutahia was the fighting in prepared positions, at all other places the fighting was in the open and was generally the fight of the infantryman. The Kemalist artillery appeared to me to shoot better than that of the Greek, but they seemed to shoot sparingly as if they did not have a plentiful supply of ammunition. Outside of Kutahia the Greek heavy artillery never arrived in time to take a real part in engagements. Artillery fighting was done with the mountain artillery, and such field artillery as would arrive in time.

The fighting seemed to conform exactly to the principles of our training before the World War. When objectives had been assigned to units plenty of initiative was allowed to the commanders. The importance of commanders being near the front was very apparent; the distances and difficulties of communication made it impossible for commanders far in the rear to take advantage of the rapidly changing situation. Only the commanders who stayed close to their troops were able to advance rapidly. This feature also showed the importance of small and active staffs with all units. Only simple orders had to be given, but they had to be given quickly and clearly. The division and corps commanders practically lived in their automobiles, and when at a halt their headquarters consisted simply of a few tables in a house or tent on which to spread out their maps and write their orders. Typewriters were practically unseen. Red tape did not exist.

In general, it may be said that the Services did their part satisfactorily. The sanitary service had to do its business in the open with simple field equipment, but seemed to be as good as could be expected; the most difficult feature was the transportation of the wounded over the long and poor roads in trucks.

The food supply was very simple, since the Greek soldier seems to get along on very little. Bread was practically the only thing they sent up from the rear. The regiments and divisions drove herds of sheep, goats and cattle behind their columns, thus bread and meat was the ration, but it seemed to be all that these soldiers required.

The ammunition service, which was handled by the artillery, was maintained from the base to the corps by trucks. Each corps and division had a large train of mules and camels which carried the reserve supply for their units. At no time were the Greeks ever lacking in the supply of ammunition, as these trains were always on the spot.

The conduct of the Greek troops toward the inhabitants and the Turkish prisoners was very proper. They had received orders at the commencement of operations to conduct themselves in that manner, and I neither saw nor heard of any cases of cruelty. Also, the conduct of the Kemalist army was as good as could be expected. The Turkish inhabitants, to my surprise, greeted the Greek troops in a very friendly and hospitable manner. They had been told that they would be massacred, and were at first frightened, but as soon as they found this was not to be the case, they seemed glad apparently of the Greek occupation, or rather they were glad that the Kemalists had gone. It seems that the Kemalist occupation had been rather severe on the Turkish as well as the Christian population. They continually were demanding money, clothes, horses, men and everything until the peasants were sick of it all. The expression of this sentiment was heard not in a few instances only, but in so many that one could not help but be convinced of its sincerity. The Greek soldiers were required to pay for everything they took, and when it was found that this was the case, all shops and stores were immediately opened, goods appeared from all manner of places, and a lively business ensued.

Neckar-Danube-Lake Constance Canal

By

Const. J. Centmaier, M. E. E. E.

Esslinger on the Neckar, Germany

THE Reichstag and simultaneously the legislative bodies of several German States have a short while ago passed bills providing for extensive appropriations for several new waterways in Germany. Among the new-planned arteries in the network of artificial watercourses the Neckar Canal will be the most important. Connecting later on the Danube and Lake Constance, it will form, after completion of the Rhone waterway through Switzerland, the missing link between East and West, North and South of Europe.

Beginning at Schwenningen in the Black Forest of Southern Germany and ending at Mannheim on the Rhine, the River Neckar is one of the principal tributaries of this large European waterway. The Neckar forms the most important stream in the State of Wurttemberg, with a total length of 225 miles (367 kilometers) and a total fall of about 2,000 feet. The first part of the canal will be from Mannheim up to Plochingen. The former is the foremost industrial and commercial center of southern Europe, the latter a very important branch point, the junction of the railway lines to Bavaria and Switzerland. The first part of the canal will be about 120 miles long (Mannheim-Plochingen by train at present approximately 140 miles) with a total fall of about 525 feet and about 26 locks. It will be built for a traffic of nearly 10 million tons per year and for vessels up to 1,200 tons capacity. The width of this waterway will be 115 feet, tapering to 88 feet in width at the bottom, at an average depth of 12 feet. The locks will be about 380 feet long, with gates 40 feet wide, so that vessels up to 2,000 tons capacity can pass in the future. For the purpose of an easy judgment of the importance of this waterway as a source of power it may be stated that the whole waterpower gained on this first part of the river will be about 100,000 horsepower and nearly 600 million kilowatt hours per year.

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The connecting link between Plochingen and Ulm on the Danube will be about 62 miles long, the section Ulm-Lake Constance about 70 miles. The crossing of the high plateau of the Suabe or Rough Alb will have a summit elevation of 1,760 feet above sea and 950 feet above the Neckar at Plochingen, to be reached by a series of locks located approximately 2 to 3 miles apart. All these locks will be in duplicate—that is, two chambers side by side. The dimensions of the locks will be the same as are planned at present for the first section. The river Lone will empty into the summit of this mountain part, aided by a pumping system near the City of Ulm. It is also planned to tap the Danube by means of an 18-mile tunnel passing through the Rough Alps, taking about 20 cubic meters per second and gaining by this method about 125 kilowatt hours yearly.

The most important towns along the first section of the canal line are Mannheim, Heidelberg, Heilbronn, Stuttgart, besides many smaller ones, Neckarsulm, Cannstatt, Ober, and Understurkheim (with the Daimler Works, manufacturers of the Mercedes automobile), Esslingen (large factories for tools and machinery, Dicks' file factory, Mueller's presses). Later on the industrial towns Goppingen, Ulm, Friedrichshafen, will fall into the canal zone. Mannheim is the most Americanized city in Europe in having streets and blocks built in American manner; it has also the biggest inland harbor in Europe. The trade and industries of the stretch from Mannheim to Ulm are second to that of the industrial and commercial center of Germany at Duisburg, Essen, etc., alone.

The Neckar-Danube-Lake Constance Canal will serve an enormous area. After completion, it will connect the North Sea with the Black Sea by means of the projected Rhone Canal, the Mediterranean with the two former. The canal, with its extensions, will then serve as a very cheap medium of transportation for the export and import of all nations of Europe and of the world.

The above data and figures convey some idea of the enormous importance and the sure coming volume of traffic flowing through this new artery and the widespread effect it will have upon the commerce between East and West, North and South.

The Neckar Canal Shares Company, a semi-public stock corporation with a capital of nearly one million marks will issue bonds with 5 per cent interest besides shares. Supported by the German nation, the three States—Wurttemberg, Baden and Hesse—the enterprise will grant the guaranty of the bonds by the nation and the three named States. As a further security the right of mortgage upon the power plants is provided for.

Up to this date the subscriptions for the capital stock show a very marked interest among industrial and commercial circles, so that the work already begun in several places will soon be carried on on a large scale.

Increased Enrollment in Engineer R. O. T. C.

The healthy growth of the Engineer Reserve Officers Training Corps is shown by the increase of 50 per cent in enrollment as compared to last year. Twenty-one units are now in operation.

	Basic	Advanced	Total
Enrollment Oct. 1, 1920	2,110	356	2,466
Enrollment Oct. 1, 1921	3,096	572	3,668
Increase over 1920	986	216	1,202

Orientation

By James A. Maher

In teaching topography to the military student the necessity for keeping himself oriented cannot be emphasized too much. Whether a command is in motion or at rest the officer in command should know his exact location at all times and he can only know this if he has kept himself oriented with relation to his point of departure. It is true that some persons have the "mule sense" highly developed but the majority need the importance of this prerequisite of movement borne in upon them by careful teaching.

It is not only necessary that the officer know his position with reference to the units in his immediate vicinity but he should know it with reference to the whole terrain.

This knowledge will enable him more quickly than anything else to grasp the import of orders that may be more or less obscure in wording, which is often the case, owing to verbosity or lack of clear expression on the part of the writer of them.

It will not answer to have himself located only with reference to the units with which he is in contact. He should have a general idea of the whole occupied terrain and a particular one of his immediate surroundings, neither of which he can get clearly in mind and fixed there without keeping himself at all times oriented. He can then more readily interpret the orders he receives and more clearly and precisely express those which it may be necessary for him to issue.

Test of Rods Grouted Into Concrete

Some tests to determine the holding power of rods grouted into concrete were recently conducted at the Georgetown Bridge, Washington, D. C., with results as tabulated below:

Depth to which grouted	*End of rod upset or plain*	*Age of grout when tested, days*	*Pressure recorded, tons*	*Bond stress per sq. in. at failure*	*Failed by*
2 ft.	Upset	11	18	424	Eye breaking
2 ft.	Plain	11	26	614	Eye breaking
2 ft.	Upset	12	36.5	861	Eye breaking
2 ft.	Plain	12	33.5	740	Rod pulling out
3 ft.	Upset	11	33.5	526	Eye breaking
3 ft.	Upset	12	44	692	Rod breaking
3 ft.	Plain	19	45	708	Eye breaking
3 ft.	Plain	19	45	708	Eye breaking
4 ft.	Upset	19	47	740	Rod breaking
4 ft.	Plain	19	47	740	Rod breaking

Rods used were 1⅛-inch diameter deformed steel, half of them with the end upset to a diameter of 1¾-inch, the other half with the end left plain. The outer end of the rod was bent into a loop, to take a 3-inch diameter shaft, and clamped with cable clamps.

Rods were grouted into horizontal holes 2½ inches in diameter with neat cement grout mixed just thin enough to permit it to run freely through a 1½-inch pipe. The pipe was withdrawn gradually as the hole was filled with grout. The rod was then pushed into place, displacing part of the grout, and the opening of the hole around the rod closed with waste. After the grout had set sufficiently, the waste was pulled out and the hole plugged with neat cement mortar.

Rods were pulled with hydraulic jacks, the pressure being indicated on the pump gage. Cable clamps did not hold as well as was expected with the result that in most cases the rod was broken in the eye by a combination of bending and direct tension. Low pressure of the first two tests was due to clamps not being drawn tight enough.

The pressure gage on the pump has been calibrated and corrected readings are given above.

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The Engineer R.O.T.C. Camp of 1921, at Camp Humphries, Va.

By

Lucius D. Clay

Captain, Corps of Engineers

On June 16 there were assembled at Camp Humphreys, Va., for the 2d Annual Encampment of the R. O. T. C., 620 engineering students, representing nineteen colleges and universities in all parts of the country.

There can be no better measure of the success of a voluntary movement such as the R. O. T. C. Camp than the increase in the number in attendance from year to year. The first of these camps was held in the summer of 1920 at Camp Humphreys. It was described in an illustrated article in THE MILITARY ENGINEER, in which the author, Capt. W. D. Styer, confidently predicted the success of the movement. This prediction was fully justified at this year's camp. That every student at the first camp went home a "booster" for the R. O. T. C. is rather plainly indicated by the gratifying increase of nearly 200 per cent in the attendance at the second camp.—ED.

THE following technical institutions had students enrolled at the camp: Massachusetts Institute of Technology, Yale University, Carnegie Institute of Technology, Virginia Military Institute, Virginia Polytechnic Institute, Alabama Polytechnic Institute, University of Alabama, University of Tennessee, University of Cincinnati, Rose Polytechnic Institute, University of West Virginia, University of Illinois, Iowa State University, Iowa State College of Agriculture and Mechanical Arts, University of Kansas, Missouri School of Mines, Colorado School of Mines, California Institute of Technology, and Oregon Agricultural College.

When the students reported to the camp, they were assigned to companies according to the number of years of military training they had received at their schools. In general, students who had completed more than two years' work at schools were assigned to Advanced Companies, while students with less training were assigned to Basic Companies. The men started reporting on June 16. The remainder of that week, consisting of three days, was devoted entirely to organization, physical examination of the men, assignment to the proper companies, fitting uniforms, issuing equipment, etc. With this accomplished, the way was paved for the actual course of instruction to start on the following Monday, free from interruption.

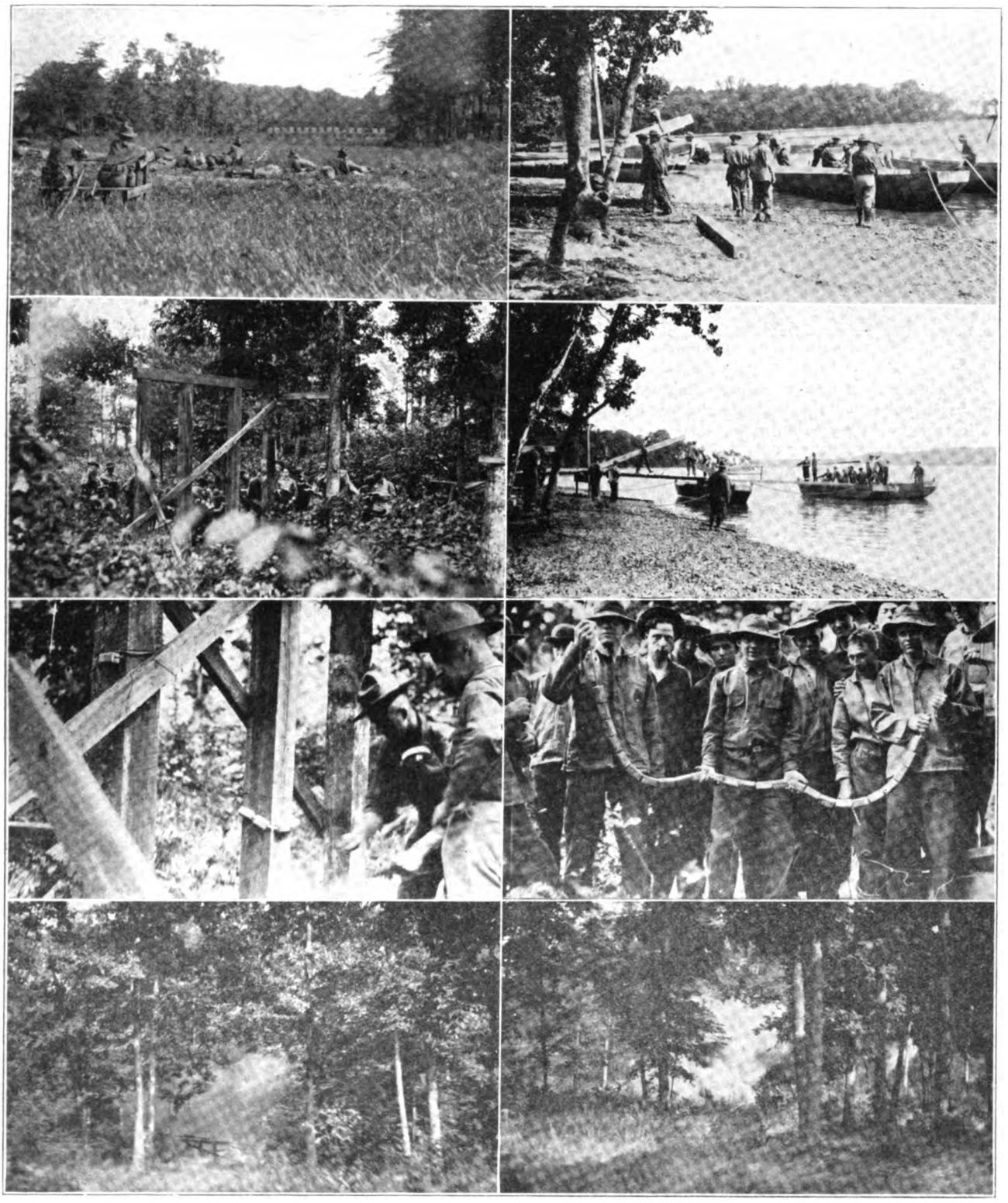
The course as originally contemplated was to be of six weeks' duration. However, due to shortage of appropriations, the actual course as given was cut to five weeks. The first week's work was devoted to the training of the infantry soldier, and also to a review of the work covered theoretically in the colleges, and practical handling of engineer equipment. This week's course was practically the same for both Basic and Advanced Companies and included infantry drill, physical training, bayonet fighting, preliminary target practice, rigging, military bridges, demolition, ponton work, and first aid. The day was divided into three periods—the first period, from 7:15 a. m. to 8:30 a. m., was devoted to infantry drill, physical training, and bayonet fighting. The second period ran from 8:45 to 11:30 a. m. and from 1:00 to 4:00 p. m. It was devoted chiefly to engineering training of a military nature. The third period was from 4:00 p. m. until taps, and was entirely at the men's disposal to use for recreational purposes. Parades were held twice a week, with daily guard mounts.

The second week of camp life saw a radical change for the Basic companies, for this week was designated for training on the range. The rifle range is located about five miles from the camp proper, and the march served as an opportunity to work in a small tactical problem. In the range camp itself, life was made as comfortable as possible in a temporary camp, in order that the minds of men would not be diverted from the range practice. The men were established in comfortable pyramidal tents and were messed in screened and covered mess halls. During this week all of the students were first required to fire the regular army preliminary or instructional course, and then to fire the regular record course. Every effort was made to teach the student not only how to handle the rifle, but also how to teach others marksmanship and confidence in the rifle. In keeping with this idea, advanced course men were developed as rapidly as possible, and instructed in the duties of a coach, and then assigned to do actual coaching on the firing line. In addition to rifle instruction and range firing, all advanced students were given instruction in the automatic pistol and allowed to fire the record course.

Men who successfully qualified in the various grades of marksmanship were later given the badges of their grade by the Camp Commander. Considering the short period of instruction available for preliminary target practice, the number of qualifications was entirely satisfactory. Nevertheless, all was not work on the range. The old Potomac backs up and winds about the camp, forming many bays and estuaries. One of these bays is sufficiently close to the range to allow swimming and boating, and, in addition, athletic contests were encouraged. At night almost every squad tent was a miniature theater—devoted to musical entertainment ranging from the plaintive tones of the violin to some deep-noted freshmen yodellers. During the week, one night was given over to an explanation and display of pyrotechnic signalling devices, while the final night was used for a night march back to the camp proper and for a night tactical problem. The advanced companies followed the basic companies to the range in two sections—the first section attending during the third week of camp and the second section during the fourth week. On the whole, the range work was satisfactory from every viewpoint. The men, having that inborn American love for the rifle, were eager for instruction, and as a result were well pleased with their week of firing on the range with service ammunition.

During the second week, while the basic companies were on the range, the advanced companies were proceeding rapidly with their infantry and engineering training. In fact, the remaining period of camp life was devoted to infantry and engineering drills with particular emphasis always placed on the methods of applying the principles of civil practice to military necessities. For the advanced

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The Range—300 yards
Demolition—How much T.'N. T.?
Demolition—Charge in position
Demolition—"There she goes"

The First Bay—Trestle in position
Laying Chess—Boats coming in
Charge for Bangalore Torpedo
The Explosion

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course, the last week was devoted to special courses in engineer terrain exercises based on fitting the students' college course in with their military training and thus improving the theoretical side of both by actual practical work.



Lampert foot-bridge—Construction



Pile-driver and hydrographic surveying party

Drills were of a varied nature, designed to insure the continued interest of the students and fresh enthusiasm of the instructors. They included instruction in infantry drill,



Students inspect rigging

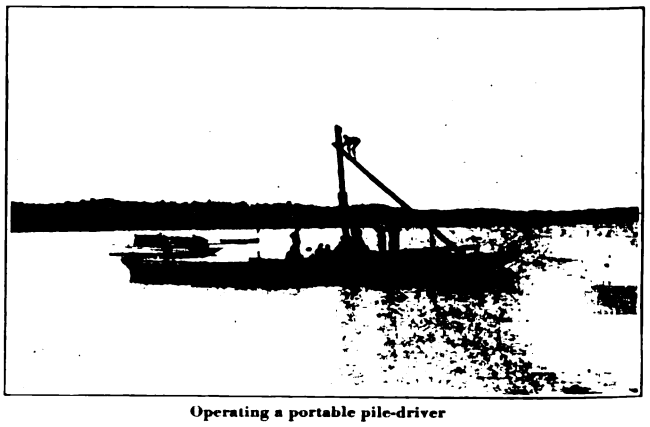


Students operating a searchlight

physical training, bayonet fighting, first aid and gas, demolitions, fortifications, rigging, bridges, mining, preliminary target practice, range firing, minor tactics, and special engineering problems. All engineering drills were given as far as possible in the form of problems, and as such called for actual solution in the field. The students were quick to see the value of such training in their own engineering study, and as a result thoroughly appreciated and enjoyed the instruction.



Bridges—Lashing spars



Operating a portable pile-driver

In both the engineering and military aspects of training, the true purpose of the R. O. T. C. to train our educated citizenship to become potential leaders in military capacities was fully recognized. To aid in securing this result, to develop leadership and initiative, advanced students were assigned to basic companies as non-commissioned officers and officers, and, whenever practicable, all parades and ceremonies were handled entirely by the students themselves.

A true appreciation of the value of the course of instruction as herein outlined can best be obtained by a resumé of its purpose. This can be expressed for this, the second engineer camp, exactly as it was expressed for the first camp, exactly as it will be expressed for all camps. Capt. W. D. Styer, C. of E., in his article in this magazine on last year's camp, well describes this purpose: "The course of instruction for the camp was planned and ar-

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ranged with the following object in view: To make the course interesting as well as instructive; to cover a maximum amount of practical work, leaving the bulk of the theoretical instruction to be covered at the institutions; to



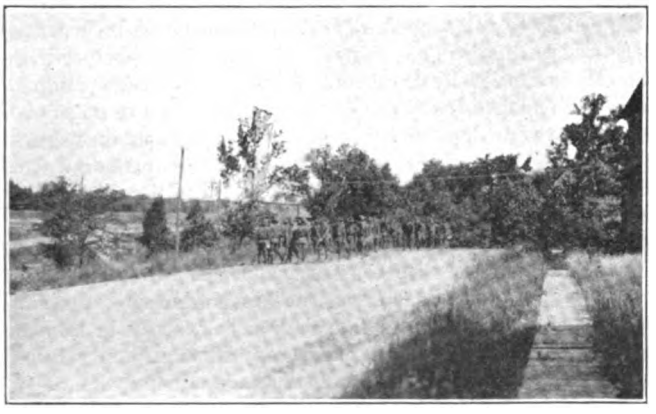
R. O. T. C. battalion parade

give instruction in phases of engineer work which, due to lack of proper facilities, cannot be handled at the institutions; to instill in each student a high sense of discipline,



As they arrived

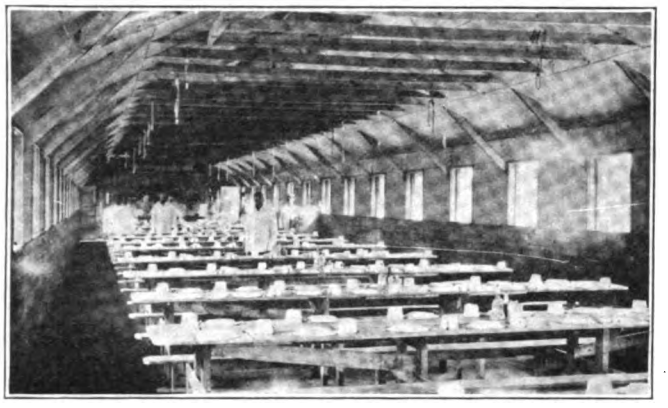
to develop qualities of leadership, initiative, and resourcefulness by placing the maximum amount of responsibility upon the individual; to teach the students to be *instructors,*



A tactical walk

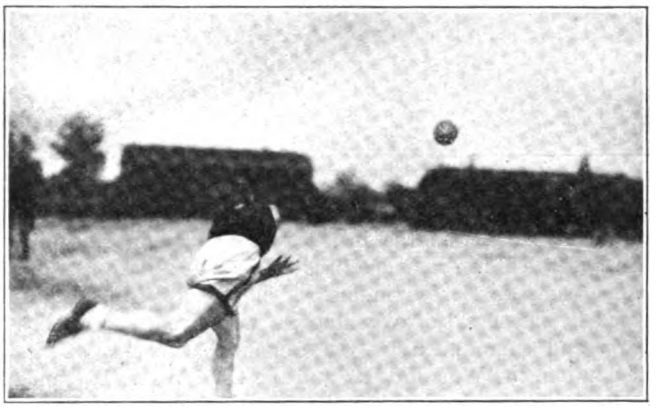
and to give practical instruction in the problems of the military engineer, the solutions of which will be of value to the student in his preparation for his future career in his chosen field of engineering." Such has been the purpose of the instruction courses at our past two summer camps, and such must always be the purpose to keep the Engineer R. O. T. C. Camp firm on the foundation it has built for itself.

The R. O. T. C. is a phase of military training of vital importance in our National Defense Policy, for it provides



A company mess hall

our potential reserve of trained officers for future emergencies. It is a voluntary course of instruction in military art given in practically all of our colleges. The attendance



Putting the shot—The track meet

at a summer camp is also voluntary until the student has decided to remain in the R. O. T. C. for his full four years of college work. Hence, if camp attendance is to be kept



Service Club—The recreation center

on the increase (and this is very important as the work in the camp is essential to round out the theoretical work at the schools), the camp must be made a pleasant memory in the minds of all attending. To secure this result the camp must be more than a success from the viewpoint of instruction given and received; it must give the student a live sum-

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mer of work and play; it must provide all varieties of recreational and athletic diversions to offset the rigid course of instruction.

Not the least of the advantages of this camp are the meeting of young men from various parts of the country, and the close association in which they find themselves. An exceptional opportunity is afforded for the interchange of ideas, and the broadening effect of contact of different minds and varying personalities.

The site of Camp Humphreys is ideally suited to the purposes of the engineer camp, both by reason of the exceptional facilities for instruction and the pleasant summer outing afforded the students in this beautiful and historic spot. Engineer officers and troops in ample numbers are



Off for a ride

available to assist in the instruction, and engineer equipment, complete in every detail, is at hand for use.

The camp is located in historic northern Virginia, hallowed by memories of Washington, who lived and worked there, and surrounded by the famous battlefields of the Revolution, the War of 1812, and the Civil War. It stands upon a plateau overlooking the beautiful Potomac River, scarcely four miles from Washington's home at Mt. Vernon, and seventeen miles (one hour by rail, water or automobile) from our Capital city, Washington, the Mecca of America. The atmosphere of such an environment is stimulating and elevating.

The advantages of frequent visits to Washington and of real use of this opportunity to see our National Government at work was impressed on the students, with the result that a large percentage of them made frequent visits to the Capital City. Then, the Fourth of July brought with it a three-day holiday over the week end, and enabled many of the men to make trips to the various beaches near Washington, or to Baltimore, to Philadelphia and New York.

Another advantage of proximity to the National Capital, the headquarters of our government, was the opportunity afforded the students to listen to the views of some of our most progressive thinkers, both within and without the service. Reviews were held for Col. M. L. Walker and Col. Mason M. Patrick, the two camp commanders, and the students were privileged to hear the views of both on the future of the R. O. T. C. Each Sunday night the Camp Theater was the scene of a "get-together" party under the influence of the Camp Chaplain. After a few minutes of devotional exercises, short addresses on interesting subjects were made by distinguished speakers. These addresses were followed by excellent picture shows. Among the most interesting addresses during the summer were a talk on the old Army by General McCaw, a talk on the American Mission in Armenia by General Harbord, and a short talk by Professor Tilden of Yale. As a final honor, the R. O. T. C. was reviewed by General Pershing, who, after the review, personally presented commissions to those men qualifying for them on the completion of the camp. General Pershing addressed the men and expressed his satisfaction with their excellent appearance and marching. In addition, he told them of his own interest in the future of the R. O. T. C. and of its real importance in the new policy of National Defense. Such visits and addresses had a most wholesome effect on the morale of the camp, as they impressed on each student how he can play his part in the general scheme of national preparedness, and also emphasized the importance of the work in the R. O. T. C.

In addition to these attractions of sightseeing, etc., every possible means of making the camp attractive to the men was utilized. Each company had a building fitted up with magazines, papers, books, games, stationery, and a piano for recreational purposes. The Camp Service Club was opened to all students, and the Officers' Club was thrown open to the advanced course men. An exchange was opened in the heart of the camp. A weekly hop was held at the Service Club under the direction of the camp hostess; girls were invited from Washington by the hostess, with such happy results that the hops were always popular and the men made many pleasant acquaintances to renew in town during the week ends. Athletic competition on a company basis was encouraged, and a variety of equipment was provided. An inter-company baseball league was soon functioning, and a camp team was organized to play the 13th Engineers. A tennis tournament, a track meet, and a swimming meet were held at various times during the camp, with suitable medals for the place winners. As many horses as were available were placed at the disposal of the students, and many used the opportunity to enjoy horseback visits to the many places of interest surrounding the camp. As a final wind-up to the recreational side of the camp, the entire personnel held a picnic on the banks of the Potomac, with swimming and boating as diversions, and on the last night each company held a farewell banquet, at which the work of the camp was reviewed and the company spirit solidified into an active campaign for next year's engineer camp.

The true success of this, the second Engineer Camp, cannot be definitely determined until the students have returned to their institutions. The spirit that they carry back with them, as developed by the campaign for next year's camp and the attendance thereat, will be the true measure of success. However, the immediate results of the camp were highly gratifying. The men were eager for instruction, willing to work, and amenable to strict discipline. They were impressed with the scope of activity of military engineering and were able to form their own ideas as to how to adapt civilian practice to military needs. In addition, they were given practical experience in engineering problems in such a way as to add to their college work in their chosen field of engineering. The camp ended in universal satisfaction, and the enthusiasm of the students who attended the second camp speaks well for possibilities of the third camp. This satisfaction was secured by the loyal cooperation of the entire personnel of the camp and because each and every student on the last day of camp could truly say that he had spent a summer with the R. O. T. C., filled with profitable work mixed in the proper ratio with plenty of social and athletic activities; that on looking back over the five weeks of military training, he could say "Well done."

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Are We Really Building An Officers' Reserve?

By

John A. Miller, Jr.
Member S. A. M. E.

[Note: If our peace time army is reduced to an inadequate maximum to cope with our next emergency, what will be our method of procuring officer personnel for that emergency? Were the expedients resorted to in 1898 and 1917 entirely satisfactory? These, and many more similar questions must present themselves, not only to the army but to the vast majority of our population. It is that majority which inevitably "pays the price." In this well considered article the writer constructively criticizes methods of the past, while recommending ways and means for the future. It should be read by every person—Regular, Reserve or Civilian—interested in the maintenance of peace.—ED.]

EVER since the years immediately following the Revolutionary War, it has been the policy of this nation in time of peace to keep a military establishment of much smaller size than would be necessary to cope with a serious emergency. But it is only recently that there has been any general interest in schemes to provide a reserve force to supplement the Regular Army in time of need. As a result of the war, however, numerous suggestions have been offered and some experiments tried along this line. It is a problem which men in all walks of life are now carefully studying, and it seems not improbable that in time a satisfactory solution will be reached. Meanwhile, a frank discussion among those who have had personal experience with different phases of the situation, may bring forth new ideas or confirm the old ones.

The problem of creating an organized army reserve has so many ramifications that a thorough understanding of the entire subject would be impossible without very long study. However, the question is susceptible of division into two major parts—the training of a reserve force of commissioned officers and the training of a body of enlisted men. By confining the discussion to the first phase of the problem, and especially to the matter of training reserve Engineer Officers, the situation may be simplified to such a point that a few definite conclusions are attainable.

Any man who has held a commission in the engineers, whether as an officer of the Regular Army or as an emergency officer, is probably more or less familiar with the methods that have been followed heretofore to create a body of reserve officers. Nearly all of the emergency men were themselves the graduates of training camps organized for that purpose. Many of the regulars have become quite conversant with the subject as instructors to the camps or through association with emergency officers during the war.

A careful and thorough analysis of the methods that have been used, and the results that have been achieved, would be of great interest and profit, and would no doubt suggest possible improvements. Such studies have in fact already done something of the sort. But the difficulty met in basing a program for the future upon a consideration of the achievements of the past is that new and radically different ideas, however good, are unlikely to be introduced.

It may be worth while, therefore, to look at the question of creating a body of reserve officers, without regard to the attempts that have already been made to solve the problem, and with particular attention to the mental process of the man to be trained. To do so it is necessary to start at the very bottom, and to consider not only the possible methods of training, but also the proper qualifications and the available resources of personnel.

To begin with, what are the requisite qualifications of a commissioned officer of engineers? They appear to be of four kinds—physical, mental, professional and military. The proper physical standard is for the medical men to decide upon. Suffice it to say that there seems to be no good reason why an officer should be expected to have a physique superior to that of his men, and it may be doubted if the policy is a wise one of rejecting for commission a man qualified in all ways except physique, and accepting the same man for service in the ranks. This happened occasionally during the recent war and probably lost to the army the service of some very capable officers.

The determination of a proper standard of mental qualification is less simple, but of even greater importance. An active mind, accustomed to the consideration of affairs, and quick in weighing relative values, is of more use in the army, as in civil life, than a mind which has become a mere storehouse of accumulated facts. Experience has shown that a poor plan well executed will often succeed, while even the best plan will certainly fail if indifferently carried out. One of the most pithy sections of the Infantry Drill Regulations says to do any intelligent thing in an emergency, but do not hesitate. An officer should be a man who can be relied upon to choose a fairly intelligent plan, and carry it out. For this is needed the ability to observe, consider, decide and execute. The basis of selection should therefore be mental training rather than specific knowledge of particular subjects.

But an engineer officer nevertheless must have a certain amount of definite information on technical subjects. The ordinary conditions of service with combat engineer troops do not demand highly specialized professional education. A general understanding of the fundamental principles of science, in combination with a mind trained to consider and apply such knowledge, is sufficient to meet the usual requirements. Probably most of the graduates of any first-rate scientific school would possess the proper mental qualifications for an engineer officer, as well as the necessary professional knowledge. The few technical graduates who might be temperamentally unfit for the work of the army could be easily eliminated, and the able practical man without scientific education could be included by careful selection.

There are undoubtedly a large number of men who have the physical, mental and professional qualifications requisite for an engineer officer. But unfortunately only a comparative few have also a considerable fund of military

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knowledge and experience. This is not acquired in any of the ordinary pursuits of life, and a special effort must be made if one would become thoroughly qualified in this particular. It may be said that the military training of reserve officers is the crux of the whole problem of organizing a supply of competent leaders for an emergency.

Starting from the assumption that in a future war the army is going to immediately require the services of a much greater number of commissioned officers than are included in the permanent military establishment, the first question then concerns the possible sources from which men can be obtained, properly qualified in the four respects just mentioned. The number who can be promoted from the ranks of the Regular Army is limited. There are not a great many enlisted men who possess the necessary mental and professional qualifications. The fact that these men sometimes lack the social polish which is expected of the commissioned officer is, of course, no argument against their selection if they are otherwise fitted. At the old army game the Regular Army non-coms are without superiors, but in the face of an unexpected and unusual situation, the rules of the game as they know it are useless to solve the problem, and the mind trained to cope with such conditions is frequently lacking. It is certainly very desirable that a man of ability in the ranks should be promoted to be an officer, but it would be folly to suppose that mere length of service will insure the necessary qualifications.

As the number of engineer officers to be obtained by promotion within the engineer service is limited, so also is the number to be had from among the emergency officers of the past war. The possibilities of the latter method depend entirely upon when the next emergency occurs, and if it be not soon, which everyone hopes it will not be, the number of former officers available will hardly be very great. It must therefore be from among the engineers in civil life without actual military experience that the largest number of leaders of the future will come.

At the present time the body of available engineers in civil life is composed of two groups, a small organized minority in the National Guard and in the Officers Reserve Corps, and a vast unorganized majority. While under existing circumstances the engineer officers of the National Guard have a good chance to practice what they may have already learned, and under the proposed army reorganization the Reserve Officers will have a similar chance to keep up to date in military matters, yet in neither case is there discernable much opportunity for a man without any experience to acquire a thorough military education. And that is the real problem, for, as has been said, the ranks of former officers cannot be depended upon to furnish sufficient experienced leaders in a future emergency. It appears, therefore, that even the organization now in existence is insufficient without a program to give satisfactory military training to men entirely devoid of it. The same program would be equally useful in training men outside of the present organized reserves.

There are two general methods now being followed to that end—the R. O. T. C. units at many colleges and universities and the summer "Plattsburg" camps. Just how successful the student courses in military training have been, and how well they will continue to function, is not easy to tell without thorough study. But experience at one camp of the Plattsburg type has convinced the writer that it is difficult, if not wholly impossible, to get in that way all the training that a man needs to be successful as an officer. It seems improbable that the university military courses are more successful.

For a man thoroughly acquainted with any subject to teach that subject to a man who knows nothing whatsoever about it is never an easy matter. It is extremely difficult for the instructor to understand, unless he has had long experience at teaching, which subjects need most emphasis. Things which he takes as a matter of course are often the hardest for the student to grasp. In considering possible ways of giving satisfactory military training to the great mass of engineers eligible to be officers in a future emergency, the mental attitude of the student is worth serious study.

To begin with, a Reserve Officer should be thoroughly familiar with infantry drill. This, however, is no great problem for an intelligent man. Engineer drill, although slightly more complicated, can be readily mastered. Administration is a less simple problem. The ways and means of administration in the army require study before they can be thoroughly understood. By diligent application, however, one may expect to get a satisfactory working knowledge of this subject, simultaneously with infantry and engineer drill.

A wide range of information that the Reserve Officer should have, however, can be got neither from books nor from the experience of an ordinary training camp. Under this head come the problems of field service—what to do if the picket line breaks at night, how heavily the escort wagons can conveniently be loaded, where to build the incinerator, and a thousand other matters, not particularly important in themselves perhaps, but in the aggregate vitally affecting the efficiency of the command. In addition there are the problems of military discipline and morale. One must know how to be a soldier, in order to understand what to demand of another soldier. One must know when and how to insist upon the rigid obedience of the very last letter of an order, and when it is better to be a little lenient. These things can be learned from no text book, and it is very difficult, if not quite impossible, to acquire such knowledge during the short period of a training camp.

A layman might think that a military education could be acquired from careful study of proper manuals, as many people, indeed, believe that a college education is gotten wholly in the classrooms. But in neither case is that the true situation. The effect of university training is not to be gauged by a puzzling questionnaire, nor is knowledge of Infantry Drill Regulations an index to a man's military ability. The least successful army officer of the writer's acquaintance was letter perfect in text-book learning. Those who have been in the army know that a part, at least, of military training must be absorbed from experience, and that for men without any experience a special solution of the problem must be found. Reserve Officers, unused to the details of army life in the field, must be equipped with sufficient knowledge to cope with the situations that are sure to arise. Increasing the duration of the annual training period is not the answer. If this were possible it might produce the desired result, but obviously men engaged in civil professions cannot spare a long time every summer.

But if the mountain cannot come to Mohammed, Mohammed must go to the mountain. The army must go to the engineer who is unable to get away from his business, and must give him a chance to become familiar with its workings without interruption to his daily tasks. This the Regular Army cannot do, but the National Guard can and should offer an opportunity for a man to get sound practical military experience. At first thought one may see huge obstacles in the way of such a plan. All the evils

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that have undoubtedly existed in this organization would be incorporated into the training of Reserve Officers, one thinks. But this need not be so. Certain units of the Guard could be specially designated as training units for officers. They should be commanded by experienced men of outstanding ability. Politics and irrelevant social considerations should be absolutely eliminated. The full performance of duties by the men would become a privilege instead of an obligation because the army would be in the position of conferring an honor upon the deserving rather than in the position of receiving the services of patriotic citizens while giving small recompense in return. The time spent in a high-grade training unit of the National Guard would be more valuable than an equal amount of time spent in a summer training camp, because experience has shown that short periods of instruction spread over a long space of time are more satisfactory than the same amount of continuous instruction. The mind fails to assimilate knowledge after a certain saturation point is reached, and an interval must be allowed for the information to be filed, so to speak, before any more teaching is done.

Moreover, in such an organization the prospective officer would have a chance to learn the intangible and indefinable things concerning the army while proceeding with the routine training. He would of course have the same chance in an officers' training camp, but in the latter instance so much has to be crammed into a short period of camp life, that the student is apt to become confused, and miss a great deal that cannot be taught directly from a text book. In the National Guard, however, he would have a chance to get his bearings after a few weeks and begin to take mental notes concerning the way things should be done. The weekly drills would serve well to keep constantly in the forefront of his mind all the detail of army life in garrison, and the occasional week-end hikes would do as much as can well be done to give field service experience. In addition there would be the same two weeks of camp in summer, and if properly conducted, this period could be quite as profitable as the two weeks now customary for Reserve Officers to spend at training camps. In fact a National Guard camp could easily be the more profitable of the two because the men, having previously mastered the minor details, would be able to receive field service instruction with a broader outlook than that of men who were trying to learn the elemental and advanced subjects simultaneously.

Let it not be supposed that such an officers' training unit of the National Guard, commanded by experienced and capable soldiers, with intelligent earnest men in the ranks, free from political or other baneful influences, is an impractical idealistic dream. Units have existed in that organization, and some continue to exist, which very closely approach the type described. From them came a great number of officers for the army in the war with Germany. The single cavalry troop in which the writer formerly served furnished nearly one hundred commissioned officers to the army in the recent emergency. The possibility of selecting some of the high class units of the National Guard as special training organizations for Reserve Officers, deserves serious consideration as one way of solving the problem to giving thorough military instruction to men qualified to be leaders in time of war.

Another method, however, is even more promising. It answers the most difficult question concerning the military training of civilians; how to give instruction and experience in the subjects which cannot be studied from books. In brief this method consists in giving temporary commissions in the Regular Army during peace time to graduates of approved colleges and universities. By this means, as by the use of the National Guard, high grade men could get some actual field service experience prior to the outbreak of war. The mountain would come to Mohammed in this case, before it became too firmly established to move.

That such a suggestion is likely to be received with limited enthusiasm in some quarters can easily be imagined, for at first glance it might appear to place on an equal footing the graduates of civil institutions of learning and graduates of the United States Military Academy. To a certain extent that might be the result, but the equality would be more superficial than real, and would be of temporary character in any event. A not dissimilar condition confronts the college graduate when he first goes to work. He finds himself no better off than men of far less technical training and scientific knowledge. It seems hardly fair that his education should have given him only equality with them. But he soon finds that the man who has missed the advantage of a college education has improved those years by gaining practical experience. Until the technical man has begun to accumulate a similar fund of experience he deserves scarcely to be on an equal footing. However, he should on account of his trained mind, be able to learn more rapidly the practical side of his business, and eventually go much farther than the untrained man is likely ever to go.

The parallel is close in the case of the graduate of the Military Academy and the ordinary college graduate. In the first place it must be admitted that a large part of a cadet's time at West Point is spent learning precisely the same things that a man learns in any good college. If a period of intensive military instruction follows immediately upon graduation from the civil institution, the man so trained compares not unfavorably in many respects with a graduate fresh from the Military Academy. Neither has the well rounded ability of an older officer, yet either should be able to handle the problems of a lieutenant. In the long run the man from West Point, because of his more thorough study of military subjects, may be expected to succeed better in the army than the man with civil education, exactly as the technical man eventually outstrips the purely practical man. This is entirely as it should be for the basis of the whole plan is that the ordinary college graduate should enter the army only temporarily before commencing in earnest his real life work.

The British Army follows a somewhat similar plan. Its success depends largely upon the careful selection of men for appointment to the army. There appears to be no reason why such an arrangement would not work satisfactorily in the United States Army. At the time a man graduates from college he often has no very clearly defined plan for his immediate future. A year or two in the army would benefit him in many ways. It would broaden his outlook upon life, as has been incontrovertibly shown by the experience of many during the last few years. It would bring him into close contact with men and ideas that he might never otherwise encounter. It should solidify the development of character and give him poise. At the termination of the period of his temporary appointment as an officer he would return to civil life richer in experience, in knowledge of human nature, and prepared at any future time to assist in the solution of the problems of a military emergency.

Nor would this plan be without profit to the army itself. It would gain for a time the services of many of the best young men of the country who do not wish to take up the profession of arms permanently. But more important

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than the mere service by which the army would profit, is the sympathy that would be gained. Unfortunately, the people have in the past understood their soldiers very poorly. Even now there is much misconception about military matters. But with a steady stream of young men going from colleges and universities into the army and later returning again to civil life, a very powerful leaven would be widely distributed throughout the population, and would inevitably produce a better understanding and closer co-operation. At the same time an invaluable reserve of trained officers would be established.

Much would depend upon the right selection of the graduates of civil institutions of learning. One doubts if the ordinary mental examination, no matter how stiff, would discriminate successfully between those adapted to such service and those who would be misfits. But the army has now become so skillful in the selection of personnel for its various activities that one may safely dismiss this as a minor detail.

Possibly the arrangement would provide more officers in time of peace than would be really needed. In that case the difficulty would be met by detailing more of the permanent officers to the War College, to staff duties, to the School of the Line at Leavenworth, or in any one of many ways that seemed desirable to the War Department. The great outstanding advantage would be that men of the best sort, already educated to be leaders, would receive a thorough fundamental military training and would be prepared to respond to the country's call in time of need, knowing the work expected of them, and able to perform it.

A very important phase of the problem of training additional army officers for an emergency must not be overlooked. Under the most favorable circumstances it will hardly be easy in war time to secure as many properly qualified men as one would wish. Rather than commission men who lack some of the important qualities, it would seem better to be extremely economical in the use of officers. By this is not meant some absurd scheme of keeping them out of danger, such as the Germans were said to have used, but simply to be careful in the assignment of officers, so that a trained mind will not be wasted upon a job that does not require it. Sometimes it seemed in France that commissioned officers were used where sergeants or corporals could have functioned with equal efficiency. There were reasons for this situation, and a thoughtful person would not waste time in criticism of faulty minor details of a gigantic undertaking so successfully conducted, unless some lesson were to be learned therefrom.

But an impartial consideration of such details may show how to avoid little mistakes another time. If the commissioned officer is a man of superior training and ability, as he should be, and usually is, the work done under his supervision ought to be more efficiently performed than work done without such supervision. When the undertaking is important, skillful superintendence is needed, but if the able executives are assigned to unimportant work, there will be a shortage when bigger jobs come along.

In order to assure the careful performance of important duties, the army has habitually insisted upon the presence of officers at certain times and places. But during the war, new conditions developed demanding additional supervision by commissioned officers. It was difficult to separate the more important work from the less important, and to distribute the available officers to the greatest advantage. Some commanders made little attempt to discriminate and used the phrase, "an officer shall be present" as a sort of formula to be included in every order. When organizations lacked a full complement of officers, it sometimes happened that literal adherence to instructions would have required the same officer to be in two or more places at one time.

The French, always keen observers of American methods, laughingly asked, "For what have you sergeants and corporals? Your officers do all the work." The training and encouragement of non-coms to supervise minor details will simultaneously increase the dignity and importance of their position, and reduce the number of commissioned officers needed. Only if this be done, will it be possible for the supply of competent Reserve Officers to fill the demands of a serious emergency.

One other phase of the situation is worthy of careful thought. If a competent force of Reserve Officers is to be built up, the men of the highest caliber in civil life must be attracted to it. There are some difficulties in the path, and it is well that they should be frankly considered. No one who served as a commissioned officer during the recent war will deny that the relations between the permanent officers and the temporary officers were sometimes not harmonious and sympathetic. Sufficient time has now elapsed, however, for one to look at the matter without the antagonism that prejudiced opinion at the time.

One understands easily the reasons why Regular Officers sometimes distrusted the Reserve Officers. A highly specialized profession was swamped by the influx of a great number of outsiders with little or no previous military experience. The time devoted to their instruction had been so short that nothing like proficiency was to be expected. Under the pressure of the emergency it was necessary to take strangers right into the bosom of the family. Such a proceeding cannot but be embarrassing for both stranger and family. To make matters worse some of the outsiders rudely abused the hospitality, even rather patronizing their hosts. This was, happily, the exception rather than the rule, but the majority suffered for the sins of the minority. At the beginning, the temporary officers were quite humble and willing to learn from their more experienced associates, the regular officers. To be told at that time how things were done in the army was what they expected. But time should have separated the objectionable ones from the many others, and the latter ought not to have continued to suffer on account of the deeds of the former. Each individual had his virtues and his shortcomings.

So it was very exasperating to a temporary officer after two years of service to be charged with all the faults ever found among his class and to be credited with only the virtues which he had personally demonstrated. It did not seem sometimes that the temporary officer was ever really accepted into the family. He was with the army but not of it, and was too often tolerated as a sort of necessary evil for the duration of the emergency. From this fundamental attitude of toleration rather than acceptance, sprang most of the incidents that bred antagonism between Reserve and Regular. Those commanders who rebuked and humiliated the junior officers in front of the men would hardly have acted in that way toward officers whom they regarded as co-workers. One single incident will serve to illustrate the point. A certain colonel, after warning his officers that the company streets were not clean enough, and finding somewhat later that a little dirt yet remained, turned out all of the commissioned officers of the regiment to be a detail that personally policed the area while the enlisted men looked and laughed. It is hard to imagine what idea lay behind this order. Certainly it was detrimental to discipline, stirred up antagonism that lasted many months, and made even more difficult for some time thereafter the not easy work of those officers. Had the

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colonel regarded his temporary officers as associates in a joint undertaking, such an incident could not have occurred.

Experience shows that the way to encourage good work is to treat the worker as a partner in the enterprise. Imagine the feeling of a Reserve Officer during the third year of his military service who was told by a Regular, "In the army, we think thus and so." Was it not clear that the permanent officer did not consider the temporary officer to be really "in the army" at all, and never would so consider him? Yet after all the army is not a thing apart, composed of beings from a different world, moving in a mysterious way. It is the army of the people, and the farmer in his field, the mechanic in the mill, and the officer at the head of his company should all have a common interest in its welfare.

No good end is now served by cherishing the memory of incidents that caused friction in the past. But it is necessary to frankly face the facts in considering how to avoid a repetition of this antagonism. No satisfactory reserve force can be built upon a foundation of toleration. The situation demands more than that. The civilian must understand that the army is composed as Kipling's soldier says of "single men in barricks, most remarkable like you," and the army must know that the civilian engineer is "most remarkable" like them.

Therein lies the great advantage of a scheme that will bring into closer contact the best minds of the every day world and the best minds of the military world. To a certain extent the method of utilizing some parts of the National Guard as training units for officers, might accomplish this object. One cannot remain out of sympathy with a vast organization of which he himself is a part. Moreover, the cost would be comparatively small and no great divergence from precedent is involved. But the desired goal would be very much more closely approached by the method of making temporary appointments to the commissioned personnel of the army from among the promising graduates of approved colleges and universities. A much more real contact would be established between the leaders in the army and the leaders in civil life. The cost would be more and the divergence from precedent greater, but the final good would be increased proportionately.

It is always difficult to estimate exactly the result that will follow the attempt to execute a new plan. One hesitates to assert that certain advantages will surely be gained. Yet by a careful analysis the probable effect can be fairly accurately forecast. This is particularly true when the analysis is made by different persons who view the situation from various angles. It is not with any assurance of success if tried, that either of the foregoing plans is suggested to solve the problem of creating a large force of reserve officers of the army, but rather they are proposed in the hope that one view of the question may suggest ideas to persons holding other views, and that a free discussion may bring forth suggestions to satisfactorily solve the question.

Counter Intelligence in the Field

By

Evarts Tracy

Lieutenant Colonel, Engineer Reserve Corps

[*Note.*—Colonel Tracy speaks with authority on the subject which is the title of this article, and what he has to say will be of interest to all our readers. He served with the A. E. F. throughout our participation in the World War, and as consulting expert on camouflage, Camouflage Officer of the First Army, and Professor of Camouflage at the Army Engineer School (A. E. F.), his activities in his chosen line covered the entire area occupied by the A. E. F., from the battle line to the base ports. His great practical knowledge of the subject, his unbounded enthusiasm and persistence, combined with tact, diplomacy and persuasiveness, were important elements in the development of an efficient camouflage service in the American Army. Colonel Tracy's interest in camouflage has not ceased with the conclusion of hostilities, as this article will show. In a few words he lays down some important practical principles for our future guidance.—ED.]

CAMOUFLAGE, French police slang signifying disguise, became during the war the most overworked word in two languages.

Mere disguise or concealment is by no means the whole of what has been called camouflage, which really is Counter Intelligence in the Field. What may be called Tactical Camouflage, which starts with map reconnaissance and ends with camouflage discipline (if it ever ends), is the most essential part of the whole work.

It has its greatest value for artillery, and the writer believed, even before the end of the war, that artillery camouflage should be entirely an artillery function, and should be taught to all officers and enlisted men just as carefully as any other branch of their work.

"Strength in a defensive battle depends essentially on the precautions taken to conceal from the eyes of the enemy all our means of fighting. The fighting means (trenches, dugouts, machine gun and battery emplacements) will *surely* be destroyed if they appear on the enemy's aerial photographs." (Signed) "General Sixt von Arnim, Commanding IV Army." So thought the Germans, as evidenced by this captured order.

"I would as lieve go into action without ammunition as without camouflage; I consider one as essential as the other," said Major General Summerall, after long experience in action.

The writer, after much discussion with artillery officers, took up the matter of instruction at field artillery camps with the Chief of Field Artillery, and with Capt. Homer St. Gaudens, E. O. R. C., volunteered to go to any of the artillery camps this summer and be of whatever service possible in conducting firing practice under war conditions from the counter intelligence standpoint.

There was, under the present conditions, no provision for giving reserve officers active duty status, but the Chief of Field Artillery issued instructions to proceed to Camp Knox and give whatever assistance was possible to the students and regular troops there.

As there were artillery R. O. T. C. students from nineteen universities for the summer camp, it was thought that the opportunity for teaching these men who would form the nucleus of the field artillery reserve in emergency, was great. Instruction was also ordered for the Basic School of Field Artillery and the regular brigade of artillery there stationed.

The instruction given consisted of: First, lectures on

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the theory and practice of counter intelligence illustrated by lantern slides from both terrestrial and aeroplane photographs taken during the war. These showed plainly both good and bad instances of concealment and the corresponding results; Second, reconnaissance and choice of positions in varying terrains and the placing of the guns, wiring of paths and approaches, overhead concealment, defiiade screens, auxiliary positions for ammunition supply, command posts, kitchens, dugouts and latrines, and most important of all, so-called "camouflage discipline."

The main points in the lectures were discussed somewhat as follows:

The first thing necessary in approaching this subject is for one to free himself from all the popular conceptions of camouflage, the spectacular stuff, scene-painting fakes, protective coloration of animals, painting guns and vehicles, etc.

After long experience, the relative values of the factors entering into successful concealment were decided as follows:

Reconnaissance and choice of position	45 per cent
Camouflage discipline	25 per cent
Correct installation of camouflage material	20 per cent
Camouflage material used	10 per cent

The main idea is to so conceal your batteries that you may damage the enemy before he damages you. If you have even an hour's advantage in this way you may do incalculable damage to the enemy.

The ultimate value of a battery is its potential power for damage to the enemy at the time of the crisis, in the hour of its mission. Personnel and matériel, if destroyed, can be replaced, but the lost hour of opportunity in battle never returns.

The choice of position is paramount. Of course a battery must be where it can fulfill its mission, but one often saw during the war, a position taken, utterly impossible of concealment, when within one hundred yards was an ideal position.

The study of aerial photographs is of the greatest importance, as well as obtaining aerial views of positions before and after occupation. If the position shows on the photo it is time to move, leaving the old one for a dummy. The French say *"Une batterie vue est une batterie perdue."*

The lens, in many respects a more perfect instrument than the human eye, is a most accurate observer. It sees everything, forgets nothing, and records every object in its exact relation to every mark on the terrain, so that the transference to the map is easy and accurate.

Always tie in your position to something which shows an irregular blotch on the photo, even if it be no more than low bushes, weeds or a patch of different colored grass.

Overhead cover is then more difficult to detect. Avoid regularity, echelon your guns at unequal distances. One spot on a photo, irregular and of slightly different color may be bushes or weeds, but four in a straight line and at equal distance simply spell Good-night.

The making of tracks when bringing up guns, approaches for personnel, and promiscuous tracks from billets, dugouts, kitchens and latrines, are the most deadly signs commonly seen about a battery, and resulted in the destruction of more positions and material than any other cause during the war.

A gun or battery itself would rarely show on an aerophoto taken under war conditions. It is the signs of occupancy which are dangerous. Tracks and blast marks are the two surest signs that a position is occupied and active.

If a road must be made where it is visible, never stop it at the position, continue it and let it lead to some logical objective such as another road, a farm, or lose itself in woods, and *keep* it open, use it at night so the enemy will not detect the fact that part of the road is not in use.

In the field work at Camp Knox a regular sergeant and four men were detailed every day, and from twenty to fifty students for the actual work on positions.

There were three positions for firing used, and at each position two batteries were placed, one under concealment and one in the open. We had, therefore, three batteries which were placed in widely varying terrain, one at the edge of some low woods, just off a road, an ideal spot, good approaches, good locations for ammunition and dugouts along the road—altogether ideal as there were many other patches of woods in the near neighborhood so that it would be impossible to know just which one to shell (a solitary patch of woods is of course suspicious *per se*).

Another position had two guns under single trees, needing no overhead cover, while the other guns of the battery were at irregular distances in patches of bushes, and were covered. All were on an existing path.

The third position was on the edge of a huge blackberry patch and all guns required cover. Blackberries were ripe, a condition very bad for track discipline. I had the same condition once on the other side with blueberries and in a few days we had to move the battery.

We were confronted with the entire lack of matériel for concealment. This I considered a distinct advantage in instruction as it is the most likely and usual situation in war, and it is good to show men how to take advantage of whatever may be in the surrounding country.

There were miles of old telephone wire on the ground and we set our details to bringing it in. It was not as good as No. 9 or 10 annealed, but it served the purpose of overhead framework and for wiring off paths.

The first thing done was to wire off authorized approaches, anyone going outside was disciplined.

Details were then set at work tearing down the woven wire fences from the farms on the reservation, and these made our superstructure. Natural vegetation, branches and weeds furnished the final cover. Blast marks were taken care of by low wire entanglements with branches thrown in upright. These of course had to be constantly replaced.

One man was detailed as camouflage sergeant for each battery, his duties being to preserve the camouflage discipline, replace withered foliage, tighten wire, etc., asking for a detail from the battery commander when necessary. Aerophotos were taken both before and after the positions were occupied, and no evidence of occupancy was visible on them. It is a most important principle of successful camouflage *to preserve the former appearance of the terrain.*

The men, both students and regulars, were keen on the work, and were careful to observe all necessary precautions. We had just enough violations of discipline to serve as examples, mainly ammunition wagons leaving shell-case litter at entrances to positions.

With the increasing development of aircraft, counter-intelligence in the field becomes daily more important. I have just heard it is to be made a strong point of at the French maneuvers this autumn. I believe for us, its future lies in three things:

1. Choice of position.
2. Camouflage discipline.
3. Use of natural materials.

(Continued on page 507)

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Transportation by Inland Waters in the Campaign In Mesopotamia*

By

Lt. Col. L. J. Hall, R. E.
Digest by L. E. Lyon, Major, Corps of Engineers, U. S. A.*

A WORK on river transportation in the British campaign in Mesopotamia has recently appeared in England. This book, entitled "The Inland Water Transport in Mesopotamia," compiled by Lieut. Col. L. J. Hall, of the Royal Engineers, under the direction of Brig. Gen. R. H. W. Hughes, Director of Inland Water Transport, Mesopotamia Expeditionary Force, is published by Constable and Company, Ltd., London. The volume opens with a Foreword by Maj. Gen. Sir G. F. MacMunn, Inspector General of Communications, Mesopotamia Expeditionary Force, under whose orders the Inland Water Transport operated. General MacMunn pays a high tribute to the work accomplished by the Inland Water Transport under most difficult and trying conditions. In this campaign transportation by water took on a greater importance than transportation by railroads. Ordinarily railroads dominate in transportation questions. Only rarely is a campaign undertaken in which rivers and canals present the best or the only immediate solution of the transport problems. The campaign in Mesopotamia was one of these. Lieut. Col. Hall gives a most painstaking account of the river transport operations in connection with the operations in Mesopotamia after August, 1916. Only brief reference is made to the transport operations and difficulties prior to that date, because previous to that time no distinct Inland Water Transport Service existed. The Royal Engineers brought it into being about that time. Water transport facilities had been deplorably inadequate and in an unsatisfactory state. They were becoming worse with the arrival of additional forces and the increase of distances as the troops advanced from their base at the head of the Persian Gulf. Only after persistent appeals and recitals of the difficulties encountered did the British War Office come to a realization that to keep its army in Mesopotamia supplied with the necessities of life and munitions a large and well-managed river transport service must at once be brought into being and operation. But when it did come to this realization it filled all demands made upon it and gave the officers in the field charged with that work its full support. The predicament of General Townsend, besieged at Kut, was instrumental in driving home the lesson that a poorly organized and inadequate river service made up of makeshift craft handled by inexperienced men would not suffice. It had become apparent that a large and well managed river fleet was essential to the success and even existence of the troops.

The streams utilized were the Tigris and the Euphrates, the Shatt-el-Arab and a few tributaries of these streams; principally the first-mentioned, upon which is situated the city of Bagdad. The word Mesopotamia signifies "the land between rivers," and is applied to the plain situated between the Tigris and Euphrates rivers. These two rivers have their origin in the Armenian highlands and flow in a southeasterly direction towards the Persian Gulf. They unite at Kurna (spelled Qurnah on the map), 108 miles above the Persian Gulf, where they form the Shatt-el-Arab, which empties into the north end of that gulf. Kurna is considered the head of ocean navigation.

The Mesopotamia Expeditionary Force was operating in Turkish territory. Its enemy was the Turk and its objectives were Bagdad and Mosul, and the Turkish Army. Its base was at Basra, 62 miles beyond the head of the Persian Gulf, and was approached through that gulf. The campaign was an operation in a secondary theater, but no doubt formed an important part of the larger strategical plans of the British War Office.

River transportation became dominant from the beginning. The British encountered almost no resistance up to the taking of Kurna. After the taking of Kurna, the need of additional river transport was sorely felt and became more serious and acute as the campaign advanced, notwithstanding the continual additions of plant and personnel to the river transport activities. Military operations began in 1914. An Inland Water Transport Service was not organized until August, 1916, after costly attempts at improvising such a service.

The magnitude of the river operations is shown by the following table of the river fleet in commission at various dates from the time the Inland Water Transport of the Royal Engineers took over the duty of river transportation to the date of the Armistice:

Classes of vessels	September, 1916	March 31, 1917	*Dec. 31, 1917	Nov. 11, 1918
Self-propelled vessels	138	242	358	446
Barges	134	315	585	774
Motor boats	95	187	356	414
Total	367	744	1,299	1,634

*At time of taking of Bagdad.

The personnel engaged upon the various phases of Inland Water Transport work at certain dates from December 31, 1916, to the date of the armistice, was as follows:

*This review by Major Lyon is of special interest as indicating the variety of duties which fall to the lot of the military engineer in time of war. It also indicates that inland water transportation is by no means obsolete, but still finds useful application in localities where railroad development is backward. It can frequently be placed in operation in much less time than would be required to build railroads.—ED.

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Grade	Dec. 31, 1916	Dec. 31, 1917	Nov. 11, 1918
British Officers	292	703	804
British Warrant Officers	19	51	99
British other ratings	1,445	2,277	2,596
British West Indians	427	382	392
British African or Eastern races	16,338	42,640	41,940
Total	18,521	46,053	45,831

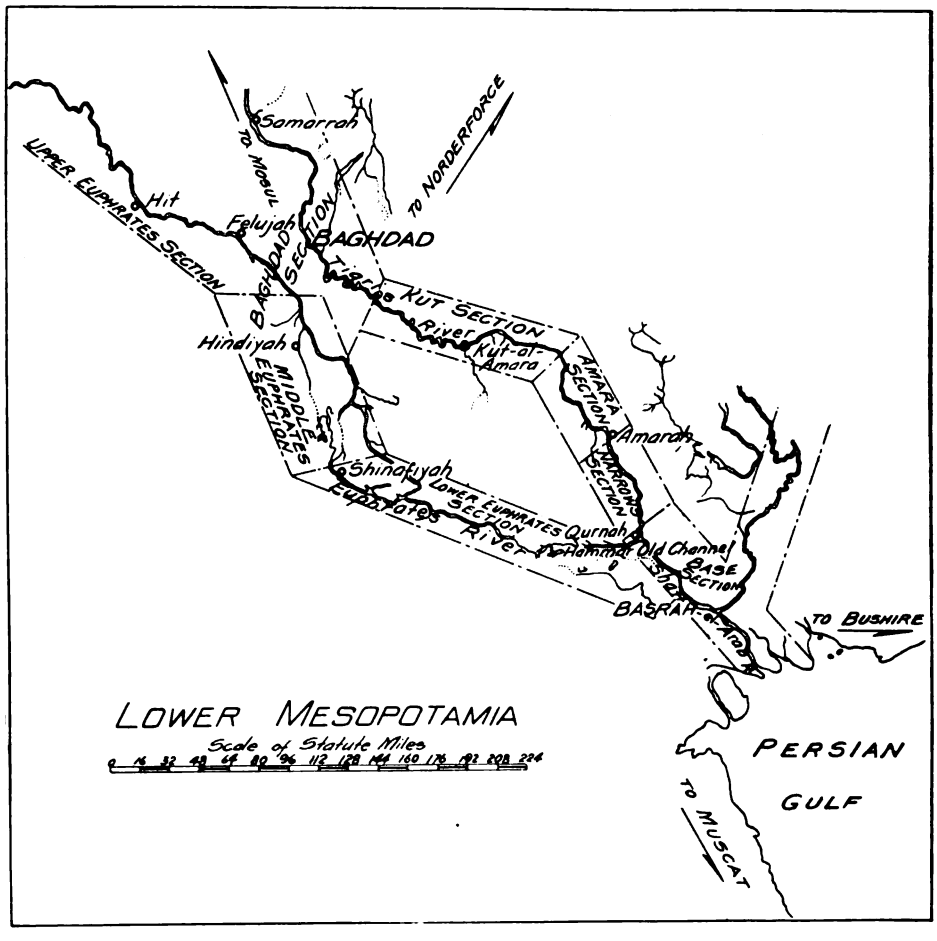
For purposes of administration, the work of the Inland Water Transport was divided into departments, all departments reporting through heads of departments to a Director. These departments consisted of Transport, Dockyards, Construction, Craft Reerection, Vessels, Marine Engineering, Accounts, Stores, Buoyage and Pilotage, Native Craft. Conservancy and Reclamation, and Personnel.

The Department of Transport was the operating department. All other departments were for the purpose of assisting it and facilitating its work. The name of each department is descriptive of the class of work upon which it was engaged.

In addition to the departmental organization described, the administration of the Inland Water Transport work was divided into geographical sections, in order to attain more direct supervision. The head of each geographical section acted in the capacity of the agent of the Director, Inland Water Transport, and also as the agent of the head of each of the departments. He was responsible to the Director, Inland Water Transport, for the satisfactory operation of all Inland Water Transport activities in his section. Officers from each department served under the section head and were responsible to him for the work belonging to their departments. At the same time these officers were responsible to their department head at Headquarters for the proper performance of their special duties.

As soon as a barge or a boat entered a section the head of the section became responsible for its prompt movement, loading or discharge in his section, and was assisted in this duty by officers from the transport and other departments. If a vessel required repairs to its machinery while in a particular section, the head of the section caused the repairs to be made through officers stationed in his section and representing the department charged with the repairs to be made. In the same way if a channel in a section required marking with buoys, the officers of the Department of Buoyage and Pilotage stationed in the section and reporting to the head of the section directed the work. The map shows the limits of the geographical sections.

The officers of the Inland Water Transport were designated by the titles of Director, Deputy Director, Assistant Director, Deputy Assistant Director, and Officers, in addition to their military rank. The Director was in command of the entire service. He was assisted by a Deputy Director and Assistant Director at his Headquarters, and a Deputy Director as Chief Engineer who was held responsible to him for all construction and engineering work. A third Deputy Director represented the Inland Water Transport at General Headquarters and directed the service's activities in the advance. The heads of departments and of sections were Assistant Directors and Deputy Assistant Directors. Officers in charge of branches of departments and of sub-sections were also designated Deputy Assistant Directors. The commissioned strength was as follows:



Director	1
Deputy Directors	3
Assistant Directors	15
Deputy Assistant Directors	36
Officers	715
Reserve	34
Total	804

The tonnage carried by the Inland Water Transport in 1916 was 117,882; in 1917, 1,231,398; and in 1918, up to the date of the armistice, 1,532,834 tons, making a total of 2,882,114 tons from the beginning of operations under the Royal Engineers to November 11, 1918.

As the campaign progressed, grave doubts arose in 1917 as to the advisability of relying entirely upon the Tigris for transportation in the low water seasons. It was feared that the river would fall to such an extent as to interrupt

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for an unduly long period the transport of supplies in the quantities required. The construction of railways paralleling the river between certain points, and also from the Tigris to the Euphrates, was decided upon. A railroad was built from Bagdad to Kut, one from Basra to Amara, another from Bagdad to the Euphrates, and some shorter lines. At no time was the territory between Kut and Amara covered by a railway, and the Inland Water Transport carried all supplies between these two points during the entire period of the British campaign and occupation.

A conception of the transport difficulties encountered by the British upon arrival in Mesopotamia may be formed from General Townshend's statement in his book entitled "My Campaign in Mesopotamia," in which he describes the territory immediately above Kurna as having the appearance of our Lake Michigan. The Tigris was in flood at that time, and the river overflowed the banks on both sides, leaving visible only islands formed by high ridges and knolls here and there. General Townshend also describes one of his first attacks upon the Turks as having been made from a large fleet of native boats prepared for the purpose. The Turks occupied high ground, and the high waters of the river cut off all approach except by boat.

The work of the Inland Water Transport in Mesopotamia differed from similar work on the Western Front in France and Belgium, in that the Mesopotamian Expeditionary Force was operating upon unimproved rivers, very distant from industrial centers and sources of supplies, while the Inland Water Transport on the Western Front was upon improved rivers and canals to which supplies could be brought from England in a few hours. In Mesopotamia the rivers were the only means of transport from the outset, and the forces to be supplied depended entirely upon the rivers for their support. On the Western Front the water transport was auxiliary to railroad transportation, and although it relieved the railroads to a great extent at a time when the supply of railroad cars and locomotives did not equal the demand and when congestion was continually occurring upon the railroads, the forces supplied were not absolutely dependent upon it. Again, river and canal craft already existed in large numbers upon the waterways and such additional craft as were needed were constructed in England and had to journey but a short distance. The craft used on the Western Front were more nearly all of one type, that is, standardized canal barges which were towed by tugs, while the craft used in Mesopotamia were of all descriptions. Self-propelled boats were used to a greater extent in Mesopotamia than in Belgium and France, where the greater part of the tonnage was carried in river and canal barges in tow of tugs. The average tonnage of the boats used in France and Belgium was much higher than those used in Mesopotamia, where liberal use was made of the native boats having a carrying capacity of less than 50 tons.

The administration of the British Inland Water Transport in Mesopotamia and on the Western Front were very similar, each being controlled by a Director, under whom operated Chiefs of Departments and heads of geographical sections. On the Western Front the supervision of the moving craft was much easier, on account of the roads and towpaths following closely the banks of the rivers and canals. Officers traveling on motorcycles on these towpaths exercised constant supervision over the movements of craft, and took immediate measures to keep the craft moving in case of accidents or delays.

While the British modeled the administration of their Inland Water Transport along lines similar to those which would be followed in a commercial organization, the French, who also operated an Inland Water Transport service, followed more strictly military lines. In the French service water transport by barges was based on company administration. Each company had assigned to it certain territory to be covered, and was provided with the necessary barges and equipment. The bargemen and other personnel needed in the operation of the barges belonged to the company, and were directed and cared for by the company commander. The tonnage handled by the French was vastly smaller than that handled by the British, and was confined largely to the transportation of road material. These companies operated mostly upon the canals and smaller rivers. A large amount of water transportation was done by the French upon the Seine, but this traffic was handled by civilian bargemen and barges requisitioned for the purpose. The American Expeditionary Force also operated an Inland Water Transport in France. The 57th Engineers, functioning in the Transportation Service, were engaged upon that work. Large additions were contemplated to the organization when the Armistice rendered expansion unnecessary. Most of the transport work done was upon the Seine, but operations were also conducted upon the canals in the central and eastern parts of France. The work on the Seine was very urgent, and required all available barges in connection with overseas freight and freight from England received at the ports of Le Havre and Rouen. Railroad freight cars could not be secured at these ports except in small numbers, and barge transportation was depended upon for the evacuation of freight for the American Army arriving at these ports. Most of this freight was barged to river ports in the environs of Paris and then trans-shipped by railroad to its destination. Railroad cars for trans-shipment were more easily obtained at Paris, on account of that city being a large consuming center. The American Inland Water Transport was administered along lines similar to those used by the British.

It is evident from a perusal of this book that it was written as the work of the Inland Water Transport proceeded. It has therefore taken the form of an official review of the work done rather than of a book intended for the general reader. It will appeal especially to those who were connected with Inland Water Transport during the World War, but it has not thereby lost all interest for the general reader. It is to be regretted that in connection with the descriptions of craft, difficulties overcome, and statistical matter contained, the author has not dwelt more upon the general plan of the campaign and pointed out more fully and specifically the connection between the work of the Inland Water Transport and the operations of the combatant forces. Transportation by water assumed a greater importance and was a more dominant factor in the Mesopotamian campaign than in any other campaign in history. It is fortunate that Lieut.-Colonel Hall has put the achievements of the Inland Water Transport in Mesopotamia on record in his book. The book is a valuable one, and as General MacMunn remarks in his foreword: "The record of the Inland Water Transport, Royal Engineers, should remain as a text book and pattern for many generations to come."

Panama Canal Revenues and Expenses

During the fiscal year ending June 30, 1921, the excess of revenues over cost of operation and maintenance was $2,712,000. This was the fourth consecutive year in which the Canal has earned an excess of revenues over expense of operation and maintenance. This excess was sufficient to wipe out the last of the deficit that had resulted from slides in Gaillard Cut in earlier years and to leave an excess for the entire period of Canal operation of $420,000.—*Panama Canal Record.*

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Student Military Training

(Continued from page 480)

he said, "To be prepared for war is one of the most effectual means of preserving peace. A free people ought not only to be armed, but disciplined; to which end a uniform and well-digested plan is requisite."

This simplifies and defines the problem of preparedness for all of us and it particularly defines the purpose and objective of the training system in our schools and colleges. It has always been the mission of the Reserve Officers' Training Corps to train young men to serve as officers in the event of emergency. In the past this mission has been vague and its obligations uncertain. It has always been understood that they would serve as officers in such an Army as we might require in the event of war. But that Army did not exist as a vital national institution and therefore the reserve officer could have no definite conception as to the unit with which he might serve or the character of duty which might be expected of him.

The important constructive features of our military law were originally contained in the so-called Wadsworth Bill which was prepared by the Senate Military Affairs Committee during the last session of Congress. This Bill provided for a National Citizen Army and for a system of universal military training through which all of the units of that Army would be filled with trained men with an ample surplus for replacements. The military system proposed in this measure was similar in form to the military system of Switzerland but adapted to American conditions. This bill was not accepted in its entirety by Congress. Congress did provide for the national Citizen Army composed of the National Guard and Organized Reserves but it rejected compulsory military training. It provided, however, in the Citizens' Military Training Camps, for the germ of a national system of voluntary training. Through the development of these camps and of the system of training already established in our schools we may hope that the day is coming when every young man who is willing to take it will have an opportunity to prepare himself for service in one component or other of the Army of the United States. Under universal training all of the units of the Army of the United States would be filled to overflowing. Under voluntary training the number of trained citizens will of course be less, but I believe that we may reasonably expect enough of them to maintain the Regular Army and National Guard at effective strength and to provide the officers, non-commissioned officers and specialists and a considerable number of the private soldiers required for the units of the Organized Reserves.

It is impossible to predict the number of young men who will undergo voluntary training. But I take it that as the system develops a number of influences will tend to increase its popularity. In the first place with an organized Citizen Army localized and officered in time of peace, it must soon become apparent that only those can hope to lead in war who prepare themselves for the responsibility of leadership in time of peace. Therefore, the young man who aspires to be any higher than a rear rank private upon mobilization will be impelled to prepare himself for leadership in time of peace. Another influence and I think a most potent one, will be the gradual development of the idea that it is the proper action for every self-respecting young American to give a portion of his time during his youth to preparation for effective service if his country should ever need it. I expect to see the development of a feeling of *Noblesse oblige* that will spur all patriotic young men to prepare for national service.

With our military policy and organization definitely settled by law, the mission of the Reserve Officers' Training Corps is clarified. We can now say that the young men of the Reserve Officers' Training Corps are being trained to serve in a definitely organized Army of the United States. After they receive their reserve commissions they will have an opportunity to join definite territorial units organized and established in the neighborhood of their homes. They will be officers of local units of the organized Citizen Army. They will know precisely what is to be expected of them upon mobilization. This will enable each reserve officer with the greatest possible economy of time to prepare for his assigned mission. This means more definite organization for the nation and a more precise understanding of the obligation incurred by the individual citizen soldier.

In the future, when a graduate of the Reserve Officers' Training Corps receives his commission and returns to his home he will find in that vicinity an organization either of the National Guard or of the Organized Reserves with which he can identify himself. His duty of preparedness will thus crystallize into the very definite duty of helping to prepare this particular organization for service in an emergency. When he joins this unit he will probably find enrolled in it older men of his acquaintance who have served in the World War and it will be a part of his mission to receive from them and to transmit to the future, the experience and traditions of the great War Army of 1918. He will report to this unit as a junior officer but a well defined pathway of promotion will be open to him, through which, if he has the time, the ability and the industry, he can prepare himself for the highest rank and the greatest responsibility in any future emergency.

The establishment of this national military organization will go far towards funding the cost of the World War as a permanent national investment. At several times in our past history it has been necessary at great cost of money and energy to create a great national military organization and then, after the emergency, we have demolished that organization without making any provision for making it available for the next generation that may be subjected to the burden of war. It is the great feature of our new military law that this defect in our national policy is corrected for all time. In our new organization we will actually perpetuate the principal military units that fought in the World War. We will assign each such unit to a definite locality. We will enroll in these units those veterans of the neighborhood who are willing to serve for a time until they can be replaced by younger men. The initial officer corps of this great Citizen Army will thus be provided by the veteran officers of the war. The problem of the R. O. T. C. has become the well defined problem of providing gradual replacement for this veteran officer corps. In any future emergency, mobilization will not be a process of hasty organization and classification of millions of untrained and unprepared men but the much simpler process of filling the ranks of organized units assigned to definite localities and provided with competent officers and non-commissioned officers.

I have explained that the new law provides for an Army of the United States comprising the Regular Army, the National Guard and the Organized Reserves. It is very important for all of us to form a clear conception of this force as a whole and of its several components. The Regular Army comprises those organized military units which are always ready for immediate military service and it also includes the corps of professional officers and enlisted

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men who are required to train and develop the Citizen Army which comprises the National Guard and the Organized Reserves. The sub-division of this Citizen Army into two separate parts is a logical one. But there should be no rivalry between these two parts. The National Guard is that part of the Citizen Army prepared for any sudden emergency as a first re-enforcement of the Regular Army and is composed of those citizen soldiers who voluntarily assume that special obligation. The Organized Reserves will comprise those citizen soldiers who obligate themselves to serve only in the event of a great national emergency. There must be a harmonious relation between these two forces. The proper development of either should advance the development of the other. Those young men who desire continuous military service for a time will find their place in the Regular Army. Those who desire service only in periods of emergency but who are prepared for any emergency will find their place in the National Guard. Those who are able to obligate themselves only in the event of a great war will find their proper place in the Organized Reserves. In practice there should be an interchange of personnel between these two forces. Every young man who desires to become a member of the Army of the United States and who is free to take the special obligation involved, should be encouraged to enter the National Guard. Later, the same man, when business and family obligations restrict his freedom for military service, will transfer to the Organized Reserves.

There has been an impression in some quarters that the development of the Citizen Army will tend to reduce the importance of the Regular Army. It is indeed true that by the development of effective citizen forces, we make it possible to reduce our regular establishment to a safe minimum. But the development of the Citizen Army in time of peace provides the greatest field for constructive work that our regular officers have ever had. Considering the Army of the United States as a whole, the Regular Army forms the keystone of the arch. But its trained officers and men serving in institutions like this and with the National Guard and the Organized Reserves form the cement which binds all of the members of the structure into one complete and permanent whole.

Thus we find that the Reserve Officers' Training Corps has a more definite mission than was anticipated at the time of its inception. It was proposed then to prepare young men for an undefined service in the event of an emergency. It is proposed now, under the new law, to prepare young men to be officers in a definitely organized Citizen Army. The Reserve Officers' Training Corps will always be one of the most important agencies for training our citizen officers but it will not be the only agency. Through attendance at training camps and by actual membership in the Organized Reserves and National Guard, any young American with sufficient ability and industry will be able to prepare himself for a commission in the Citizen Army whether he is able to go to college or not. With this conception in mind it is important that we should not permit the R. O. T. C. to regard itself as a separate agency of preparedness. It is an important part but only a part of the machinery for developing leaders for the Army of the United States. Its members should, therefore, take every means of identifying themselves with the National Guard and Organized Reserves. I take it that the time is coming when many young men who come to college expecting to prepare themselves as reserve officers will come as members of the local military organizations formed at or near their homes. They will come here and enjoy exceptional opportunities to prepare themselves for leadership. But they will retain their identification with their home organizations and they will return to these organizations after their graduation. Their real title to leadership will be determined there.

Today the Government of the United States is determined to take such measures in time of peace as a prudent nation should take, not in the interest of, or with the thought of military aggrandizement, or military aggression against other nations, which the sentiment of our people and the fixed policy of our Government forbid, but in the interest of the preservation of peace among the nations of the earth, and the War Department appeals to the Universities and Colleges—the Institutions of Higher Education in our land—to give effective aid to this end by giving our intelligent educated college-bred men such reasonable means of military training and knowledge as will make better men of them, and prepare them to efficiently serve the country if need should arise.

Personals

All members are cordially invited to submit contributions to this column.

Col. LYTLE BROWN, Corps of Engineers, has been transferred from the 2d Engineers at Camp Travis, Texas, to Fort Leavenworth, Kansas, for duty as instructor at the General Service Schools.

Col. THOMAS H. JACKSON, Corps of Engineers, has been ordered to Kansas City, Mo., for duty as Instructor, Engineers, Missouri National Guard

Col. CHARLES W. KUTZ, Corps of Engineers, upon being relieved from his duties as Engineer Commissioner, District of Columbia, by Colonel CHARLES KELLER, has been ordered to Cincinnati, O.

Col. LEWIS H. RAND, Corps of Engineers, has been transferred from Camp Lewis, Wash., to Memphis, Tenn.

Col. THOMAS H. REES, Corps of Engineers, has been transferred from San Francisco, Cal., to Honolulu, T. H., for duty as Commanding Officer of the 3d Engineers.

Col. CLARKE S. SMITH, Corps of Engineers, has been transferred from Fort McPherson, Ga., to Camp Jackson, S. C., for duty in connection with the Organized Reserves.

Lt. Col. PAUL S. BOND, Corps of Engineers, has been transferred from New York City to Cleveland, Ohio, for duty as instructor, Engineers, Ohio National Guard.

Lt. Col. W. GOFF CAPLES, Corps of Engineers, has been relieved from further duty in connection with recruiting at Fort Logan, Colo.

Maj. HARRY F. CAMERON, Corps of Engineers, has been transferred from Florence, Ala., to Honolulu, T. H., for duty with the 3d Engineers.

Maj. FREDERICK B. DOWNING, Corps of Engineers, has been transferred from Los Angeles, Cal., to Washington, D. C., for duty in the Office of the Chief of Engineers.

Each of the following-named officers of the Corps of Engineers has been relieved from his present assignment and has been assigned to the organization specified:

Major Raymond F. Fowler, from the 9th Engineers to the 2d Engineers, Camp Travis, Texas.

Captain Peter E. Bermel, from the 2d Engineers to Engineer Training Company No. 8, Camp Bullis, Texas.

Captain EUGENE M. CAFFEY, to Engineer Training Company No. 1, Camp A. A. Humphreys, Virginia.

Captain FRANK M. S. JOHNSON, from the 4th Engineers to Engineer Training Company No. 9, Camp Lewis, Washington.

Captain JOHN B. LA GUARDIA, from the 7th Engineers to Engineer Training Company No. 5, Camp Jackson, South Carolina.

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The Military Engineer

Dedicated to the National Defense

Lt. Col. P. S. Bond, C. of E. *Managing Editor* | Maj. W. H. Lanagan, C. of E. *Assistant Editor* | Lt. Col. G. A. Youngberg, C. of E. *Consulting Editor* | Capt. H. H. Pohl, C. of E. *Business Manager*

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New Orleans Post—Capt. E. H. Coleman (A. L.), 1018 Hibernia Bldg., New Orleans, La.

New York Post—Maj. Percy E. Barbour (E. O. R. C.), 29 W. 39th Street, New York, N. Y.

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St. Louis Post—Lt. Col. John L. Buchanan (E. O. R. C.), 7th and Clark Avenue, St. Louis, Mo.

Seattle Post—J. M. Clapp (A. L.), 637 Burke Building, Seattle, Wash.

Washington, D. C., Post—Mr. E. P. Ellis (A. L.), U. S. Coast and Geo. Sur., Washington, D. C.

Wilmington Post—Secretary, Society of American Military Engineers, U. S. Engineer Office, Wilmington, Del.

Warfare Is Evolutionary, Not Revolutionary

THE account of the operations of the Grecian army which appears elsewhere in this issue will be convincing proof to thoughtful persons that the methods of warfare have undergone no radical change as a result of the World War.

It was certainly not to be expected that the principles and methods which have been gradually and progressively developed during thousands of years of continued conflict would be completely upset and rendered obsolete in a single war of four years' duration.

Man is a conservative creature, even when he makes war, and the laws of nature are unchangeable. All the arts and sciences which we know today have been gradually and slowly developed during many years of patient, plodding research and experiment. The steam engine, the aeroplane, the dynamo, the automobile, were not conceived and created over night. They were not even independent inventions, but painfully slow developments by many men. The tea kettle preceded the steam engine, the kite preceded the aeroplane, the bird on the wing and the autumn leaf whirling through the air preceded the kite.

No industry has ever been "revolutionized" by any one man or any one invention. Our material civilization and all its component arts and sciences have followed the law of evolution. Violent changes are disturbing, they are against nature, and the race as a whole frowns upon them. There is no machine or method in use today whose evolution may not be traced over a period of many years.

The methods of warfare are based chiefly upon the nature of man, which certainly changes more slowly than anything else in the world, if indeed it has ever changed. Warfare is a composite of all the arts and sciences, and accordingly the most radical development in any one science can effect but a slight change in the all-including science of war.

There was nothing revolutionary in the developments of the World War. Nearly all the machines employed, certainly the most important ones, had been invented, used and highly developed prior to the conflict. They were further developed and employed in increased numbers during the course thereof.

Yet it is always the case that these plain lessons of history are thrown aside by many persons, in favor of some wild obsession. We were told during the war that a few submarines would render all surface navies obsolete. And as if this were not enough to dispose of them, a few recent experiments in bombing with aeroplanes have caused some wild enthusiasts to announce the doom of the battleship, and to advise that we build no more of them. Some thoughtless persons who have not sufficiently studied the law of evolution in all human developments, have in-

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formed us that the next war will be fought entirely with tanks. Others of the same unthinking class say it will be fought entirely in the air. Still others assure us that it will be settled by poison gas, with which we shall all be wiped out.

The facts are that all future wars like all those of the past, will be fought by men. And the more numerous and the better trained and equipped these men are, the better will be their chances of victory. Tanks, aeroplanes, poison gas, will form part of the equipment—of less importance than rifles, machine guns and artillery. Man will never devise any instrument of warfare which will take the place of and render obsolete the human element, the fighting machine devised by the Creator.

Whether the persistent circulation of these unsound theories is studied, pacifist propaganda or the result of mere ignorance, they are always hailed with delight by an apparently large number of our people. Mr. Lincoln said you can fool some of the people all of the time, and more recently Mr. Barnum observed that "the people like to be fooled."

The eternal hope that we will find some cheap substitute for the soldier and the battleship is one manifestation of a desire very close to the American heart—to get something for nothing. It is the same hope that causes many people to believe the wonderful cures announced in patent medicine advertisements and to use such medicines even after they have been pronounced frauds by the medical profession, who know the facts. It is the same unthinking people who furnish the money for wild-cat investments and thus help to perpetuate that curse.

It is the duty of those who have studied the evolution of civilization and of warfare and who know the facts, to be on their guard to protect the nation against the dangers of the false theories touching the vital matter of the national defense. If we are to disarm let us at least do so with our eyes open, fully appreciating the risks that we are taking, and not in the false belief that a poison gas factory can take the place of an army and a navy.

Object of the Society of American Military Engineers

THE object of the Society of American Military Engineers and of its journal, THE MILITARY ENGINEER, is to promote harmony amongst and between military engineers in and out of the regular service, in the interests of the national defense. And such, we believe, has been the real motive of every article and argument that has appeared in our columns. Certainly we should suppress or advise the revision of any writings calculated to tear down rather than to build up the harmony and esprit de corps of our Society as a whole.

The ultimate object of this harmony is *efficiency* in the service of the country. This cannot be built up by flattery alone, nor do any of us desire the American Military Engineers to degenerate into a mere mutual admiration society. There is probably no man living who does not need a little honest criticism now and then to jar him out of his ruts or loose from his too fixed ideas along certain lines. The criticism must be honest and constructive, given in a spirit of helpfulness, and accepted in the same spirit.

All of us enjoy honest praise and appreciation. And it is helpful. But we should also be thankful for honest criticism, grateful to those who point out our mistakes or shortcomings, thus giving us the opportunity to correct them.

The "military mind" may be, and is sometimes born. But in general it is the result of the training which the individual has received. An exclusively military training like any other training of an exclusive nature, may have a narrowing influence. The successful military engineer must be a broad-minded man. The profession demands men of this type. We are broadened by professional and social contact with men in other lines of endeavor. In our Society, consisting as it does of engineers of varied experience in many civil and military lines, the opportunity for such contact exists. It must be "exploited" to the utmost. A free interchange of information and ideas, honest praise where such is due, honest criticism of a constructive nature, are the means to our end. It is not "military minds," but broad minds which we seek to develop, minds whose point of view commands the entire horizon. Such is the composite mind of our Society, and such we desire to have the mind of each individual member.

Our Society was not organized solely for the training and benefit of the civilian engineer who may be called to the colors in case of war. Association with civilian engineers during the late conflict, and the opportunity to observe their methods and learn their point of view, resulted in a marked increase in the efficiency of the regular Corps of Engineers. An appreciation of this fact by the regulars gave rise to a desire to continue this helpful association after the close of the war. And our Society resulted from a mutual desire for a continuance of pleasant and profitable relations between engineers in and out of the service. It has already justified the hopes of its founders, and there is more reason than ever for its perpetuation and growth.

Our future armies, like our A. E. F. in the World War, will consist of a mixture of professional military men and civilians with only a small amount of military training. The military mind and the non-military mind must co-operate in a common cause. To bring these two classes together and to hold them together in time of peace, to enable each to appreciate and in the greatest possible measure to share the point of view of the other, thus paving the way for more effective co-operation in time of war, is the aim and purpose of our Society. This basic idea cannot, we believe, be too often repeated.

The Unknown Soldier

On the tenth of November there lay in state in the rotunda of the Capitol at Washington the body of an unknown and unidentified American soldier, brought from France to be buried with the highest military honors among the nation's heroic dead in the National Cemetery at Arlington.

A company of soldiers from the 13th Engineers stood guard while organizations representing the multitudinous activities of America's citizens held special services in honor of the dead and laid floral tributes upon the coffin. All day long and far into the night a steady stream of people filed through the rotunda and paid tribute in awestruck silence to the remains that symbolized the sacrifice made by scores of thousands upon the fields of France.

During the morning Colonel C. H. Birdseye, E. O. R. C., and Major R. W. Crawford, C. of E., laid upon the coffin the floral tribute of the Society of American Military Engineers, consisting of a wreath of green with a center of white roses upon which a castle was raised in red roses.

Emotion craves outward expression, and nothing could have been more fitting than this ceremony as an opportunity for the expression of an emotion that has filled the hearts of all since the days when casualty lists brought their terrible news daily into hundreds of homes.

Even in our short and comparatively peaceful history, occasions such as this have not been infrequent. And always with the emotion of grief over the dead has been mingled the high resolve that the dead shall not have died in vain.

For the first time in our history, however, there exists a definite military policy which, if faithfully carried out, will insure that either there will be no war, or, if war must come, that it will be carried to a victorious conclusion with the minimum expenditure of human life.

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Activities of Our Local Posts

Buffalo Post

HENRY P. JONES, 540 Federal Building

A meeting was held July 6, 1921, at the University Club of Buffalo, N. Y., with an address by Major Wm. E. R. Covell, District Engineer, U. S. Engineer Office, Buffalo, N. Y. Application made for charter and plans discussed for perfecting organization.

Albert F. Krause was made temporary President and Henry P. Jones temporary Secretary-Treasurer.

Minneapolis Post

H. V. BURNETT, 526 McKnight Building

This Post has completed its organization and has elected the following officers:

President—Captain William R. Lee.

Vice-President—Captain O. F. Woodrich.

Secretary-Treasurer—Captain William E. Clark.

Application for charter, signed by twenty-five members, has been made to the parent Society.

The chairman appointed S. W. Farnham, Philip A. B. Bellin and M. T. Northey as a membership committee of three, to call on eligibles for membership.

Col. E. H. Marks, Corps of Engineers, U.S.A., whose station is Duluth, Minn., spoke on Organization, and instructed the members present in the best method of procedure.

New York Post

PERCY E. BARBOUR, 29 West 39th St.

The first meeting of the season was held on November 1st at the Engineering Societies Building, 29 West 39th St. Major Douglas W. Johnson, of Columbia University, gave a very interesting and instructive lecture on "The Strategy and Tactics of the Great War in Their Relation to Geographical and Geological Features of the Theatre of Operations." Numerous lantern slides were shown.

Major Johnson has written a book on this subject which is attracting wide interest and attention.

Plans were made for an interesting winter program.

Portland, Oreg., Post

E. BURSLEM THOMSON, 321 Customhouse

The August field trip of the Post was to Forts Stevens and Canby, as guests of the United States Corps of Engineers and Major Wing of Fort Stevens. Fourteen members left at 9 A. M., August 6th, on the Engineer boat *Woodland*. A stop was made for inspection of the government dredge *Wahkiakum* at Kalama, Wash. At Altoona the party transferred to the U. S. Engineer boat *Vigilant* and continued on to Astoria. Reaching Astoria about 6 P. M., dinner was had at the Weinhard Hotel, after which the party were taken to Fort Stevens, landing about 8 P. M. Here the members were assigned very comfortable quarters in the barracks. The members showed a complete disregard for the sounding of taps, being busily engaged at the time, in true army fashion, in card games and anecdotes typical of barracks life. Early Sunday morning a fine ride was enjoyed across the Columbia River to Fort Canby where the party was shown over the older fortifications and especially the emplacements recently completed by Major Park. Returning to Fort Stevens for lunch, the party was met by Major Wing, who devoted the entire afternoon to a trip of inspection over the fortifications, accompanied by a most interesting and instructive explanation of the defenses of the mouth of the Columbia. The workings of the large gun emplacements, fire control stations, mortar batteries and the war game room were most interesting and thoroughly enjoyed by every member present.

After another good army meal the party left on the *Vigilant* transferring at Altoona back to the *Woodland*, where all passed a pleasant night, reaching Portland at 8 A. M., Monday, August 8.

This trip was undoubtedly the most enjoyable and instructive one yet made by the Post and our sincere thanks are due to both Major Park and Major Wing of Fort Stevens for making the trip both pleasant and instructive.

Many of our members being away on vacation, the regular business meeting was postponed until September.

The September meeting of the Society was held at Elk Rock on Tuesday, September 13, 1921, at the invitation of the Hauser Construction Company. An excellent opportunity to view the work of the tunnel construction being done by the S. P. Ry. Co., was obtained. This work is under contract by the Hauser Construction Company, Major Kenneth Hauser being in direct charge of the work for the contractors.

The 24 members and eight guests present were treated to an excellent dinner, served on the old steamship *Potter*, which is being used by the contractors as a barracks for their workmen.

Two military problems were prepared and analyzed for the members by Major Mayo and proved very instructive.

The program committee decided to invite some of the officers of the army stationed in and about Portland to attend the next meeting with the view to propounding a comprehensive traffic problem relative to this particular district. The solution of this problem is to be divided into various subjects to be apportioned to various committees from among the membership. It is believed that a problem of this nature will occupy the interest of a large number of the members for several meetings, and should prove of great practical value.

The October meeting of the Society of American Military Engineers was held at the University Club on the 11th. The meeting was preceded by a club dinner at 6:30 which was enjoyed by 23 members and guests.

The meeting was of unusual interest, plans being discussed and formulated for an extensive study of the traffic problem in Oregon in relation to an assumed attack of an enemy on the western coast line. The development of the problem will be of interest to all members, and the information gathered will be of public value whether in peace or war.

The following officers of the U. S. Army were guests of the Society:

Colonel Whitworth, Chief of Staff for 96th Division; Colonel Cavanaugh, Major Mayo and Captain Tansey, Corps of Engineers; Colonel Dentler, Instructor to the Oregon National Guard, and Majors Andrus and Peake, Aides to Colonel Whitworth.

The advice and experience of these officers was of great assistance to the Society in drawing up their plans, and Colonel Whitworth kindly consented to draw up an outline of the proposed study for discussion at the next regular meeting.

Continued on page 508

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Counter Intelligence in the Field

(Continued from page 498)

Discussion

By

H. S. Bennion

Major, Corps of Engineers
Formerly Chief Camouflage Officer, A. E. F.

Colonel Tracy has outlined in a very satisfactory way the camouflage question. It was new to us and our period of active operations was so short that its relative importance and the best way to handle it were left more or less unsolved at the close of the war. But we learned much and must profit thereby. Some of the salient points are given below.

In the first place, it is important that all troops have an understanding of the subject and are properly trained in its application before they undertake active operations. It is hopeless to expect a few trained specialists to camouflage the operations of a large body of men when the activities of each one of thousands of men is tending to disclose the operations; and it is equally hopeless to expect troops in battle to remember and to act in accordance with instructions hastily and imperfectly given them just before the fight. The first time they forget everything and do only those things which have become habitual or are instinctive. The second time they are strongly inclined to do the things they did the first time and thereafter they are scarcely amenable to instruction.

The best way to learn how to camouflage is to study the means and methods of obtaining intelligence and of disseminating it. If this is thoroughly understood, the means of defeating the enemy's intelligence system will often suggest themselves.

The theory of camouflage is simple but its proper application is very difficult. Resource, ingenuity and common sense in abundance, study and experience, and a high state of discipline are required. It is essentially a game of wits where you must do the outwitting. The early ideas of it, developed by not too practical artists and dressed up and shaped by imaginative but uninformed writers, must be discarded and it must be considered as a phase of the old military problem of concealment and deceit.

The importance of camouflage depends directly on the development of the air service, of the intelligence service, and of artillery and, since it is safe to assume that these activities will increase greatly in effectiveness, our officers should study the subject with care and our troops should be trained in it. The execution of camouflage requires the expenditure of time and labor and perhaps materials and transportation. It seriously restricts operations and therefore it is essential that all officers understand the subject as well as they understand other military problems with which they have to deal so that when confronted by a situation they may be able to make an intelligent decision as to what sacrifice to make in the interest of camouflage.

The action of Colonel Tracey and Captain Saint Gaudens in giving their time to instruct at Camp Knox was most commendable and should produce excellent results. The enthusiasm with which these two men undertook the work is almost as valuable as the training they gave in practical camouflage.

Subsidence for River Banks—Discussion

(Continued from page 479)

that this treatment will be effective. It will be seen that Mr. Harding's proposed method of drainage will not apply, there being no impervious stratum to act as the bottom of the drainage system, and the high bluffs preventing its installation. In the narrow limits between the river and the bluff, no great disturbance of existing conditions can be allowed.

Another method of preventing the movement of underlying sand has been found to be effective. It sometimes appears that the head necessary to move the sand is produced from a pond or swamp behind. This case can be handled effectively by surface drainage.

It is not believed that there is much to support the theory that the river water enters the sand at high water, and that its return to the river, as the water falls, carries out the sand. Most of these sand strata carry their own water, particularly in the wet season when the river is high. The effect of the high river is to hold back the water in the sand—prevent its escape. Then when the river falls the water is allowed to escape, carrying with it the sand. The effect is the same and it might be argued that the point is immaterial, but it has a bearing on the treatment. Many think that an impervious treatment to keep the river from supplying water to the sand will solve the problem. The water is in the sand, with a head equal to or greater than the fall that has taken place in the river, and therefore any attempt to stop the sand movement must be instituted against the water in the sand and not to prevent the river from supplying the water to the sand. The usual argument that the river water does the damage is believed to be unsound. That is true only to the extent of direct river action in washing away the sand. Other than this the river's only offense is that it rises and prevents the escape of the water naturally in the sand. It does not supply, in the general case, the water that does the damage.

Hints to Speakers

The following hints were suggested to speakers at the Illinois Short Course in Highway Engineering.

1. Don't apologize for your presence as a speaker. If any apologies are needed, let the management make them.

2. Don't tell the audience you are a poor speaker. If it is true, it will be found out soon enough.

3. Be brief. The orator who preceded Abraham Lincoln on the program at Gettysburg talked over two hours. Today we don't remember who he was or what he said; Lincoln spoke a few words, and those immortal thoughts are a part of the life of every American. Draw your own conclusions.

4. Marshal your facts. The best extemporaneous speakers are those who have planned in advance what they intend to say and how best to say it.

5. Make every word hit the mark. If a word is not necessary, don't use it. You are not singing a swan song; you are presenting engineering facts.

6. Be heard! If you prepare the best information of the day, and then smother it by swallowing your voice, mumbling your words and slurring your syllables, your effort will be a rank failure. Every engineer can yell cross section readings for six hundred feet; he can therefore make himself heard by a thousand people. Remember that if you are too quiet, the appointed coach in the rear will yell "louder."

7. Keep within your time limit. The other fellow may have a few valuable things to say also.—*Professional Engineer.*

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ACTIVITIES OF OUR LOCAL POSTS

(Continued from page 506)

San Antonio Post

Lieutenant Ray S. Quick, Post Office Box 262.

On August 9th a preliminary meeting was held, attended by 27 members of the Society. Col. Edgar Jadwin was elected chairman and Lieut. R. S. Quick acting secretary. Following a talk by Capt. Elliott Vandevanter in which he outlined some of the features of other Posts, a motion made by Col. F. G. Chamberlain to form a San Antonio Post was carried. A committee consisting of Col. Chamberlain, Maj. E. W. Ropes, Capt. Vandevanter, Lieut. J. C. Adams and Lieut. A. T. Colwell was appointed to draft a constitution and by-laws. A motion was made and carried that charter memberships be held open for two weeks.

At the second meeting of the Post held on August 28, three applications for membership were received and the organization completed. A constitution and by-laws were adopted and application for charter, signed by 54 members, was prepared for transmission to the parent Society,

The following officers were elected:

President, Col. Edgar Jadwin; First Vice-President, Col. W. B. Tuttle; Second Vice-President, Col. F. G. Chamberlain; Treasurer, Maj. W. N. Vance; Secretary, Lieut. R. S. Quick; Director, Maj. R. F. Fowler; Director, Lieut. Joseph A. Dodge.

A committee consisting of Maj. Fowler, Capt. C. B. Falley, Capt. V. H. Browning, Capt. Anderson and Alfred G. Ranney was appointed for the purpose of securing new members and arousing interest in the Post and its purposes.

San Francisco Post

Douglas W. Dodge, 733 Rialto Building

San Francisco Post of the Society is doing things.

The daily press of San Francisco recognizes that the Post by the Golden Gate is doing more than merely getting together at intervals, of evenings or around the lunch table, to chat of "over there" reminiscences, and has detailed reporters to attend the meetings of the Post and record its activities and plans. Particularly have the San Francisco *Chronicle* and *Journal* exhibited this interest, the former paper having detailed Mr. R. E. Quinn, one of its writers who served overseas with the 23d Engineers, to attend San Francisco Post sessions and luncheons, and accompany the Post on military inspection trips, to "cover" them in his paper.

This is as it should be. The public should be informed of the work the Society is doing in keeping alive general interest in those vital things that have to do with the National Defense. That public apathy towards essential military activities which has been manifest after all of our national conflicts should not be allowed to continue this time. Co-operation of the daily press, enlisted and maintained by live-wire publicity committees in every local Post, will be a powerful factor in wiping it out.

Inspection of Spring Valley Water System

The members of San Francisco Post, with officials of the Spring Valley Water Company, of San Francisco, as hosts and guides, spent two Saturdays in making an exhaustive military reconnaissance of the city's water supply. July 16 was taken up with an inspection of the properties of the company—reservoirs, pumping stations and pipe lines—down the peninsula from the city, west of San Francisco Bay. July 30 was given to a similar trip over the Alameda County or "east-bay" watershed and properties of the company—the Calaveras reservoir, the famous earth dam that slipped its clay core out into the lake two years ago, the Sunol sand-filter beds, the noted and beautiful Sunol "Water Temple," the pumping stations at Pleasanton and Belmont, the Niles Canyon weir dam, and the system of two 22-inch and two 16-inch ball-joint submarine pipes that carry beneath southern San Francisco Bay and to San Francisco exactly one-half the city's total present available water supply—21,000,000 gallons daily out of the total of 42,000,000.

The inspection trip was a corollary to the work undertaken by San Francisco Post in studying that essential factor in the problem of the city's defense against a hostile force approaching by land from the south, the specific defense of the city's water supply, essentially a military engineering problem, and one that would be laid upon the Corps of Engineers at the very outbreak of hostilities with a foreign power that would menace the Pacific Coast.

At the meeting of the Post Thursday evening, July 28, Col. R. E. Child led a discussion of the military aspects of this factor in the San Francisco defense problem, following an interesting stereopticon talk on the engineering features of the Spring Valley Water Company's system by Mr. J. J. Sharon, Assistant Manager and Engineer of the company.

The problem in question is now being concretely worked out under the direction of a committee, the personnel of which is as follows: Col. Herbert Deakyne, C. of E.; Col. Robert E. Child, E.R.C.; Lieut.-Col. Charles B. Wing, E.R.C.; Major A. R. Ehrnbeck, C. of E.

In conjunction with this problem, the more general one of preparing a system of military maps of the San Francisco region of the Pacific Coast, from a point 75 miles north of the metropolis to one that distance south, and east to the San Joaquin and Sacramento Rivers, has likewise been undertaken by San Francisco Post under the general supervision of the following committee: Capt. Addison N. Clark, E.R.C.; Capt. C. A. De Camp, E.R.C.; Mr. H. B. Truett.

In this broader work, the objective will be to provide instruction in the art of military mapping for the benefit of military men not now familiar with such work—Regular Army, Reserve and National Guard officers and men—and for cadet organizations and similar bodies.

In all of our work we are proceeding with the knowledge and approval of Headquarters, Ninth Corps Area, and it is our aim not only to secure valuable training for our members but also to make definite contributions that will be of value to the Corps Area in its study of the military problems with which it will be confronted in the event of emergency.

Yet it's not all work and no play for San Francisco Post. Each alternate meeting (i.e., every other month) the meeting takes the form of a luncheon at a popular restaurant, and business and war play second fiddle to congenial good-fellowship. Ladies' night and social hikes in which the ladies of the knights participate have been a feature of the Post's activities throughout the spring and summer.

Nor was the Spring Valley water reconnaissance allowed to be too serious a matter by the Spring Valley officials, who, when they play host, do so royally. The piece de resistance of the Peninsula trip was a trout dinner de luxe. That of the Alameda County trip was a barbecue beneath the trees at the Sunol water temple, presided over by Manager Sharon, Superintendent George Pracy and George Espey, not overlooking Chef Gee Fong, who, a comedian as well as a famous cook, was distracted to provide enough roasting ears and ash-baked potatoes, likewise barbecued mutton, plus that which gurgleth and gleameth a ruby gleam when it poureth from the bottle, for that famished flock of engineer officers. It may be added that everything on those long tables was grown or—er, manufactured—on the Spring Valley premises.

Trip to Muir Woods and Mt. Tamalpais

On Sunday, August 21, our party, including twenty-five members and ladies, left San Francisco at 9:45 a. m. on the N.W.P. ferry. At Sausalito, the ferry terminal, we were provided, through the courtesy of the Northwestern Pacific Railway, with

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a special car in which we proceeded to Muir Woods under the escort of Mr. Ingram, the vice-president and general manager of the Mount Tamalpais Railway Company. At Muir Wood Tavern we were provided with an excellent lunch through the prior arrangements of the Entertainment Committee, and continuing under the personal escort of Mr. Ingram, ascended to Mount Tamalpias over the "Crookedest Railroad in the World."

A great value is being attached to these occasional social trips of members with their families and friends. This trip was the second social undertaking of the Post, and the effect is most plainly evident. Wives and families of different members are becoming well acquainted and a considerable spirit is being manifested in our membership and purpose, and especially notable is the interest and support that is being given by the wives that the members shall do everything possible for the success of the Post.

Plans for Instruction in Mapping.

The necessity for adequate instruction of all officers in map reading and map making was strikingly brought out by Major L. M. Adams in his article on "Map Reading," in the July-August number of THE MILITARY ENGINEER.

The committee appointed to develop a plan for carrying on instruction along these lines has taken the matter up with the Ninth Corps Area and will make a report at a later date.

Dinner to General Wright.

Shortly after the arrival in San Francisco of Major General W. M. Wright, the commanding officer of this Corps Area, he was tendered a public dinner, to which all reserve officers were bidden. Our own members made up two large tables of approximately twenty men. We are keeping in very close touch with headquarters and as matters of information of interest to our members arise notices are sent to them, which always are considerably in advance of the official distribution. In this way Special Regulations No. 46 have been distributed.

State Highway Inspection Trip.

On October 20th a luncheon was held, and on October 22d a tour of inspection was made over the state highway from San Francisco to Santa Cruz and through Redwood Park and the Big Basin territory to gather data of a military aspect on the highways for the defense of the bay regions should an emergency arise.

Colonel John H. Skeggs of the California State Highway Commission acted as guide for the party and explained the obstacles it was necessary to overcome in building the roads.

Among the members of the post who made the trip were Colonel Herbert Deakyne, engineer officer of the San Francisco district; Colonel Thomas H. Rees, engineer officer of the Ninth Corps Area; Colonel Lee Rand, Presidio; Major Thomas M. Ward, Captain L. D. Jones, C. A. DeCamp, Captain B. P. Miller, Captain Walter E. Buckingham, Captain Douglas W. Dodge, M. J. Lyon, Colonel R. E. Child and Captain C. W. Backe.

Problem on Defense of Water Supply System.

The committee on water supply defense has submitted the following problem:

General Situation:

War has recently been declared and the hostile forces (Red) have advanced up the Santa Clara Valley and hold a general east and west line across the valley from the base of the foothills two miles south and east of Milpitas, through Santa Clara to Calabazas Creek and via that creek to the foothills. Red army consists of about 40,000 men with a small air force.

Special Situation (Blue):

The Blue forces, composed of hastily mobilized troops from nearby posts are holding a line about a mile north and roughly parallel to the enemy.

It is expected that the Reds will try to destroy the water supply to San Francisco by artillery fire, air raids, and penetration of the Blue lines by raiding parties or individuals. No land attack is expected from the west, and shore defensive forces are able to keep off landing parties from the Golden Gate southward of Halfmoon Bay.

One regiment of Engineers under Colonel "A" has been concentrated near Belmont. Two companies of Engineers without transportation, under Major "B," will arrive at Niles tomorrow morning at 6 o'clock, with instructions to report to Colonel A for orders.

All troops of other arms are required in the line. About 1,500 civilians are available for labor work with the Engineers. Colonel A has authority to commandeer any needed auto trucks with drivers.

The Commanding General has issued an order to Colonel A to proceed at once with his regiment to the construction of such defensive structures as he deems necessary for the protection of the water system on the west side of San Francisco bay exclusive of the City of San Francisco proper. He is to furnish Major B with transportation and labor, and order him with his two companies to construct the necessary defensive works for the San Francisco water system east of San Francisco bay.

Required:

1. A definite statement of the mission (Colonel A).
2. A definite statement of the plan of action adopted (Colonel A).
3. Written orders of Colonel A to Major B for carrying out the work required east of San Francisco Bay.
4. Written orders of Colonel A to subordinates of his regiment for carrying out the work west of San Francisco Bay.
5. Written orders of Major B to his subordinates.
6. Location of defensive works on map (U. S. G. S. sheet).
7. Sketch designs of defensive works.
8. Estimate of materials required.
9. Estimate of labor required.
10. Estimate of time required.

Denver Post

Lieut. Col. CHARLES H. RANKIN, Room 4, Building A, Denver Tramway Co.

This Post has completed its temporary organization and has made application for charter to the parent Society. The following officers have been elected:

President, Col. Joseph C. Taylor; Vice-President, Maj. Charles Larson; Secretary, Lt. Col. Charles H. Rankin; Treasurer, Captain George B. Clark; Assistant Treasurer, Maj. R. R. Mayther.

Baltimore Post

STEUART PURCELL, City Hall

A meeting was held at the Engineers' Club on November 1st, at which Col. Jenks G. Jenkins, E.O.R.C., presided. The organization of the Post was completed and constitution and by-laws adopted.

Major F. C. HARRINGTON, C. of E., Engineer, Third Corps Area, made an address in which he outlined the steps that have been taken to date for the establishment of units of the Organized Reserve in the Third Corps Area, with particular reference to the engineer units.

Major W. H. Lanagan, Corps of Engineers, on duty in the Office of the Chief of Engineers in Washington, spoke on the

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history and objects of the S. A. M. E. and the close relation that it bears to the engineer units of the Organized Reserves.

Colonel Jenkins emphasized the fact that civilian engineers even though not members of the E. O. R. C., could by affiliation with the Society and the local Post do much to further the cause of National Defense.

Washington, D. C., Post

E. P. Ellis, U. S. Coast & Geod. Sur.

By courtesy of the Chief of Ordnance a demonstration at the Proving Ground at Aberdeen, Md., was given on November 2d to the Washington Post of the Society of American Military Engineers. A large delegation from the Post was met upon arrival at Aberdeen by Capt. K. L. Brown-Jones whom Col. H. W. Schull, the commanding officer, had directed to explain the work that is being done at the Proving Ground.

The most striking exhibits are two 16-inch guns, one of which is mounted on a disappearing carriage. This gun has an effective range of 35 miles and is the most powerful one in existence. The disappearing carriage has proven completely successful in actual use, its principal advantage being the concealment of the gun emplacement which it accomplished very successfully prior to the employment of aircraft for observation purposes. Camouflage is a more effective means of concealment from overhead observation than is the disappearing carriage.

An interesting exhibit is the famous French 75-millimeter gun and those of the same size developed in this country during and since the war. Although the French 75 was perfected as long ago as 1897 it was used without change throughout the war by France and her allies. That the Ordnance branch of the United States Army has made important improvements in artillery is indicated by the fact that the French 75 gun had a range of only 8,000 yards while that of the new U. S. 75 is 15,000 yards. The latter is also much superior to the French original by reason of greatly increased elevation and ease of manipulation.

As the value of artillery is largely dependent upon the quickness with which it can reach the scene of action, the development since 1918 of the caterpillar tractor as a gun mount has been a notable advance in ordnance. An inspiring sight is a battery of artillery dashing into action with drivers urging the horses on with lash and voice, but the actual progress is slow and halting. Less thrilling but more impressive was it to see modern 6, 4 and 3-inch high-powered guns moving towards their stations at 20 and 25 miles an hour and ready to fire as soon as they had taken position.

Great as have been the improvements in ordnance matériel, the changes now being introduced in sea coast defense are nothing short of revolutionary. Specimens of the heavy 12-inch naval guns mounted on railway trucks that were used by Admiral Plunkett against the Germans were exhibited at Aberdeen, together with improved trucks and mounts designed in this country since the close of the war. The success of this type of artillery has suggested its employment in seacoast defense. Plans have been formulated that provide for the construction of concrete emplacements at suitable points adjacent to or within reach of railways. Guns mounted on railway trucks will be parked at strategic points from which they can quickly be dispatched to any section of either coast that may be threatened by a hostile fleet. Coast artillery regiments can be maintained intact at the strategic points, the advantages over the prevailing custom of breaking up the regiment into numerous detachments being self-evident.

The development of the use of Aircraft for bombing has not been neglected at Aberdeen. A Handley-Page airplane capable of carrying a 4,000-pound bomb has been built at the Proving Ground. This is the largest bomb that has ever been projected by any means and its destructive power is so great that its effect is irresistible whether on land or sea. The bomb has proven completely successful in tests.

While the development of new ideas in ordnance is an important function of the Proving Ground, the real task of the plant is the testing of all guns and ammunition used by the army. Every gun is subjected to the strain of charges 15 per cent in excess of those used in actual service.

The Proving Ground has important work to perform and those who designed the layout and equipment planned generously, and with a view to meeting the enormous demands of a great army. There can be no doubt that as long as our country maintains an army, and just so long as there is a possibility of another war the work at the Aberdeen Proving Ground should go on and the plant be fostered and developed so that it may function fully and without delay should another great emergency arise.

Seattle Post

J. M. Clapp, Burke Building.

The members of the Seattle Post of the Society of American Military Engineers were highly honored on Monday night the 17th of October at the Assembly Rooms of the Chamber of Commerce by Colonel John Millis, Corps of Engineers, U. S. Army, who made an informal address.

Colonel Millis was a visitor in the city for a few days in attendance at the convention of the World's Port Authorities held at the New Washington Hotel last week where he was to present a paper on "Regulation of the Great Lakes."

Although his itinerary included his attendance at the Coast Ports Convention held in Vancouver, B. C., on the 17th and 18th, Colonel Millis very generously stopped over a day to meet with the Seattle Post, and his talk proved highly interesting to the forty or fifty members present.

Colonel Millis will be remembered as District U. S. Engineer at Seattle from 1900 to 1905, when he left Seattle for a tour of duty in the Philippine Islands where he had charge of the Defenses of Manila harbor and the river and harbor work there. This is the Colonel's first visit to Seattle in sixteen years.

During Colonel Millis' tour of duty in this district he started the work on the Lake Washington Ship Canal; continued the construction on the Gray's Harbor Jetty System; the Rainier National Park Road; the Harbor work at Everett and Bellingham; directed the survey for the road and trail work in Alaska and had charge of the other engineering work of the Department, scattered over eastern and western Washington, Idaho, Montana and Alaska.

The description of his trip to the Philippines from Seattle, via the Northern route, Japan and China and later his homeward voyage by way of Singapore, Mandalay, India, Ceylon, the Red Sea, Egypt and the Mediterranean proved most interesting to all present, who gave him the closest attention.

Aside from the description of the scenery and the habits and customs of the inhabitants of the various countries he visited on his trip, he touched briefly on some of the engineering features he observed, including the great break-water at Colombo, the ponton bridge at Calcutta, the Suez Canal and the irrigation works at the Nile.

The Colonel's description of the changes he noted in Seattle after his long absence, of the changes of the business center of Seattle and the construction of the various buildings and other improvements, many of which had been made for ten years or over, made all present realize what wonderful progress the city had made and that Seattle was still in the "March of Progress." His lecture made all present feel contented with Seattle.

All were happy to note that there had been very little change in the Colonel during his absence and all united in expressions of pleasure for the talk he had given them.

At the conclusion of his address, a rising vote of thanks was tendered him.

The Seattle Post of the American Military Engineers sincerely hopes to have the Colonel with it again and that sixteen years will not elapse before his next visit.

New Posts

The following Posts are now in course o forganization:

Akron Post—Lieut. Sears S. Day, Lock Box 254, East Akron, Ohio.

Baltimore Post—Major Steuart Purcell, E. O. R. C., Highways Division, City Hall, Baltimore, Md.

Boston Post—Lieut. Lewis A. Armistead, Room 701, 108 Massachusetts Avenue, Boston, Mass.

Cincinnati Post—Capt. Hugh J. Krampe (E. O. R. C.), 1608 First National Bank Building, Cincinnati, Ohio.

Indianapolis Post—Capt. C. L. Harrod (E. O. R. C.), Public Service Commission of Indiana, Indianapolis, Ind.

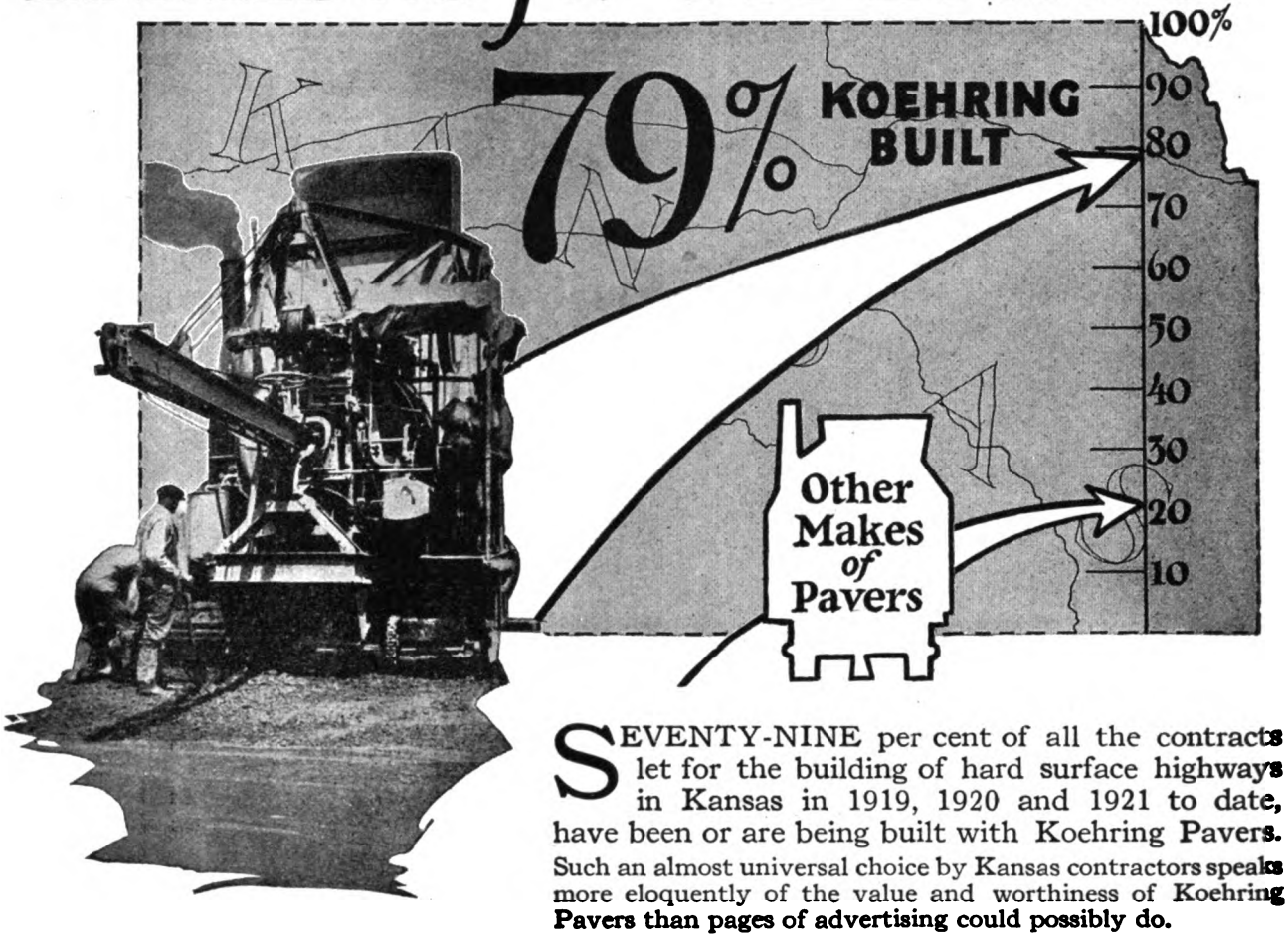
St. Paul Post—Capt. John F. Druar (E. O. R. C.), 512 Globe Building, St. Paul, Minn.

Silver Button Winners

Winners who have failed to advise the Secretary of the kind of emblem desired are requested to do so at once.

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Kansas *for* KOEHRING



SEVENTY-NINE per cent of all the contracts let for the building of hard surface highways in Kansas in 1919, 1920 and 1921 to date, have been or are being built with Koehring Pavers. Such an almost universal choice by Kansas contractors speaks more eloquently of the value and worthiness of Koehring Pavers than pages of advertising could possibly do.

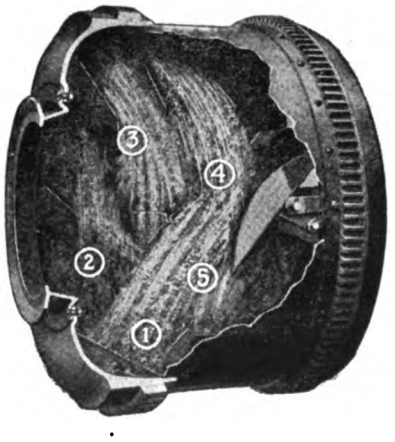
Here are the statistics:

Total number miles of concrete road let to date in Kansas	181.349
Total number miles of brick road let to date in Kansas	60.043
Total mileage of hard surfaced roads let	241.392
Mileage paved or being paved with Koehring machines	191.309
Mileage paved or being paved with all other machines	50.083
Percentage of Koehring paved roads	79.249
Percentage of roads paved with all other machines	20.752

Of the 181.349 miles of concrete roads let, 137.224 miles, or 75.668% are Koehring built roads. And of the 60,043 miles of brick roads let, 54.085 miles, or 90.077% are constructed with Koehring pavers.

The customer is the final judge of worth. And 79% of the state hard road builders of Kansas back their judgment that the Koehring Heavy Duty paver is the paver of absolute dependability.

Koehring re-mixed concrete is DOMINANT strength concrete.



KOEHRING COMPANY
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The Field Artillery Journal

Official Organ of the

United States Field Artillery Association

The U. S. Field Artillery Association was organized in 1910, and is composed of officers of field artillery of the Regular Army, the National Guard, and the Officers' Reserve Corps, and other persons interested in field artillery.

The Field Artillery Journal is published bi-monthly by the Association. Each number contains approximately one hundred pages of technical information of value to officers of all arms of the service, although of course of particular value to those who are interested in the development of field artillery.

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War Department, Washington, D. C.

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Personals

(Continued from page 503)

Captain TATTNALL D. SIMKINS, from the 9th Engineers to the 18th Engineers, Camp Bullis, Texas.

Captain KENNETH M. MOORE, to Engineer Training Company No 2.

First Lieutenant HOWARD V. CANAN, from the 12th Engineers to Engineer Training Company No. 5.

First Lieutenant CHARLES D. JEWELL, from the 12th Engineers to Engineer Training Company No. 6.

First Lieutenant WENDELL P. TROWER, from the 12th Engineers to Engineer Training Company No. 7.

Maj. FREDERICK W. HERMAN, Corps of Engineers, has been transferred from Louisville, Ky., to Camp Dix, N. J, for duty with the 1st Engineers.

Maj. PAUL A. HODGSON, Corps of Engineers, has been transferred from the 3d Engineers to the 14th Engineers, Manila, P. I.

Maj. THOMAS B. LARKIN, Corps of Engineers, has been transferred from Washington, D. C., to Tokyo, Japan, for duty as Assistant Military Attache, American Embassy.

Maj. CHARLES E. PERRY, Corps of Engineers, has been transferred from Camp Dix, N. J., to Washington, D. C., for duty in the Office of the Chief of Engineers.

Maj. XENOPHON H. PRICE, Corps of Engineers, has been transferred from Cambridge, Mass., to Washington, D. C.

Maj. GEORGE J. RICHARDS, Corps of Engineers, has been transferred from Camp A. A. Humphreys, Va., to Memphis, Tenn.

Maj. THOMAS M. ROBINS, Corps of Engineers, has been detailed as a member of the Board of Officers to consider a system of National Highways in connection with the rural post roads.

Maj. BREHON B. SOMERVELL, Corps of Engineers, has been ordered to report by letter to the Commanding General at Fort Howard, Md., for temporary duty in the District of Columbia in connection with court-martial duty.

Maj. HENRY H. STICKNEY, Jr., Corps of Engineers, has been transferred from Camp Meade, Md., to Cincinnati, O.

Maj. HARRY M. TRIPPE, Corps of Engineers, has been transferred from Camp Grant, Ill., to Columbus, O.

Capt. CLARENCE L. ADCOCK, Corps of Engineers, has been assigned to the 13th Engineers, Camp A. A. Humphreys, Va.

The following-named officers of the Corps of Engineers have been ordered transferred from the 4th Engineers to the 6th Engineers: Captain AUBREY H. BOND, Captain CLARENCE S. JARVIS, Captain SAMUEL H. HARRICK, Captain JOHN G. LITTLE, Captain FRANK W. MOORE, Captain KERYN AP RICE, Captain STEPHEN C. WHIPPLE, First Lieutenant WILLIAM H. WHEELER, First Lieutenant LESLIE H. GROVES, Jr.

Captain BENNETT H. BOWLEY, Jr., and Captain HARLEY LATSON have been relieved from their present duties in the Hawaiian Department, effective upon the completion of their present tour of foreign service.

Capt. WILLIAM H. CROSSON, Corps of Engineers, has been ordered transferred from Camp Travis, Texas, to Camp A. A. Humphreys, Va., for duty with the 17th Engineers.

Capt. SAMUEL L. DAMON, Corps of Engineers, has been ordered transferred from the 2d Engineers to the 13th Engineers, Camp A. A. Humphreys, Va.

Each of the following named officers of the Corps of Engineers has been relieved from his present duties at the station indicated and has been detailed as Assistant Professor of Military Science and Tactics at the institution specified:

Captain NOTLEY Y. DUHAMEL, from Camp Meade, Maryland, to the Carnegie Institute of Technology, Pittsburgh, Pa.

Captain ROBERT D. INGALLS, from Camp Pike, Ark., to Alabama Polytechnic Institute, Auburn, Ala.

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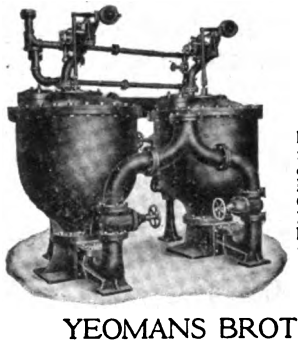
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Captain WALTER L. MEDDING, from Camp Jackson, S. C., to Missouri School of Mines, Rolla, Mo.

Captain WARREN A. LYON, from Camp Lewis, Wash., to University of Illinois, Urbana, Ill.

Captain WILLIAM C. ATWATER, from Camp Meade, Maryland, to Johns Hopkins University, Baltimore, Md.

Captain ROBERT H. ELLIOTT, from Camp Benning, Ga., to Iowa State College, Ames, Ia.

Captain F. RUSSELL LYONS, from Camp Grant, Ill., to Virginia Polytechnic Institute, Blacksburg, Va.

First Lieutenant DAVID A. D. OGDEN, from Camp Pike, Ark., to Massachusetts Institute of Technology, Cambridge, Mass.

First Lieutenant ARCHIE T. COLWELL, from Fort Sam Houston, Tex., to Rose Polytechnic Institute, Terre Haute, Ind.

First Lieutenant JAMES G. CHRISTIANSEN, from Fort Sam Houston, Texas, to Oregon Agricultural College, Corvallis, Ore.

First Lieutenant JOSEPH S. GORLINSKI, from Camp Benning, Ga., to University of Tennessee, Knoxville, Tenn.

First Lieutenant DOSWELL GULLATT, from Fort Sam Houston, Texas, to California Institute of Technology, Pasadena, California.

Captain LEONARD B. GALLAGHER, Corps of Engineers, has been assigned to the 1st Engineers, Camp Dix, N. J.

Captain LLEWELLYN B. GRIFFITH, Corps of Engineers, has been transferred from Washington, D. C., to Cincinnati, O.

Captain WILLIAM S. KILMER, Corps of Engineers, has been ordered attached for duty to the 2d Battalion, 3d Field Artillery.

Each of the following-named officers of the Corps of Engineers has been relieved from his present duties at the station specified after his name and has been ordered to Camp A. A. Humphreys, Va., for assignment to duty as student at the Engineer School:

Captain ALBERT C. LIEBER, Jr., Boston, Mass.; Captain GEORGE J. NOLD, Cincinnati, O.; Captain ROBERT M. COPELAND, Washington, D. C.; Captain CLAY ANDERSON, Camp Dix, N. J.; Captain FRANK B. HASTIE, Camp Grant, Ill.; Captain PHILIP T. COFFEY, Camp Pike, Ark.; Captain ALVA H. PERKINS, Camp Grant, Ill.; Captain ELLIS E. HARING, Camp Dix, N. J.; Captain LEROY W. CUMMINGS, Camp Grant, Ill.; Captain THEODORE B. PARKER, Camp Jackson, S. C.; Captain ROBERT C. HUNTER, Camp Pike, Ark.; Captain EDWIN P. KETCHUM, Blacksburg, Va.; Captain MARSHALL J. NOYES, Washington, D. C.; Captain GEORGE A. GEIB, Washington, D. C.; First Lieutenant JOHN C. ARROWSMITH, Cincinnati, O.; First Lieutenant CONRAD P. HARDY, Los Angeles, Cal.; First Lieutenant LEWIS A. MURRAY, Columbus, O.; First Lieutenant ROY P. BISHOP, Camp Pike, Ark.; First Lieutenant PHILIP B. BRUTON, Camp Pike, Ark.; First Lieutenant ROBERT F. GILL, Camp A. A. Humphreys, Va.; First Lieutenant ROY W. GROWER, Cincinnati, O.

Captain LEONARD LUNDGREN, Corps of Engineers, has been transferred from New York City to Camp A. A. Humphreys, Va., for duty as Instructor at the Engineer School.

The following changes in the assignment, station and duties of the officers of the Corps of Engineers have been ordered:

Captain DAVID MCD. SHEARER, from the 1st Engineers to Engineer Training Company No. 1, Camp A. A. Humphreys, Virginia.

Captain HAROLD G. LYONS, from the 2d Engineers to the 17th Engineers, Camp A. A. Humphreys, Va.

Captain HENRY B. POST, from the 2d Engineers to the 17th Engineers, Camp A. A. Humphreys, Va.

First Lieutenant FABIUS H. KOHLOSS, from the 7th Engineers, to the 2d Engineers, Camp Travis, Texas.

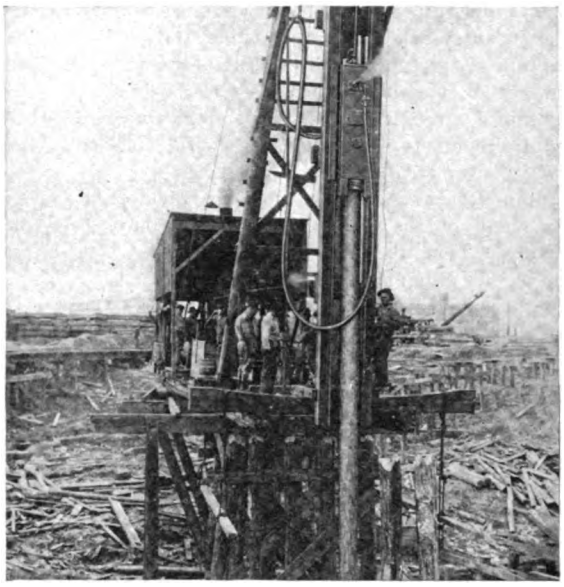
First Lieutenant Arthur J. SHERIDAN, from the 9th Engineers to the 1st Engineers, Camp Dix, N. J.

First Lieutenant PETER P. GOERZ, from the 9th Engineers to the 17th Engineers, Camp A. A. Humphreys, Va.

First Lieutenant WILLIAM C. BENNETT, Jr., from the 9th

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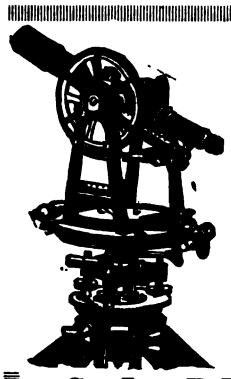


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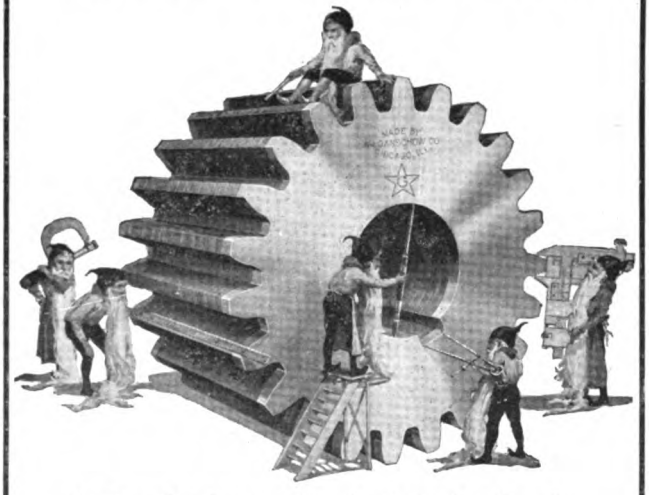
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Engineers to the 17th Engineers, Camp A. A. Humphreys, Va.

Captain HARRY A. SKERRY, 12th Engineers, and First Lieutenants CHARLES J. DAVIS, Jr., 2d Engineers, and HENRY C. WOLFE, 6th Engineers, have been assigned to duty as students at the Infantry School, Camp Benning, Ga.

Captain CLARENCE D. SYMES, Engineers, U. S. A., has been honorably discharged from the service.

Captain JAMES M. YOUNG, Corps of Engineers, has been ordered to report to Walter Reed General Hospital, Washington, D. C., for treatment.

Captain ROBERT A. LAIRD and First Lieutenant CLIFTON T. HUNT, both of the Corps of Engineers, have been ordered transferred from the 5th Engineers to the 17th Engineers, Camp A. A. Humphreys, Va.

First Lieutenant WILLIAM C. BENNETT, Jr., Corps of Engineers, has been transferred from Camp A. A. Humphreys, Va., to Washington Barracks, D. C., for duty at the Engineer Reproduction Plant.

First Lieutenant MARK M. BOATNER, Jr., Corps of Engineers, has been ordered to Camp A. A. Humphreys, Va., for duty.

First Lieutenant ROBERT E. COUGHLIN, Corps of Engineers, has been ordered transferred from the 4th Engineers to the 6th Engineers.

First Lieutenant SYDNEY W. GOULD, Corps of Engineers, has been detailed as student observer with the Pennsylvania Railroad with station at Philadelphia, Pa.

First Lieutenant OLE G. HOAAS, Corps of Engineers, has been transferred from Camp Meade, Md., to Washington, D. C., for duty as Assistant Engineer with the Federal Power Commission.

First Lieutenant RICHARD LEE, Corps of Engineers, has been transferred from Fort Sam Houston, Texas, to the 7th Engineers, Camp Jackson, S. C.

First Lieutenant FRED W. MARLOW, Corps of Engineers, has been detailed as student observer with the Southern Pacific Railroad with station at San Francisco, Cal.

First Lieutenant LEMUEL POPE, 3d, Corps of Engineers, has been detailed as student observer with the Baltimore and Ohio Railroad with station at Baltimore, Md.

Each of the following named officers of the Corps of Engineers has been relieved from station and duties at the place specified and has been ordered to proceed to Camp A. A. Humphreys, Va., for assignment to duty as student at the Engineer School:

Second Lieutenant PETER A. FERINGA, Philadelphia, Pa.
Second Lieutenant FREDERICK H. FOX, Kansas City, Mo.
Second Lieutenant CARTER JENKINS, Camp Grant, Ill.
Second Lieutenant HARRY MEYER, Kansas City, Mo.
Second Lieutenant DAVID ALBERT MORRIS, Camp Grant, Ill.
Second Lieutenant PAUL C. PARSHLEY, New York, N. Y.
Second Lieutenant RICHARDSON SELEE, Buffalo, N. Y.
Second Lieutenant EDWARD H. WALTER, New York, N. Y.

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"What and Why is a General Staff"

Discussion

Eben Swift
Brigadier General (Retired)

In the May-June number of your magazine there is an article entitled, "What and Why is a General Staff," by Donald H. Connolly, Major, General Staff. On page 225 the following statement appears: "In 1906 Major Morrison (now Major General) revolutionized the educational system of the army by putting into effect at the Leavenworth School a definite system to prepare officers for the tactical command of troops and General Staff duty."

Major Morrison assumed charge of the Department of Military Art at Fort Leavenworth on August 15, 1907. (See Report of Commandant for the year 1907-8.)

There is a belief among many of our officers that the most important development in the educational methods of our army was due to the adoption of the "Applicatory method of instruction." If this is true it may be in the interest of history to state some facts bearing upon that subject.

Between the year 1893 and the close of 1906, Captain (and Major) Eben Swift, U. S. Army, was on duty at the Fort Leavenworth schools for about six years. During that time he acted as Assistant Instructor and Senior Instructor in Military Art; as Assistant Commandant and Acting Commandant, he prepared the work here listed:

1. Lecture. Field Orders and Reports, April 2, 1894.
2. Map Problems, June, 1894. The march of a detached brigade of all arms from Fort Leavenworth against an enemy on Big Stranger Creek. There were six requirements included in the orders for the movement. Other problems followed, based on the French edition of Griepenkerl, April, 1896.
3. Lecture. Field Orders, Messages and Reports, November 22, 1895.
4. Translation. The War Game Simplified. Verdy du Vernois, 1897. Published by Hudson Kimberly and Company, Kansas City.
5. Essay. The Lyceum at Fort Agawan. Journal of the Military Service Institution of the United States, March, 1897.
6. Lecture. Introductory to the Course in Military Art at the Infantry and Cavalry School and Staff College, Fort Leavenworth, Kansas, September, 1904.
7. Course of Instruction for the Department of Military Art for the year 1904-5. (See Report of Commandant.)
8. Lecture. Orders, November, 1905.
9. Course of Instruction for the Department of Military Art for the year 1905-6. (See Report of Commandant.)
10. Translation. A Tactical Ride. Verdy du Vernois, 1906. Printed at the school.

The first lecture on orders was the basis of the following lectures on the same and kindred subjects, the last of which was officially adopted by order of the Secretary of War, for the guidance of the Regular Army and the Organized Militia, July 10, 1906.

The Map Problem in June, 1894, seems to have been our first problem of the kind, requiring the systematic issue of Orders.

The Essay in 1897 was an analysis and a plea for the introduction of the Applicatory System of Instruction into our army.

The translations in 1897 and 1906 were intended as text books for two out of the three district branches into which the Applicatory System was divided. The British translation of Griepenkerl became available in December, 1896. It covered the third branch and caused work on an American translation to be abandoned temporarily.

The lecture of September, 1904, was an announcement that the Applicatory System was adopted. The schedules showed the details of the course.

Colonel Arthur L. Wagner, the Assistant Commandant, wrote a long memorandum for the Commandant, on December 28, 1903. Referring to the school he said: "Its curriculum is not up to the standard that had been attained by the old institution which was discontinued at the outbreak of the Spanish War." (See Report of Commandant, 1904, page 87.) Whether we entirely agree with this criticism or not, it is plain that the school was still handicapped by a lack of text books in the several branches of Applied Tactics. The best books of the kind in the military world of that day were formally adopted in 1904-5-6. The principles therein contained were fixed by daily recitations, and the students were thus prepared for the original work which followed.

Major Boughton conducted the instruction of the Infantry and Cavalry Class from January 3 to August 15, 1906, and of both classes for the year 1906-7. Major Morrison had the course for five years following. During all this time and up to the present, a steady improvement has marked the progress of the Fort Leavenworth Schools.

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Maintaining the Motor Transport of a Field Army

(Continued from page 469)

Discussion

By

Brainerd Taylor
Major, Quartermaster Corps

"Maintaining the Motor Transport of a Field Army" by Major M. D. Mills, Engineer R. C., presents in the main a very fair and conservative picture of one of the most trying and dangerous situations in the A. E. F. during the World War. I have always believed that had the war continued a few months longer great disaster must surely have overtaken an army so extended into enemy territory as was ours, with its principal means of field mobility in the condition described by Major Mills. The failures to observe the "seven essentials" which Major Mills gives in italics, in his sixth paragraph, could have had but one end, that which would have followed the paralysis of motor mobility of an army greatly extended from its forward bases and deployed in front of a powerful enemy.

Major Mills' idea that "Efficiency of operation is not possible of attainment until all motor vehicles, excepting only combat and special vehicles, are operated and maintained by a single arm of the service with all personnel, whether drivers or mechanics, drawn from, trained by, and looking to that arm for their promotion and technical control" is the crux of the whole situation. In any serious competition requiring a high order of mechanical mobility for its personnel and material, the employment of a corps of specialists is inevitable if superiority of mobility over rivals or opponents is to be gained and maintained. With the accomplishment of a homogeneous motor transport organization most of the other difficulties described by Major Mills would rapidly disappear. The change of opinions from dissatisfaction to satisfaction among those who depend upon motor transport for their mobility would be very great in a reasonably short time, because they would control not just so many vehicles and drivers, but an effective local motor transport service in the thoroughly organized units detached from, and with all the support of, a highly specialized service possessed of equipment, trained personnel and authority to meet all the mechanical requirements of motor vehicles in the field.

Intelligent handling of automotive spare parts, effective and adequate replacements, minimizing the necessity of shop repair and gaining a maximum of vehicle life, are all inseparably bound together within the technical functioning of a single transportation service. Who and what are transported and for whom or for what purposes personnel and material are transported, have very little to do with the question of gaining and maintaining superiority in motor mobility. These matters belong purely to the *business* functioning of a transportation service, and while of paramount importance to the military establishment, their successful transportation when and where needed depends absolutely on successfully meeting the mechanical requirements of vehicles.

The business of a motor transport service is to give passengers and shippers or personnel and material transported the most effective and economical mobility required by their special missions or uses. This primary purpose is ultimately defeated when any part of the technical functions, especially vehicle operation and control of driving personnel, is surrendered by the technical organization to the passengers or shippers that it serves.

The turning over of freight trains to shippers, or consumers, or the turning over of artillery without artillerymen to the infantry for operation, would be no less extravagant and ineffectual than our present system of turning over motor vehicles, with or without personnel, to any other service for operation than the specially organized motor transport service.

In justice to the Motor Transport Corps, which struggled bravely and patiently under the great disadvantages cited by Major Mills, to give the greatest possible service to the armies in the forward areas, I wish to correct an erroneous statement in Major Mills' article. The "Provisional First Army Supply and Repair Park," referred to by him, was not organized in the First Army and by it located first

(Continued on page 523)

Seattle Post Endorses American Cable Project

On May 28, 1921, the Seattle Post of the Society of American Military Engineers met and on the conclusion of the regular business, a resolution was offered and unanimously adopted as follows:

"Recognizing the commercial and strategic value and importance of an all-American cable between the United States of America and the Orient, *Be It Resolved That*: The Seattle Post of American Military Engineers in meeting assembled do indorse the efforts now being made by Senator Wesley L. Jones and the Washington delegation in Congress for the construction of an "All American Cable" via the shortest practical route between the United States of America and the Orient. That copies of this resolution be mailed to Senator Jones, Senator Poindexter and our Congressmen at Washington and to the Secretaries of all Posts of Society, including the parent office of the Society."

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Proposed Amendments to Constitution and By-Laws

At the last annual meeting of the Society, a committee consisting of Lieut. Col. G. A. Youngberg, Lieut. Col. C. H. Birdseye, and Major W. O. Tufts was appointed to consider a resolution passed by the Chicago Post in October, 1920, reading as follows:

"Whereas, the Society of American Military Engineers is organized for preparedness, promotion of good citizenship and the furthering of friendships created during the World War, it is desired to open the doors of this Society to the young men who will be the future citizens of the country.

"Therefore, be it resolved, that the parent Society be requested to consider such a change in the Constitution as will add another class of members called Junior Members."

Subsequent to that meeting, the question has also come up concerning the establishment of student chapters, which question was referred to the same committee for consideration.

The committee accordingly suggests the following:

Amendments to Constitution

Amendment No. 1. After the word "Associate" insert the word "Junior," so that this section shall read:

"1. *Classification.* The membership of the Society shall be classified as Active, Associate, Junior and Honorary."

Amendment No. 2. Re-number sections 4 and 5, so that they shall bear the numbers 5 and 6 respectively.

Amendment No. 3. Insert a new section 4, as follows:

"4. *Junior Members.* Male persons not less than fifteen, nor more than twenty-one years of age shall be eligible to junior membership: *Provided* that no such person shall be deemed a junior member unless he shall also be a member of a junior post or section, as provided in the By-Laws of the Society."

Amendments to By-Laws

Amendment No. 1. Article IV. Number the existing section No. 1.

Amendment No. 2. Add a new section, viz.:

"2. *Student Sections.* Male persons duly enrolled as students in engineering or technical courses in educational institutions, being eligible to associate membership, may form student sections, subject to conditions described in Section 1 of this article: *Provided* that the annual dues of associate members, who are also members of such student sections, may, by a majority vote of the Board of Directors, be fixed at less than the annual dues for active members; *Provided further* that the number of copies of THE MILITARY ENGINEER and other publications sent to such units shall be fixed by the Board of Directors, according to the cost of publication and the amount of money paid in by such student sections."

Amendment No. 3. Add a new section, viz.:

"3. *Junior Sections.* A junior post or section to be composed of junior members only may be organized in affiliation with any (senior) local post or section, upon favorable vote by such (senior) post or section. The name of such an affiliated junior post or section shall be the same as that of the (senior) post or section with which it is affiliated, except that the word 'Junior' shall be inserted at the proper place in the title, to distinguish it from the (senior) local post or section proper. Subject to the general supervision of the (senior) local post or section, exercised through such persons or agencies as the latter may direct, each such affiliated junior post or section shall establish its own rules of government and procedure, which shall conform to any regulations which may be promulgated by the Board of Directors. The number of copies of THE MILITARY ENGINEER and other Society publications to be sent to such units shall be fixed by the Board of Directors according to the cost of publication and the amount of money paid in by such junior sections."

Comment

The reasons for the proposed amendments relating to the establishment of student chapters are obvious.

The objects to be obtained by the amendments relating to junior members merit some explanation. At first glance, this might appear to be a variation of the Boy Scout idea, and competition might be introduced; but there is a period between the ages of fifteen and twenty-one when a boy is too old for Boy Scout work, and too young to go to college, and during this period it is possible that some useful work might be done by junior organizations of the Society. It is the opinion of the Committee, however, that junior members of this class should not be admitted unless they can be united into junior posts or sections under the direct supervision of a senior post

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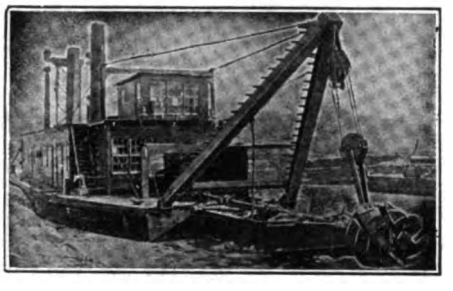
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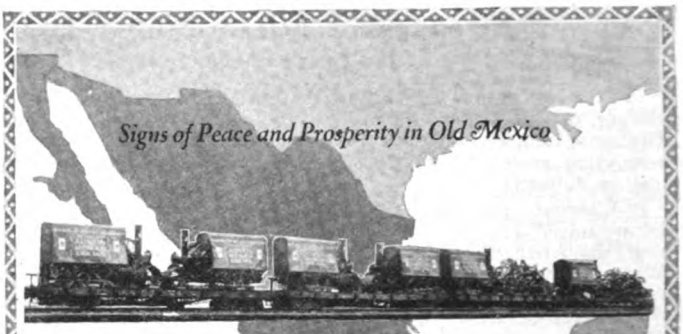
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or section. It is believed that local posts can do a great deal to further the interests of the Society and to recruit future members, by interesting themselves in the Boy Scout movement in their communities, aiding in the instruction of the Boy Scouts, and introducing engineer work that is interesting, and still within the mental grasp of young boys. When these boys become too old for Boy Scout work, they can readily be interested in the junior posts of the Society and eventually, upon reaching their majority, may become active or associate members, according to their technical qualifications.

Local posts should interest themselves in the student sections, and particularly in the Engineer units of the Reserve Officers' Training Corps established at the various educational institutions of the country. They are recognized elements of the Military Reserves of the country, and their support and growth are directly in line with primary objects of the Society.

As a matter of necessity, dues for student members and for junior members will be very low, and will not pay the cost of publishing THE MILITARY ENGINEER, so that one copy can not be sent to each such student or junior. It is planned, therefore, to send to each student section, or to each junior section, such number of copies as is covered by the funds received. That is to say, for each five dollars paid in the National Society by sections mentioned, a copy of THE MILITARY ENGINEER will be sent to the Secretary of the section. The amendments are worded as to give the Board of Directors a wide discretion in the matter, and if the funds of the Society warrant it, the number of copies may be increased any time.

Recommendation

The committee recommends that the amendments to the Constitution and By-Laws, together with necessary explanatory comment, be submitted to a vote of the membership of the Society, as provided by Article VI of the Constitution, and Article XII of the By-Laws.

GILBERT A. YOUNGBERG,
Lieut. Colonel, Corps of Engineers,
Chairman of the Committee.

C. H. BIRDSEYE,
Lieut. Colonel, Officers' Reserve Corps.
Major W. O. TUFTS.

(Note.—The proposed amendments will be submitted to the Society with the ballots for the election of officers.—*Secty.*)



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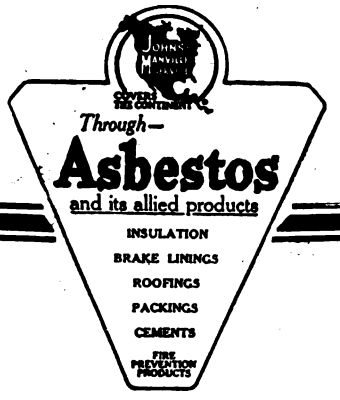
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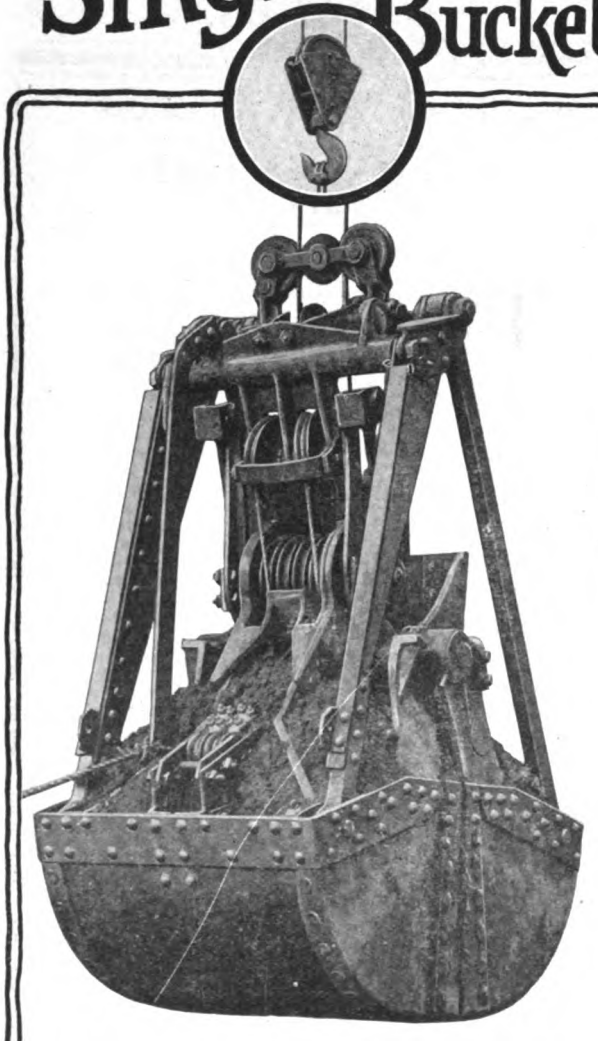
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Nominations of Officers for 1922

Report of Nominating Committee.

In transmitting a list of nominations for President, First and Second Vice-President and for six directors to serve for three years (of whom two represent the Regular Army, two the Reserve Corps and two the membership at large), the Nominating Committee has followed its understanding of the by-laws (Art. VIII, pars. 4 and 5) and restricted the nominations to a single list.

In order that the list might best fulfill the committee's policy both geographically and selectively, the following letter was addressed to the Secretary of each local post in the country so far as listed in the September-October number of THE MILITARY ENGINEER:

"October 1, 1921.

"At a meeting of the Nominating Committee of the Society of American Military Engineers held in Washington, September 30, for the purpose of making nominations as provided in the by-laws (Article 8, Paragraph 4, etc.), it was unanimously agreed to invite suggestions from local posts throughout the country. Nominations are to be made for President, First Vice-President, and Second Vice-President to serve for one year and for six directors to serve for three years, of whom two shall represent the Regular Army, two the Reserve Corps and National Guard, and two the membership at large.

"As a policy governing nominations, this Committee feels that the best interests of the Society warrants the election of a President and First Vice-President from among candidates living in or near the Washington headquarters, but that the Second Vice-President should represent middle or western country. In making nominations for the six vacancies in the Board of Directors, the committee feels that the representation in the West should be increased.

"In order that the Nominating Committee may have the benefit of local sentiment, I should be glad to receive from you by October 21, or preferably earlier, a list of those members of the Society who, in the opinion of the officers of your Post, are especially qualified for the duties of the positions as above outlined. The names submitted should be accompanied by local addresses together with status as to membership (Regular, Reserve, or at large). Your co-operation along these lines will be helpful to the Committee and will tend to make its report more representative of the thought of the Society at large.

"Your attention is also called to a clause in the by-laws (Article 8, paragraph 5) whereby a nominating letter signed by ten members and reaching the Secretary of the Society by December 1st will formally place such names in nomination."

This letter is being sent to the secretaries of all local posts. posts."

The replies received were largely based upon special meetings held by the local posts for the purpose of making such recommendations, and inasmuch as approximately 50 per cent of the Society membership is represented through its local sections your committee feels that it has obtained in the short time allotted, a large degree of representative opinion.

The Nominating Committee after full consideration of all names suggested, submits the following nominations for the offices as specified:

For President—Lt. Col. G. A. Youngberg, R. A., Washington, D. C.

First Vice-President—Lt. Col. J. P. Hogan, R. C., New York City.

Second Vice-President—Capt. Douglas W. Dodge, R. C., San Francisco.

For two directors (Regular)—Col. E. M. Markham, Detroit; Major C. T. Leeds, Ret., Los Angeles.

For two directors (Reserve)—Col. E. A. Gibbs, Pittsburgh; Lt. Col. H. P. Ralston, New Orleans.

For two directors (at large)—Col. E. J. Spencer, St. Louis; Major Joseph Jacobs, Seattle.

In submitting the above list the committee has the assurance that each name below and including the office of Second Vice-President, has the indorsement of the local post represented.

Very truly yours,

W. M. BEAMAN,
Secretary, Nominating Committee.

Nominating Committee:
Brig. Gen. Harry Taylor, R.A., President.
Col. John Stewart, R.C.
Maj. W. M. Beaman, R.C., Secretary.
Capt. E. P. Ellis, A.L.
Capt. Robert Coe, A.L.

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(Continued from page 518)

at Toul, then at Thiaucourt and finally at Frana Ferme near Nixeville, as stated. In compliance with the provisions of an A. E. F. order requiring the Chief Motor Transport Officer of the Advance Section to "keep contact" with the armies in his front, and after consultation with the Chief Motor Transport Officer of the First Army, two advance service mobile repair parks and spare parts dumps were organized from personnel and material assigned to the advance section overhaul parks at Langres and at Neufchateau. These advance agencies of the Motor Transport Corps, S. O. S., were sent up into the army area to operate under the orders of the Chief Motor Transport Officer of the Army with instructions to keep close contact with the main body of which they were a part, namely the Motor Transport Corps of the Advance Section, through its nearest overhaul parks and spare parts depots, for support and supply in meeting the immediate and urgent needs of the army. The first park and dump were located at Toul for the First Army. They remained at Toul and were later taken over by the Second Army. The second park and dump, first located at Commercy, were moved at once by the Chief Motor Transport Officer, First Army, to Thiaucourt and thence to La Frana Ferme; it remained and moved with the First Army. These were distinctly efforts of the Motor Transport Corps of the S. O. S. to render greater and more effective service to the armies under very great difficulty and confusion, due to very faulty motor transport organization throughout the army. That army policies of taking over and controlling everything in army areas robbed the Motor Transport Corps, S. O. S., of the credit for this effort and practical assistance, should not be forgotten in view of Major Mills' opening paragraph in which he pictures the Motor Transport Corps as "staggering wearily on its way, being judged and generally found wanting."

G. R. Young
Major, Corps of Engineers

I have few comments to make on Major Mills' very excellent article. Major Mills was in direct touch with the problems he discusses throughout the fighting period of the First Army. His efficiency in "begging, borrowing or stealing" spare parts, all of which he practised with persistence and success, is unquestioned by any who knew him; also his ability in handling a difficult and thankless job.

Regarding "operation," Major Mills is evidently a strong advocate of centralized operation. I concur in this heartily. But I would like to know more of his ideas with respect to the operation of ambulances, and in general of "combat" trucks. There are several degrees of operation which can be practised by the M. T. C. If he means that ambulances in a division, for example, are to be handled directly by the M. T. C. as are supply train trucks, I think he goes too far, not only because it is perhaps bad organization theory, but because the medical department would strenuously object. Everyone wants to operate his own vehicles. If this natural jealously is disregarded too much, the M. T. C. will get a universal reputation for interfering beyond its province, which will make trouble for itself. And in the case of ambulances, I think there are sound organizational reasons for letting their movements in detail be controlled by the medical authorities.

For strictly centralized operation, the line should be drawn at what I have called "supply transportation"—the cargo trucks that handle large and varying amounts of miscellaneous supplies—the old supply and ammunition trains, supply columns, trains of artillery parks, etc. Beyond that —say for ambulances, motorized combat trains, or engineer trains—the M. T. C. should make a fight to have the personnel belong to the M. T. C. and be trained by the M. T. C., but should leave their handling to the corps they serve. The principal interest of the M. T. C. is efficient handling and care of the individual vehicles. Its personnel on such vehicles should be in much the same situation as a medical detachment with a small infantry outfit. The division surgeon trains them, pins on their collar ornaments, and oversees their manipulation of pills, but does not order their movements as he does those of a field hospital.

There is a real line between "supply" and "combat" transportation, analogous to that between the railway trains that enter a city terminal and the taxicabs that leave it. Centralized operation, the railroad system, must stop somewhere. The best place for it to stop is with the assimilation of the large, uniform truck groups that move supplies or men in bulk. If it goes further it will get into organizational difficulties; and equally important, will injure so many susceptibilities that it will have to retire from the field.

Perhaps this is Major Mills' idea also; he is not definite on the point, and I want simply to have it made clear.

Major Mills rightly emphasizes the importance of mobile repair units. In open warfare, say on this continent, they will be the mainstay of the repair system. Can't he abolish the spare-parts "trailer," though? Trailers, unless very small and light, are out of place in a mobile combat force. The example of the heavy "mobile" ordnance machine shops is proof enough. As to overhaul parks, or repair battalions, it seems to me an open question whether their mobility justifies attachment to a corps; but no doubt this point has been considered by the thoroughly experienced maintenance personnel of the M.T.C. Whether armies, corps, or S.O.S. operate the overhaul parks, I think it should be the doctrine that a vehicle sent to them is *lost* to the owner, who receives (we hope) a replacement, the original vehicle being repaired and placed in general stock; whereas in the advance mobile repair units, the *individual vehicle* is repaired and returned to its owner.

Major Mills speaks with feeling of the practice of stripping damaged vehicles. I suggest a remedy. The first case I saw of this was in Mexico, in 1916. My immediate commanding officer was using a Ford car. It was in bad condition, and finding an abandoned Ford ambulance by the road, he removed from it a number of parts. He was later called on officially to state what he had taken, and why. He replied in substance that he had taken everything he could carry, and regretted it was not more; the reason being that it was the sensible thing to do. This little affair was an omen of conditions in France; and I think that the officer in question was (as usual) right. It is the sensible thing to do, within limits. I suggest for criticism the idea that when authority is obtained to salvage a vehicle, it include authority to strip the vehicle. It will be done anyhow; if the salvaging organization is too pious to do it, others will before the wreck gets back to the rear. The salvaging organization will probably have others of the same class of vehicles, so that the parts obtained will be of real value to them. The reconstruction park, where the vehicle will eventually go, will of course have additional trouble and expense. But it is down by the base of supplies, where parts are more plentiful, whereas up front they will *always* be in demand. This, of course, should apply only to vehicles in such bad shape that they are sent out of the fighting zone altogether, back to the big immobile parks at the bases.

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Major Mills is very mild in his remarks about the supply of parts and tools from America to the A. E. F. An M. T. C. board, principally of officers of the A. E. F., investigated this on their return from France, and their report is on file in Washington. The condition they found, as to disregard of the expressed needs of the A. E. F., delay and red tape in filling requisitions, etc., was probably chargeable more to the system than to any individual. It was a condition of disgraceful inefficiency.

Applications

This list contains the names of only those applicants from whom formal applications have been received between July 15 and October 20, 1921:

Adams, Lieut. James C., 618 Avenue B, San Antonio, Texas
Anderson, Lieut. Amil A., 70 John Sedgwick, Newcastle, Wyo.
Anderson, Lieut. Jos. W., 2730 Portland Ave., S. Minneapolis, Minn.
Atterbury, Gen. W. W., Broad Street Station, Philadelphia, Pa.
Atwater, Capt. Wm. C., Johns Hopkins University, Baltimore, Md.
Augustus, James M., 151 S. Light St., Springfield, Ohio.
Aurandt, George M., 1005 Twenty-seventh Aye., Altoona, Pa.
Balch, Lieut. Elwyn C., 195 Broadway, N. Y. City.
Barber, Major E. L., 1228 Sixteenth Ave., San Francisco, Cal.
Barton, Lieut. F. Eugene, 412 Bellevue Ave., Oakland, Cal.
Bates, Capt. Guy, 9 Fernwood Rd., Summit, N. J.
Baur, Lieut. George, 2732 Bedford Ave., Brooklyn, N. Y.
Bellin, Capt. A. B., 4420 Washburn Ave. S., Minneapolis, Minn.
Berry, Sgt. Carl C., Post Hqrs., Marine Barracks, Paris Island, S. C.
Best, Lieut. Richard D., 4700 Berkley Ave., Louisville, Ky.
Bickford, Capt. John W., Gilboa, N. Y.
Blanchard, S. E., Care Camp Utilities, Camp Knox, Ky.
Bouton, Charles W., Prattsville, N. Y.
Boyce, Lieut. Marvin R., 322 McCormick Bldg., Chciago, Ill.
Bowles, Maj. Hardy, 71 25th St., Elmhurst, L. I., N. Y.
Brayton, Capt. Wm. M., 111 N. Kenilworth Ave., Oak Park, Ill.
Brennan, Lieut. John T., 39 Eighth Ave., Brooklyn, N. Y.
Brooks, Capt. Frank W., Jr., 100 Jefferson Ave., E., Detroit, Mich.
Brown, Capt. Alfred T., 2 Mable Hill Ave., N. Y. City.
Burden, Maj. W. W., 1236 Goodfellow Ave., St. Louis, Mo.
Busch, Capt. G. Walton, 823 Fox St., N. Y. City.
Butler, Capt. Jesse V., Huntsville, Texas.
Byonton, Lieut. Henry B., Blacksburg, Va.
Callahan, Lieut. J. L., 814 N. Meridian St., Indianapolis, Ind.
Camet, Lieut. J. J., 311 Lincon St., Carstadt, N. J.
Carson, Maj. Matthew B., 56 N. Bartram St., Atantic City, N. J.
Chase, Hugh Donald, Unity, Me.
Chittenden, Capt. A. F., 4106 Burke Ave., Seattle, Wash.
Clark, Lieut. J. W., Troy, N. Y.
Clarkson, Maj. John L., 757 Drexel Building, Philadelphia, Pa.
Cleary, Lieut. C. Norman, 2815 Grand Concourse, Bronx, N. Y. City.
Cole, Capt. Donald, 624 McKerchey Building, Detroit, Mich.
Cole, Wesley, Signal Office, Ft. Howard, Md.
Coleman, Maj. John B., 152 Taber Ave., Providence, R. I.
Collier, Sgt. Frederick W., 2353 N. Talbot St., Indianapolis, Ind.
Corbin, Lieut. Malcolm D., 92 Nevada Ave., E., Detroit, Mich.
Cresson, Capt. H. C., 3102 Shattuck Ave., Berkeley, Calif.
Cruse, Capt. R. E., Troy, N. Y.
Davis, Jesse G., Jaser, Ala.
Dayton, Capt. R. B., 40 Maple Ave., Morgantown, W. Va.
Diver, Mortimer L., Box 69, San Antonio, Texas.
Dixon, Chas. Y., 337 Federal Building, Dtroit, Mich.
Donnelly, Lt. Joseph B., 6155 Jefferson St., Phila., Pa.
Dowling, Angus M., Denmark, S. C.
Doyle, Harry K., Rosedale, Miss.
Drips, Lieut. A. N., 813 S. Anderson St., Tacoma, Wash.
Drury, John D., 45 Lamoille Ave., Bradford, Mass.
Duff, Capt. Levi B., 1104 Empire Building, Pittsburgh, Pa.
Duncan, Geo. W., Jr., 58 Sutter St., San Francisco, Calif.
Dunn, Charles P., care Skagit River Power, 110 Cherry St., Seattle, Wash.
Eistetter, Lieut. Leo A., Apdo. 40, Tampico, Tamps, Mexico.
Feldes, Lieut. Col. R. A., Gibson, Ind.
Fisk, Maj. J. H. P., Walsenburg, Colo.
Focardi, Capt. Pier L., Army Supply Base, Boston, Mass.
Foster, Lieut. E. J., P. O. Box 315, Laredo, Texas.
Fox, Capt. Philip, Cohasset, Mass.
Freeman, Capt. John G., Brawley, Ca.
Frenzell, Lieut. E. H., 305 W. Olive Ave., Redlands, Cal.
Froebel, Lieut. G. S., 918 Union Nat. Bank Building, Houston, Texas.
Gamble, Winfield S., 1312 Terry Ave., Seattle, Wash.
Gardiner, Harry M., 2223 Euclid Ave., W., Detroit, Mich.
Gartner, Roy G., Madison, W. Va.
Geist, Lieut. A. Joseph, 276 Fifth Ave., New York City.
Gillingham, Lt. Geo. O., Lakehurst Proving Ground, Lakehurst, N. J.
Goedike, Capt. John G., 317 La Fitte St., San Antonio, Texas.
Gordon, Capt. Douglas, 88 Myrtle St., Lynn, Mass.
Gotwals, Maj. John C., Juneau, Alaska.
Graves, Walter J., 1600 R. E. Exch. Building, Detroit, Mich.
Gregory, Maj. H. W., 1310 E. Jefferson, Boise, Idaho.
Griggiths, Geo. E., Grand Gorge, N. Y.
Guiteras, Maj. H. G., Iowa State College, Ames, Ia.
Hall, G. D., Sunnyside, Wash.
Harding, Capt. George M., Wynnewood, Pa.
Haring, Capt. Ellis E., 1st Engineers, Camp Dix, N. J.
Harrison, Lieut. John J., 3422 Minnesota Ave., Duluth, Minn.
Hawley, John C., 841 David Whitney Building, Detroit.
Hazlehrigg, Maj. Thomas H., 1227 W. 29th St., Indianapolis, Ind.
Henny, D. C., 1006 Spalding Building, Portland, Oreg.
Herkness, L. C., 208 S. 3d St., Philadelphia, Pa.
Hines, Capt. P. R., 703 Lewis Building, Portland, Oreg.
Hoaas, Lieut. Ole G., 5th Engineers, Camp Meade, Md.
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Kerns, Maj. Samuel M., 1076 Cerritos Ave., Long Branch, Calif.
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Mason, Frederick H., 614 Moffat Building, Detroit.
Meyer, Lieut. Harry, Camp A. A. Humphreys, Va.
Miller, Hubert S., 611 E St., Centralia, Wash.
Miller, John D., 97 Red River St., Austin, Texas.
Monro, Lt. Wm. L., Jr., 5840 Wilkins Ave., Pittsburgh, Pa.
Mooney, Lieut. George T., 4411 Kemper Ave., St. Bernard, Ohio.
Motz, Thos. B., 1211 Syndicate Trust Building, St. Louis.
Murphy, T. F., U. S. Geological Survey, Wash. D. C.
Nelson, Maj. Wm. H., 4210 Bagley Ave., Seattle, Wash.
Nettleton, Lt. Elwood T., 29 Huntington St., New Haven, Conn.
Noble, Lt. Geo. H., 30 Gould Ave., Patterson, N. J.
Noerenberg, Maj. Clarence E., 401 L. A. Ry. Bldg., Los Angeles, Calif.
Nold, Capt. George J., Fort Thomas, Ky.
Oehmann, Maj. John W., Room 110, District Bldg., Washington, D. C.
Orbeck, Martin J., 507 Walnut St., Ann Arbor, Mich.
Ostlind, Lieut. B. B., 415 Sixth St. S., Marshfield, Ore.
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Military Instruction

No. 4: NOVEMBER-DECEMBER, 1921

EDITOR
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Corps of Engineers

MILITARY ART
Maj. ROBERT P. HOWELL
Corps of Engineers

MILITARY ENGINEERING
Maj. ROSCOE C. CRAWFORD
Corps of Engineers

GENERAL SUBJECTS
Maj. ALFRED L. GANAHL
Corps of Engineers

Military Art, Note 4

Map Problem, No. 3—A Solution

The following is a solution of Map Problem No. 3, which was published in the September-October issue of the MILITARY ENGINEER, page 462.

First Requirement—

Major M assembles Capt. B, commanding Co. "B;" Lt. D, commanding the 3rd platoon of Co. "B," and Lt. A, the battalion adjutant, in his tent and issues the following verbal order at 5:10 p. m., indicating on the map the places mentioned:

"Our detachments along the border report that the enemy has had small mounted patrols west of Harney and Stull's today and that the crossing at Bridgeport is held in comparative strength.

"The regimental commander telephones that he has no further information of the enemy and that the orders for the regiment remain unchanged. This battalion remains in its present camp tonight.

"Lt. D—Your platoon and one motorcycle will compose the outpost, under your command. Place outguards covering the roads from Kingsdale, Harney, Bridgeport and Crabster and send occasional patrols along the southeast edge of town. In case of attack, hold a line on the outskirts of the town. Have your outguards in position by 6:00 p. m. and submit sketch of the outpost to me by 6:30.

"Capt. B—Give Lt. D's men supper before they go on duty and send out hot breakfast tomorrow morning. No fires will be allowed at the outguards.

"Lt. A—Have the motorcycle now outside report to Lt. D at once. Arrange for two of your supernumerary drivers to report to Lt. D at 6:00 p. m. and relieve the present driver during the night.

"My headquarters will remain in its present location."

Second Requirement—

Outguard No. 1 (one squad) at cross roads 400 yards northeast from S. H.

Outguard No. 2 (two squads and one sergeant) at roadfork 491, one-half mile northwest from S. H. Places auto rifle covering each road and maintains double sentry at night; single sentry in day. During day sends cossack post forward to hill 507.

Outguard No. 3 (one-half squad, with auto rifle) at road cut 500 yards southwest of S. H.

Support (remainder of outpost) at main cross street. Posts single sentry. Furnishes three visiting patrols of three men each. Route: Support to Outguard No. 1; south and west around town to Outguard No. 3; east and north around the town to Outguard No. 2; back to support.

Third Requirement—

Outguard No. 1 (Sentry Squad)	Double sentinel	6	
	Corporal	1	
	Supernumerary	1	
	Total	8	—1st squad 1st Sec.
Outguard No. 2 (Picket)	Double sentinel	6	
	Corporal	1	
	Supernumerary	1	
	Total	8	—2d squad 1st Sec.
	Extra squad, in support	..	—3d squad 1st Sec.
	N. C. O. in charge	.....	—Sec. leader 1st Sec.
Outguard No. 3 (Cossack Post)	Single sentinel	3	
	Corporal	1	
	Total	4	—½ 1st squad 2d Sec.
Support	Outpost commander	....	—Platoon leader
	Patrols, leaders	3	—Platoon sergeant Sec. guide 1st Sec. Sec. guide 2d Sec.
	Privates, 3 at 2 each	6	—2 platoon runners ½ 1st squad 2d Sec.
	Support, main body, two squads	.....	—2d and 3d squads, 2d Sec.
	N. C. O. in charge	.....	—Sec. leader 2d Sec.
	Outpost commander's orderlies	2	—Platoon runners
	Motorcycle drivers.		

Note.—Support posts running guard (one man, one hour tour) from the 2d and 3d squads 2d Section.

Map Problem, No. 4—An Advance Guard

MAPS—

Gettysburg General Map.
Gettysburg 3-inch Map, Taneytown and Emmitsburg sheets.

General Situation—

This problem is a continuation of Map Problems Nos. 1 to 3, published in previous issues of the MILITARY ENGINEER.

Special Situation—

Same as for Map Problems Nos. 1, 2 and 3, with the following additions:

The outpost, composed of the 3rd Platoon of Co. "B," was established at 6:00 p. m., June 4th, on the outskirts of Taneytown, one outguard being at roadfork 491, on the Taneytown-Bridgeport road. By 6:45 p. m. the observation

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groups had returned to Taneytown, bringing the following additional information concerning the enemy:

A mounted force of 75 to 100 men entered Bridgeport from the direction of Emmitsburg about 5:00 p. m., but made no effort to cross the Monocacy. About 5:15 p. m., as a Blue Infantry patrol was leaving Harney to join the platoon at Piney Creek church, a mounted force of 30 or 40 men entered Harney from the west and apparently remained there.

At 7:30 p. m. Lt. S, from regimental headquarters at Littlestown, arrived at Taneytown in a motor car and gave Major M a secret dispatch.

At 8:00 p. m. Major M assembles his company commanders, the battalion adjutant and Lt. S in his tent and issues the following verbal order:

(Note.—It is assumed that all information concerning the enemy stated to this point has been communicated to the officers of the battalion and to Lt. S.)

"A Blue patrol from Littlestown found Two Taverns held today by a hostile force estimated between a platoon and a company. Our secret service reports that the Red mobilization at Waynesboro is proceeding somewhat faster than we expected and that a movement toward Emmitsburg in the next few days is not unlikely.

"The following general plan of campaign is confidential to the officers assembled here. Our War Department plans an immediate advance on Emmitsburg, the 1st Infantry seizing and holding the crossings of the Monocacy until the arrival of reinforcements from Westminster.

"Our regiment advances on Harney tomorrow afternoon.

"This battalion will march to Bridgeport tomorrow and seize the crossing of the Monocacy.

"The advance guard will be composed of Co. 'C' and the mounted detachment, under command of Capt. C, and will clear the street crossing at the west corner of this square at 6:30 a. m., marching by the direct road on Bridgeport.

"The main body, in order of march, Co. 'A', Co. 'D,' Co. 'B,' (less 2d Platoon), will follow the main body at 500 yards.

"Outguards will be withdrawn at 6:20 a. m. and the outpost platoon will take its proper place in column at the first hourly halt.

"The train, escorted by the 2d Platoon of Co. 'B,' will march in the order, battalion combat train, water carts and rolling kitchens, ration-and-baggage wagons, and will follow the main body at 300 yards. Wagons will report to Lt. T of the escorting platoon at the street crossing south of the school house between 6:15 and 6:25 a. m.

"I shall be at the head of the main body."

To Lt. S:

"On your return to Littlestown, please inform the regimental commander of the gist of this order."

To the Bn. Adjt.:

"Give the necessary instructions for the combat train and inform Lt. L, Lt. T and the outpost commander of so much of this order as concerns them."

To Captain C:

"I suggest that you consult with the officers who were out near the frontier today and obtain any information of value which they may have concerning the terrain."

Required—

1. Captain C's estimate of the situation.
2. His orders.

Note.—Reveille on June 5th has been prescribed for 5 a. m.

References:

Same as for Map Problems Nos. 1 to 3.

Military Engineering, Note 4

Problem 3—Organization of the Ground

MAPS:

Mount Vernon Quadrangle U. S. G. S.
Camp Humphreys 1:5000, North Section.

Texts: E. F. N. No. 13. A.E.F.

General Situation—

The James River is the boundary between hostile states, Blue (North) and Red (South). The Red Army having mobilized more rapidly than the Blue, has invaded Blue territory and has defeated the Blue forces in three engagements, the last one being near DUMFRIES on QUANTICO CREEK. The Blue Army is retreating in good order along the roads running northeast towards ALEXANDRIA. The victorious Reds are pushing vigorously forward with the purpose of capturing WASHINGTON, the Blue Capital. Blue reinforcements have arrived from the North and Blue High Command has decided to organize a defensive line east of ACCOTINK CREEK until their forces are sufficiently reorganized and reinforced to permit taking up the offensive. A rear-guard delaying action on OCCOQUAN CREEK holds the enemy on this line for four days, permitting a partial organization of the position chosen by the Blues for defense.

Special Situation—

The 1st Blue Division (1st, 2d, 3d and 4th Regts. of Infantry) is assigned to the sector on the left of the line. The 1st Infantry occupies the sub-sector from the road running east through Accotink to a line from 3125 to 4535, with the 1st and 2d Battalions in front line and the 3d Battalion in Regimental Reserve.

Orders from Headquarters, 1st Division, for the organization of the position have prescribed the following:

(a) The general location of the outpost line along the east bank of ACCOTINK CREEK; of the firing line, along the forward slopes of the hills just northeast of the Standard Gauge railroad; and of the regimental reserve line, from a point 3742 along the forward slope of the hill at MASON FARM, thence in front of the woods to point 5717.

(b) Sub-Sector Boundaries; that between the 1st Infantry and 2d Infantry being given in the first paragraph of this "Special Situation."

(c) Limits of battalion centers of resistance; the dividing line between the 1st and 2d Battalions of the 1st Infantry being along the line 4016; 6330.

(d) That each battalion shall hold the outpost line by squads detached from the platoons in the front line.

(e) That battalion commanders, after consultation with each other, shall arrange for flanking fire by machine guns across the intervals between the centers and along the front lines.

You are an engineer officer assigned to the 1st Engineers. Your Colonel (the Division Engineer) sends for you. After explaining the situation outlined above, he adds: "I want you to report to Major X, Commanding Officer of the 1st Battalion, 1st Infantry, to assist him in planning the organization of his battalion center. You will find Major X at the railroad trestle at 4422. Report to him there."

Required—

Your recommendation to Major X concerning the following:

(1) Final location of firing, support and battalion reserve lines.

(2) Location selected for machine guns and principal obstacles.

(3) Location and strength of combat groups.

(4) Location of company and battalion posts of command.

(5) Location of approach trenches.

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Instructions—

(1) Assume that two machine guns of the regimental reserve are emplaced on the hill at 5127 to fire down the ravine.

(2) The Infantry Battalion has a headquarters company, three rifle companies and one machine gun company. Each rifle company has a headquarters section, and three platoons of two sections each. Each section has three squads, each squad having one automatic rifle, making 18 automatic rifles per company.

The machine gun company has two platoons of two sections each. Each section has two machine gun squads, making 8 machine guns with the company.

(3) Show information in red on the 1:5000 map of Camp Humphreys using conventional signs given in Figs. 3, 4, 5 and 6, Engineer Field Notes, A.E.F. No. 13.

An Approved Solution of Problem No. 2—Demolitions

(See MILITARY ENGINEER, September-October 1921, p. 457.)

(1)

Four explosives are available, viz.: TNT, ammonal, 40 per cent dynamite and black powder. The last named of these explosives, black powder, is especially adapted to use in land mines because of the effect of its slow action and because in such work it is possible to give it the proper amount of tamping. Its use will save the other explosives which can be used on a greater variety of work to which black powder is not adapted because of the difficulty of giving it proper tamping. The greatest objection to the use of black powder in this case is its susceptibility to moisture. This objectionable feature can be met by water proofing the mine chamber.

The quantity of black powder required depends upon the size of crater which will effectively block traffic along the road. The road at this point lies along the side of the valley and is in side hill cut and fill. A crater with diameter equal to the width of road, 25 feet, will effectively block the road for some time because the slope of the country on both sides makes the construction of a detour quite difficult. To blow a one lined crater of 25 foot diameter will require placing the charge at a depth of 25 feet. A crater this deep is hardly necessary in order to block the road effectively. By using a two lined crater there will result an obstacle 25 feet wide and 13 feet deep, which will delay the enemy as long as would a crater of 25 foot depth, if we assume that he would be forced to bridge the breach in the road in both cases. A two lined crater or common mine is therefore adopted. The L. L. R. is 13 feet. The amount of explosive is determined by using Table II, page 421 EFM. The earth is assumed to be the equivalent of hard sand. Multiplying the cube of the L. L. R. by the factor .042 given in Table II for hard sand and a 2 linel mine we obtain 92 pounds as the quantity of 50 per cent dynamite required. If we assume black powder to be about one-third as powerful as 50 per cent dynamite we should therefor use at least 276 pounds of powder. Increasing this 10 per cent gives 300 pounds, which will be the charge used.

(2)

A shaft 3′×3′ will be put down at the east side of the road to a depth of 13 feet below the surface of the road. From the bottom of this shaft a branch gallery (3½ feet by 2½ feet) will be driven to a point beneath the middle of the road. At the end of the gallery a mine chamber 2′×2′×2′ will be constructed to take the charge. The center of this chamber will be directly under the center of the road. It will be lined with boards and tar paper in order to keep out the moisture. The charge will be tamped by closing the chamber and gallery with sand bags filled with earth and wedged into place and by throwing earth back into the shaft.

(3)

Time fuse will be used in firing the charge. Duplicate sets of fuse will be used to insure against failure, both being lighted at the same time. Each set will consist of the proper length of fuse to lead from the mine chamber to the top of the shaft. At the end in the mine chamber the fuse will be split and surrounded with finely granulated powder. The fuses in passing through the gallery and up the shaft will be encased in iron water pipe to protect them from moisture and abrasion.

(4)

The depth to which the shaft at the side of the road must be sunk in order to reach a point 13 feet lower than the surface of the road is about 8 feet. The length of the gallery from the bottom of the shaft to the entrance to the mine chamber will be about 18 feet. From the table on page 405 EFM. it is seen that one N. C. O. and 4 miners can put down 8 feet of shaft in about 6 hours. From the same table we see that one N. C. O. and 5 men can drive 18 feet of branch gallery in 9 hours. It will take an additional 2 hours to excavate and prepare the mine chamber, thus making a total of 17 hours of work before placing the charge. Placing the charge, tamping and filling in will require 4 more hours. It, therefore, will take 1 N. C. O. and 5 men working 21 hours to complete the mine ready for firing. It would be preferable to do all the work by daylight unless the work is urgent. The trees on the east side of the road will conceal the men working at the top of the shaft from aerial observation. In case the requisite number of men is available it would be well to detail 2 N. C. O.'s and 10 men to the work and use them in two shifts.

Solution to Exercise in Use of Map Co-ordinates

(1) Co-ordinates of farm house at Mason's to the nearest 100 yards may be written as single number without decimals or dashes as follows: 4339

(2) If, however, it is desired to write the co-ordinates to the nearest 10 yards, decimals and dashes must be used as follows: 4.34-3.95.

(3) Pohick Church is 150 yards west of grid lin 601,000 and 200 yards south of grid line 1,792,000. Since the co-ordinates of the origin have the value $x = 1{,}000{,}000$ and $y = 2{,}000{,}000$, Pohick Church is 398,850 yards west of the origin and 208,200 south of the origin.

(4) The co-ordinates of the Kernan house in yards are $x = 602{,}830$; $y = 1{,}793{,}480$. Expressed in meters this becomes $x = 551{,}230$; $y = 1{,}639{,}960$. Hence the co-ordinates to the nearest ten meters may be written 1.23—9.96.

(5) If the present sheet were on a scale of 1:20,000 there would then be chance of a 10,000 meter error if only one figure were shown before the decimal in each co-ordinate. The co-ordinates of the Kernan house on such a sheet would then be written to the nearest 100 meters as follows: 51.2 — 40.0.

(6) At 2418 is a dwelling house and well on the military crest of a ridge. 3.24 — 1.72 is a point just below the wood line on a ridge running about east and west.

(7) (a) The co-ordinates of Pohick Church to the nearest 100 yards are written as follows: 1118

(b) Of the intersection of the Telegraph Road and Standard Gauge R. R.: 2337.

(c) Of the cemetery in Accotink: 4519.

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General Subjects, Note 4

Questions on Interior Guard Duty

(Reference: Manual of Interior Guard Duty, 1914.)

No.	Wt.	
1	5	When does the tour of the officer of the day cease?
2	10	How does a sentinel give the alarm in case of fire? In case of disorder?
3	5	Normally from what person or persons does the officer of the day receive orders?
4	12	What does a sentinel armed with a rifle do (in the simple general case) when an officer crosses his post?
5	8	What words does a sentinel use to challenge a mounted party?
6	10	Who releases garrison prisoners whose sentences have expired and when does he do it?
7	10	Who is ordinarily authorized to order the confinement of a soldier?
8	10	What does the sentinel at the post of the guard do after challenging and receiving a response?
9	10	Between what times does a guard turn out for compliment?
10	10	What should a sentinel do in case a prisoner attempts to escape?
11	12	Enumerate three forms of punishment given general prisoners for bad conduct.

Questions on Military Law

(A Final Test on "Manual for Courts-Martial, 1921")

No.	Wt.	Question
1	2	Who are competent to serve as members of courts-martial?
2	2	Who may be tried by special courts-martial?
3	3	What is the gist of the affidavit of a person preferring charges?
4	2	If a soldier comes to you and confesses a crime, is his confession sufficient for preferring charges?
5	5	State briefly what is required in an investigation of charges by an officer detailed for the purpose?
6	5	What proportion of votes of the members present is required for each of the following (answer by tabulation, as (a) 3/5): (a) Conviction of absence without leave. (b) Sentence to death. (c) Conviction of crime which may involve not more than 20 years' confinement. (d) Sentence to 10 years' confinement. (e) Sentence to life imprisonment.
7	3	When is a reporter authorized: (a) For a general court-martial? (c) For a special court-martial? (c) For a summary court-martial?
8	2	If a member who has been absent during the taking of evidence is allowed without objection to sit on the remainder of a trial, what precautions should be taken?
9	2	What is the effect of a tie vote on: (a) A challenge? (b) An objection? (c) A motion? (d) A finding?
10	5	A soldier kills a man in the District of Columbia. He is tried by a general court-martial and convicted of manslaughter. May a court of the District of Columbia try him for murder? Give brief reasons.
11	4	A battalion commander directs that a man who has been A.W.O.L. be restored to duty. May he be later tried for desertion? Give brief reasons.
12	2	Write the oath that is administered to a witness.
13	2	What is a plea to the general issue?
14	5	When is a deposition permitted?
15	4	What is a plea to the jurisdiction? Name two grounds for such a plea.
16	4	What is a plea in bar of trial? Name two effective pleas in bar of trial.
17	2	Who ordinarily signs the record of a general court-martial?
18	3	What is the rule as to the introduction by the prosecution of evidence to prove the bad character of the accused?
19	5	What is meant by "res gestae"? Illustrate by an example.
20	5	Distinguish between a "confession" and an "admission against interest." In considering admissibility of evidence, why is this distinction important?
21	3	Define (a) Leading Question; (b) Double Question. Under what circumstances can double questions be used in the examination of a witness?
22	3	In a case not capital, the Trial Judge Advocate requests permission to introduce as evidence a deposition properly taken at the instance of the prosecution. He states, however, that he wishes to offer only the first part of the deposition, omitting the last half. What action should the court take on this request?
23	4	Pvt. A is "found drunk on duty" (A.W. 85). While drunk on duty he assaults Pvt. B. The company commander, not knowing of the assault, sentences Pvt. A for drunkenness on duty, to company punishment, which Pvt. A performs. Later, charges are preferred against Pvt. A for the above-named offenses, viz.: (1) Violation of the A.W. 85, in being found drunk on duty; (II) violation of A.W. 93, in assaulting Pvt. B with intent to do bodily harm. State whether Pvt. A can be legally tried by a court-martial (a) on Charge I; (b) on Charge II. Give reasons, in brief.
24	3	What is meant by the "Reviewing Authority"? What action, in general, may he take on a sentence adjudged by a court-martial under his jurisdiction?
25	3	What are the elements of fraudulent enlistment?
26	3	(a) Define desertion. (b) Under what circumstances is it unnecessary for the Trial Judge Advocate to prove the specific intent?
27	4	An officer is ordered by his commanding officer to make an inventory of certain company property and submit a report thereon at 11 a. m. on the following day. At 11 a. m. on the day specified in the order the junior officer is found drunk at his quarters and the inventory has not been made. Is the delinquent officer guilty of— (a) Disobedience of lawful command of his superior officer (A.D. 64)? (b) Neglect of duty (A.W. 96)? (c) Drunkenness on duty (A.W. 85)? (d) Failure to obey lawful order of superior officer (A.W. 96)?
28	3	Name three of the ordinary acts which constitute disrespect toward a superior officer within the meaning of A.W. 63.
29	3	(a) What is the nature of the conduct contemplated in A.W. 95 (conduct unbecoming an officer and a gentleman)? (b) Give two examples.
30	4	Civil authorities make due application upon a commanding officer to have delivered to them a certain soldier of the command charged with crime. Under what circumstances (in time of peace) may said commanding officer refuse to deliver the soldier?

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An Approved Solution—Test on Military Law

(See Page 20, Military Instruction, Vol. XIII, No. 71)

By Maj. Cleveland C. Cee, C. E.

(References are to "A Manual for Courts-Martial, 1921")

Question No. 1. Ref. Par. 405—

The Court should not sustain the plea. By the 54th A.W. a man fraudulently enlisted is subject to trial by court-martial for such fraudulent enlistment. This shows that he is subject to the jurisdiction of a court-martial. In general, it is contrary to public policy to allow a person to plead one crime or offense in justification of another.

Question No. 2. Ref. Par. A.W. 28—

(a) Desertion is absence without leave accompanied by the intention, either (1) not to return, (2) to avoid hazardous duty, or (3) to shirk important service.

(b) Short desertion covers cases (2) and (3) in the definition of desertion given under (a).

Question No. 3. Ref. Par. 412—

Part I. (a) No. (b) No.

Part II. (a) No. (b) Yes.

Question No. 4. Ref. Par. 417—

(a) Mutiny imports a resistance to lawful *military* authority while sedition implies a revolt against lawful *civil* power.

(b) Two.

Question No. 5. Ref. Par. 420—

(1) The gravity of the offense. (2) The character and reputation of the accused.

Question No. 6. Ref. Par. 420½—

(a) Any person subject to military law. (b) Signature under oath signifies either that he has personal knowledge of, or has investigated, the matters set forth, and that the same are true in fact, to the best of his knowledge and belief.

Question No. 7. Ref. A.W. 105—

(a) Yes.

(b) See A.W. 105.

Question No. 8. Ref. Par. 443—

In embezzlement the original taking of the property was lawful or with the consent of the owner, while in larceny the felonious intent to steal or purloin the property must have existed at the time of the taking.

Question No. 9. Ref. Par. 451—

(a) 1. For determining whether there should be trial by court-martial in a particular instance.

2. For informing and advising superior authority in cases which appear not to call for trial by court-martial, but for some other military or administrative action.

3. For the vindication of character or conduct.

4. For inquiring into the correctness of the action of classification boards in classifying officers in Class B as not to be retained in the service.

(b) Officers and soldiers only.

Question No. 10. Ref. A.W. 96—

(a) Disorders and neglects to the prejudice of good order and military discipline, conduct of a nature to bring discredit upon the military service, and crimes or offenses not capital, when not covered by a specific article.

(b) Such punishment as a Court-Martial may direct, subject to limits of punishment prescribed by Executive Order.

Question No. 11. Ref. A.W. 95—

Dismissal from the service.

An Approved Solution—Test on Military Hygiene

(See page 20, Military Instruction, Vol. XIII, No. 71)

By Maj. Alfred L. Ganahl, C. E.

(References are to "Elements of Military Hygiene," by Ashburn)

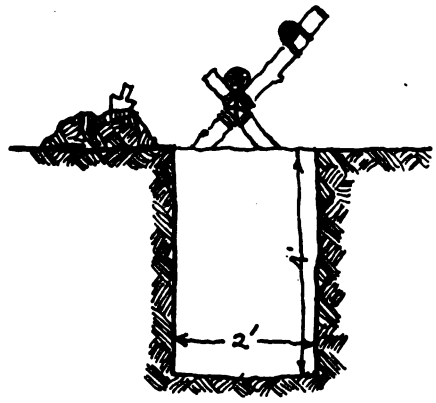
1. (a) By boiling and by chemical treatment. The latter, in the field, would ordinarily consist in adding one part of "chloride of lime" to about 500,000 parts of water, allowing the water to stand at least one-half hour before use. (Pages 80 and 81.)

(b) (1) Drinking water for the men, (2) water for cooking purposes, (3) drinking water for the animals, (4) water for bathing and (5) water for washing clothing. (Pages 80 to 86 incl.)

(c) See sketch.

Latrines should be placed as far as possible from the water supply. They should not drain toward the water supply. (Pages 93-99.)

2. (a) Flies transmit the germs of cholera, dysentery and typhoid (pages 238 and 239). Kitchens should be screened



to keep them out (page 52). Flies breed in human feces, etc. To prevent this latrines should be screened (page 239).

(b) A typhoid carrier is a person who passes the living and virulent bacilli from his body, usually in his feces or urine, in such a condition that they may infect other persons (page 228).

3. Infectious diseases are those which are generally caused from the ingestion of the causative organisms by way of the alimentary canal, but may be produced by the injection of the living organisms beneath the skin (page 222). Example —typhoid fever (page 222).

Contagious diseases are those which are more readily transmissible through contact or association: sometimes called "air-borne" diseases (page 255). Example—small-pox (page 255).

4. Pork is often infected with Trichinae, small worms about a sixteenth of an inch in length. If consumption of pork by men is preceded by thorough cooking no harm will result. If not, larvae may be scattered through his muscular system, and he suffers from pains and fever, which may cause his death (page 174).

5. Malaria is transmitted only by Anopheles mosquitoes (page 178). The success in combating malaria depends on the anti-mosquito measures taken (page 283). Of these the destruction of breeding places near habitations is the most important. The filling of pools, puddles, etc., drainage by means of ditches, the reclamation of swamps and the use of crude petroleum or larvacides in the breeding places are some of the measures that can be taken to combat the spread of malaria (pages 286 to 295).

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Does the Present Automatic Rifle Meet the Needs of the Rifleman?

By W. A. Blain
Major, Infantry, Field Officers' Class, The Infantry School

The cause which led up to the invention of the automatic rifle was a desire for increased rapidity of fire.

The first step to increase the rapidity of fire was the making of a case to contain both the powder and the bullet, but this had to be forced into the rifle from the muzzle with a ramrod, and the primer then placed on the priming vent. The second step was the invention of the rifle which was loaded from the breech, both the powder and the bullet being held in a case called a cartridge, which also contained the primer. This was a great step forward and soon led to other improvements. One of these improvements was the breech-loading magazine rifle. In this rifle a magazine contains several cartridges which are loaded into the rifle by hand operated mechanism. The result of this was a great increase in the rapidity of fire, and it is the type of rifle with which the bulk of the infantry is now armed.

But still the clamor continued for a faster firing weapon. This culminated in the invention of the automatic firing weapons, which, for the rifleman, brought forth the automatic rifle. This is automatically loaded as soon as fired, that is, it is ready to fire again without any effort on the part of the firer. There are two general principles employed to cause this automatic action, that of using the force of recoil to reload the piece, and that of using the gas generated on discharge to perform these functions. The most familiar example of the former is the Colt's Automatic Pistol. The Light Browning, or Browning Automatic, which is the automatic rifle adopted for use in the United States Army, is of the latter type.

In order to determine whether or not this rifle meets the needs of the rifleman, it will be necessary to investigate what kind of a rifle it is, its characteristics and its employment.

Data regarding the Browning Automatic Rifle:*

Weight of rifle—15 lbs. 8 ounces
Weight of magazine, empty—7 ounces
Weight of magazine, filled—1 lb. 7 ounces
Length of barrel—24 inches.
Sights graduated up to 1600 yards.
Caliber of bore—.30 inches
Rate of fire—500 shots per minute
Weight of bullet—150 grains
Weight of powder—47 grains.
Weight of shell—198.5 grains
Weight of cartridge (total)—395.5 grains
Chamber pressure—47,000 to 50,000 lbs. per square inch
Muzzle velocity—2682 feet per second
Habitual type of fire—semi-automatic.

The weight of the rifle with one filled magazine is 16 lbs. 15 ounces, and the belt with 10 extra magazines, and the tool box, will bring the load of the automatic rifleman to about 35 lbs. This is a considerable load for one man to addition to his other equipment, and is one reason why our soldiers in France threw away the automatic and secured a rifle and belt from some casualty when the opportunity presented itself.

The present automatic rifle has several defects, but most of them admit of easy correction. Among these are the following:

1. The front sight is not protected, therefore liable to become bent or damaged.
2. The sights are not graduated for settings less than 100 yards.
3. The sight has no windage guage, which oftimes requires the user to aim off his target in order to hit it.
4. The present stock is too short, which makes aiming difficult. (I believe this correction has already been made.)
5. It requires both hands to take out an empty magazine, as the release cannot be pressed and the magazine withdrawn with one hand. This makes it very awkward and time is lost in reloading.
6. The hand guard is much too large and not of a shape to fit into the hand. It is made large to protect the hand against the excessive heat of the rifle. It is believed this difficulty could be overcome by having a smaller hand guard, lined with asbestos or some similar material.

Characteristics of the automatic rifle: *

1. It is capable of the rapid production of a large volume of accurate fire.
2. It is capable of delivering fire from any of the positions used by riflemen, and from the march.
3. It has substantially the mobility, visibility, and vulnerability of one service rifle, together with the fire power of several.
4. Its cone of fire is deep and narrow, and its dispersion much less than that of the number of rifles it would be necessary to employ to produce the same fire power.
5. Its fire is easily controlled and can be shifted in any direction at will.
6. It is not suitable for overhead fire, nor generally speaking, indirect fire.
7. It is not capable of sustained fire.
8. It is liable to accidental cessation of fire.
9. It can act only by means of fire power and mobility.

From these characteristics we may make the following deductions:

Its fire power is as great as that of several rifles, for all ordinary firing.

It is especially suited for putting a large volume of fire on a special target.

Its use allows a much greater volume of fire to be delivered for the same frontage of firing line.

It should be ready for action at all times, therefore all members of the squad should be trained in its use, so that, in case the automatic rifleman becomes a casualty, some other member of the squad can continue it in action.

It can be used any place the ordinary service rifle can be used.

It can change positions quickly in case its location is determined.

It can be used effectively for marching fire.

The automatic rifleman makes a very indistinct target, hard to locate if semi-automatic fire is used, and as difficult to hit as any other rifleman.

By the nature of its cone of fire it is more effective in a flanking direction than when used frontally. It is nearly as mobile as the service rifle, and more mobile than the machine gun.

Its fire can be quickly shifted from one target to another, as it is entirely controlled by one man. To produce the same effect with service riflemen would necessitate a change of position.

It is not fitted for overhead fire, so cannot take the place of machine guns, nor is it capable of sustained fire.

*W. D. Doc. No. 853. Par. 21. Page 13.

*Lecture "Training the Automatic Rifleman." Infantry School, Camp Benning, page 14.

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Frequent stoppages occur so men should be well trained in its use in order that it may be kept in action as much as possible.

It is not suited for hand to hand combat as it is not fitted with a bayonet, and is too heavy and clumsy to be used in that kind of fighting even it fitted with a bayonet.

Due to its weight the man using it is subjected to much more fatigue than those armed with the service rifle.

Due to the rapidity with which it can be fired it consumes a large amount of ammunition.

Employment of the Automatic Rifle.

In our service there is one man in each squad armed with the automatic rifle, so that it is an integral part of the squad armament and should be kept with the squad at all times.

Its place in the firing line will necessarily vary according to the situation to be met. If the entire squad rushes from one position to another, the automatic rifle necessarily advances with the squad. If a line is advancing, preceded by scouts, when the scouts are stopped and it is necessary to infiltrate to build up a line on the scouts, the automatic rifleman should be the first man sent forward, so as to bring the great fire power of his weapon to bear on the enemy at the earliest practicable moment.

It is especially valuable for delivering flanking fire and whenever a force is sent on a flanking movement it should be accompanied by the full quota of automatic riflemen.

While a very powerful weapon, it uses ammunition rapidly, so that it should not be used more than is absolutely necessary. If the rifles of the party are sufficient to execute the task, the automatics should remain silent, holding their fire for a time when more needed, and not be without ammunition at a critical time.

Unless firing on a specially designated target the fire of the automatic rifle should be distributed over the entire squad target.

The automatic rifle is particularly valuable where a large volume of fire is necessary and there is not room to deploy a sufficient number of rifles, for example, when fighting in narrow streets, etc.

It is a valuable weapon for delivering marching fire. This class of fire is extremely desirable in combat in the woods, or to keep down the fire of the enemy while our line is advancing.

It is valuable in advance and rear guard, and of great value with patrols. Every combat patrol of four men or over should have an automatic rifleman as one of their number.

It is valuable in covering the return of patrols, especially in night raids, as two or three automatic rifles posted on the flanks can do great execution if the patrol is pursued.

It is also valuable in detached posts as it adds considerable strength to the fire power and morale of the occupants.

It is particularly valuable in an outpost line which is thinly held, as a great amount of fire power can be developed and the line held by only a few men, giving great economy of man power.

It is good weapon to cover ground which is defiladed from the fire of machine guns, or narrow approaches and defiles, with a minimum of man power.

It is quite mobile, so is not tied to any fixed position, but can be changed as quickly as a man can, and accordingly can bring fire quickly to bear on a surprise target no matter from which direction the target is approaching.

It is easily pushed forward to a flank, under cover, so as to deliver flanking fire when necessary, and is particularly effective when so used, as its cone of fire is long and narrow.

Its use with automatic fire is exceptional and only against very close and well defined targets. In fact it is so exceptional that the automatic fire could be dispensed with without materially decreasing the value of the rifle.

Its normal fire is semi-automatic, that is, fire in which the trigger must be pressed separately for each shot. This fire can be delivered very rapidly and permits of the aim being corrected between shots, making this class of fire much more accurate.

As it is not on a fixed mount, it must not be used for overhead fire, except in cases where the service rifle could be safely used in this manner, such as tiers of fire, etc.

It can be used for night firing, to cover or keep open gaps in the wire, or to cover a ravine or defile. It should be sighted by daytime and stakes driven in the ground so the proper position can be taken at night.

It is not capable of delivering sustained fire on account of the lack of an efficient cooling device. It is necessarily air cooled to keep down its weight, and gets very hot after a short period of continuous firing.

Its liability to accidental cessation of fire makes it absolutely necessary that all the men in the squad be thoroughly trained in its use and the correction of defects, so it can be ready for use at any time its fire is called for.

To recapitulate, the automatic rifle finds its greatest usefulness in:

The assault, with the assaulting waves.
Engaging enemy machine guns or automatic rifles.
Dealing with counter attacks from the flanks.
In quickly building up a strong firing line.
Being pushed forward to deliver flanking fire or to deal with menacing enemy agents.
In covering the advance of the rest of the squad.
In narrow defiles, or from any narrow frontage, from which it is necessary to deliver a large volume of fire.
In advance and rear guards.
With combat patrols.
In the outpost line or with detached posts.
In defense, in the front lines.
In delivering marching fire.
To cover dead spaces in the machine gun belt.
In the defense of a salient.
In advancing through woods.
In following a smoke screen, or barrage.

We have thus seen its characteristics, and the different ways in which it can be employed. In any special situation with which the infantry is confronted these are only to be used as a guide, because the automatic rifle must be used as the circumstances dictate so as best to take advantage of its great fire power. It should never be employed according to some fixed rule, but meet each situation as it presents itself. This is where a thorough knowledge of its characteristics, its power and its limitations, will stand the automatic rifleman in good stead.

Having taken note of its defects, its characteristics, and its means of employment, let us now consider if this weapon meets all the needs of the rifleman as a combat weapon. It is believed that anyone who has seen a demonstration of the fire effect of a squad with and without the automatic rifle, will agree as to its material addition to the fighting strength of the squad. By actual firing, under service conditions, which is the only true test, the number of hits on the target were almost doubled when the automatic rifle was used as a part of the squad armament, as against the number of hits when only the service rifle was used. The old saying that it is the infantry which wins battles is as true today as it was at any time in history. It therefore follows that the army with the best infantry is one that will win out in the end, and as men are very nearly equal, it can further be deduced that the infantry which has the superior weapon will be the winner. Now the chief weapons of the infantry are fire and movement, and since the automatic rifle does not impede the movement to any great extent, and also since its use, even as

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few as one per squad, almost doubles the fire power of that squad, thereby increasing its chances of winning, it seems to be clear that some form of automatic rifle is essential for arming modern infantry.

Following out this theory, if one automatic rifle per squad so increases the fighting strength of the squad, why would not the fighting power be correspondingly increased if every man in the squad was armed with an automatic rifle? I believe it would be. The solution would then seem to be easy—issue each man an automatic rifle in place of the present service rifle. There are several reasons why the presnt Light Browning is not fittd for this. Let us enumerate some of them:

1. It is too heavy. As before stated, our soldiers in France threw away the automatic with which they were armed, and secured service rifles from some casualty. Why was this done? I have heard the reason put forth that it was because they were armed with the French Chauchat, and that it was no good. But that answer is not sufficient. It is true that the majority of our men overseas were armed with the French automatic rifle, but, if I am reliably informed, at least one of our divisions was armed with the Light Browning, and an officer told me that he was over the ground over which that division had advanced and that the ground was strewn with these automatics. Inefficiency then could not be the correct reason, for the Light Browning is the best automatic rifle that has been issued to any army.

I believe there were two main reasons. First: The men did not appreciate what a valuable weapon they were carrying, were not familiar with it, and were very much more familiar with the service rifle. Second: The automatic rifleman had a much heavier load to carry and was required to keep up with his neighbor who had a much lighter load. The 8 to 9 pounds more that he had to carry made a big difference in a day's march and when he had a good chance to lighten it he did so.

2. The present automatic rifle does not have a bayonet. While the rifleman's chief weapons are fire and movement, yet, even in this day of long range weapons, hand to hand combat must sometimes be indulged in. It is an old saying that "you cannot shoot the enemy out of a position." What recourse then does the rifleman have? His other weapon is the bayonet. It is his only weapon for hand to hand fighting, and if he does not have it, it is impossible to make him close with the enemy. Also the moral effect of having a bayonet is too great to be estimated. The present automatic rifle is too heavy to add the weight of a bayonet, and it is too clumsy to use one effectively were it added.

3. It requires one of the other riflemen in the squad to help him carry enough ammunition. The extra ammunition is carried in extra magazines, each weighing within an ounce of half a pound apiece, which very materially adds to the load to be carried.

From the above it can be seen that the present automatic rifle is not a satisfactory weapon for issue to each rifleman. I believe that the needs of the future demand that each rifleman be armed with an *automatic loading rifle*. It is not necessary, nor even desirable, that it be an automatic firing rifle, as the present rifle is not accurate when automatic fire is used, and the rifle can be fired fast enough when the trigger is pressed separately for each shot.

The objection may be raised at this point that we will never be able to supply sufficient ammunition if each man is armed with an automatic. While on its face this does seem to be a serious objection, yet our experience in the World War would not seem to bear this out, as I have never heard, nor seen recorded, a single instance where our troops suffered from a shortage of small arms ammunition. The fact that the rifle advocated would be only an automatic loader would serve to keep a better check on the expenditure of ammunition.

Let us consider some of the specifications for an *automatic loading rifle* that will be suitable for arming all riflemen:

1. It should be as simple as possible in operation.

2. It should weight not to exceed one pound more than the weight of the present Springfield rifle, Model 1903.

3. It should have powers equal to the present automatic rifle and be capable of the same employment.

4. The defects of the present automatic rifle should, as far as practicable, be eliminated.

5. It should be equipped with a bayonet.

6. It should be capable of being loaded, by clip if possible, directly into a fixed magazine, doing away with the necessity of carrying extra magazinees, thus lightening the load to be carried.

7. With all men armed with an automatic loading rifle it will not be necessary for the magazine to carry over ten rounds. This will decrease the weight of the weapon.

It seems to be the natural tendency of the American to be able to shoot well, and as we devote much more time to rifle practice than any other nation, it is easily seen what a tremendous fighting machine one of our rifle companies would become if each man was armed with an automatic loading rifle.

Conclusions—

1. That it is desirable to have each rifleman armed with an automatic loading rifle.

2. This being true, that the present Light Browning is not a satisfactory weapon for this purpose and therefore does not meet the needs of the rifleman as a combat weapon.

3. That every endeavor should be made to develop an automatic rifle along the lines suggested, and that every encouragement be given to those now working along these lines, so that before we are compelled to take part in another war we will have an efficient automatic loading rifle to place in the hands of our riflemen, and by so doing have an infantry that will be invincible.

To show that inventors are already working along these lines the following is quoted from an article published in the *Infantry Journal* for October, 1920. The article is entitled "The Sub-machine Gun" and is written by Major A. B. Richeson, Reserve Corps:

"A sergeant-gunner with a submachine gun, firing from the standing position without rest, at a range of 500 yards, discharged 600 rounds in 70 seconds, and made 100 hits on the target. This record was made in a recent test of a new weapon with which its inventors expect to revolutionize automatic arms. The submachine gun is nothing more nor less than a machine gun in the form of a pistol which can be carried in a case under the coat if desired, and yet is able to deliver a stream of several hundred shots in a minute. It is the simplest of all automatic weapons, one type having but 11 parts, and in less than a minute can be readily dismounted by hand without the use of a tool.

"Magazines are of the disk type, having a capacity of 50 and 100 cartridges. The inventors say it can be produced at a price hitherto unknown in automatic arms. The military uses which such a weapon would have will instantly suggest themselves to the army. The submachine gun has a range up to one mile. The extreme lightness and simplicity of this weapon are made possible by the new application of an old scientific principle in the construction of the breechblock.

The Colt Patent Firearms Co. is manufacturing the submachine gun, which is soon to appear on European battlefields. Several South American governments have adopted the new gun. The submachine gun was developed by one who has also successfully applied its operating principle to semi-automatic shotguns. For the autorifle it is claimed that it is the first and only gun firing from the shoulder semi-automatically and weighing less than ten pounds that has ever been through the Springfield endurance test without breakage or repair."

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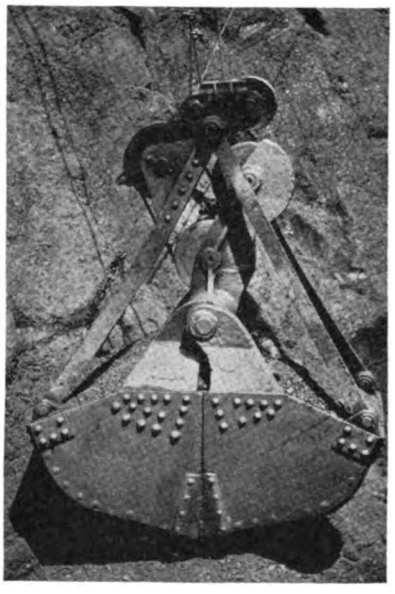
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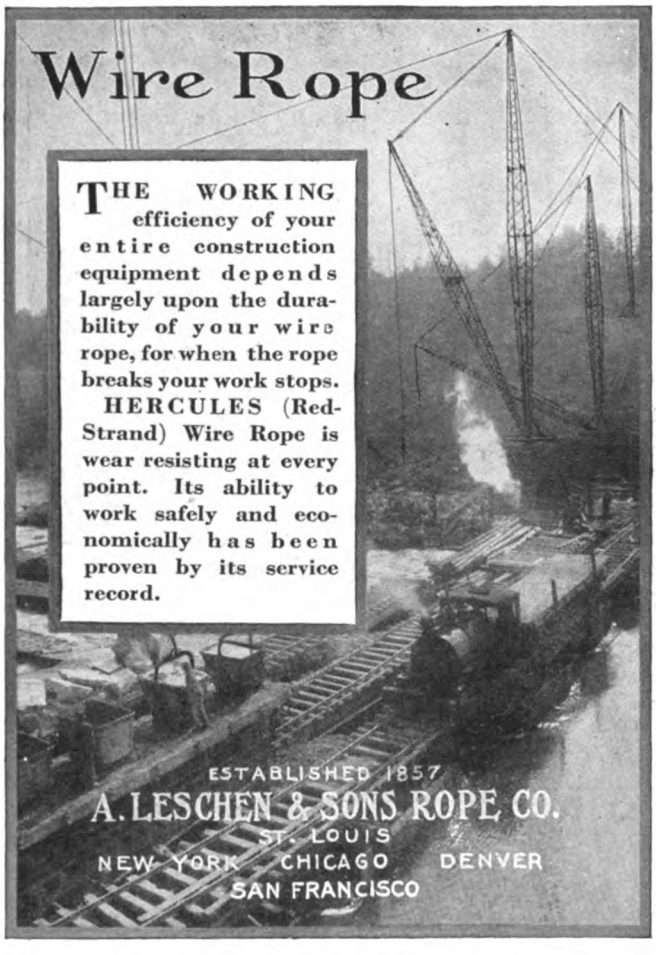
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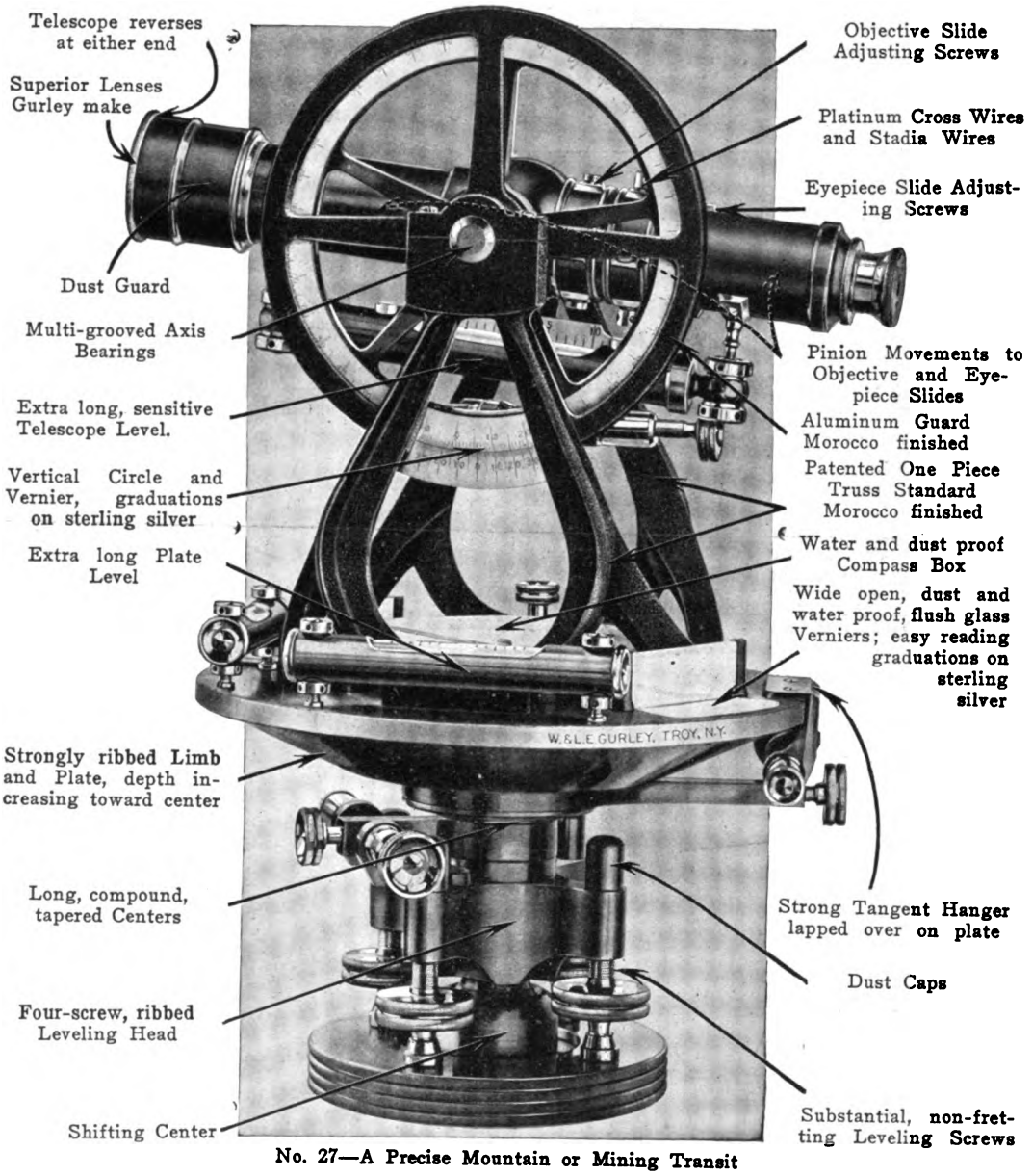
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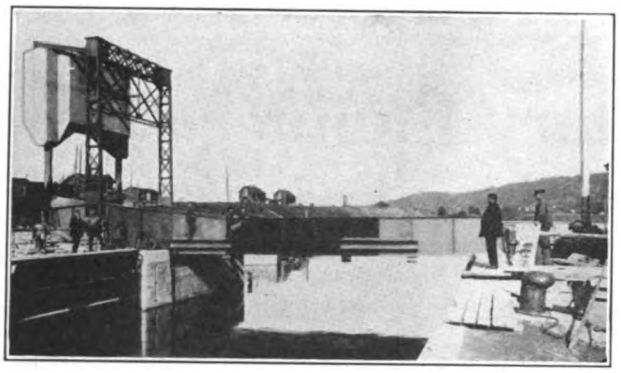
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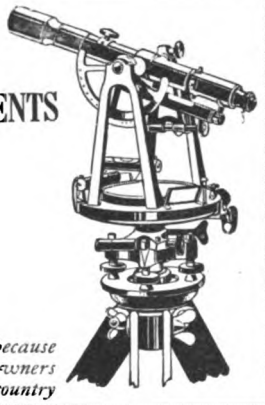
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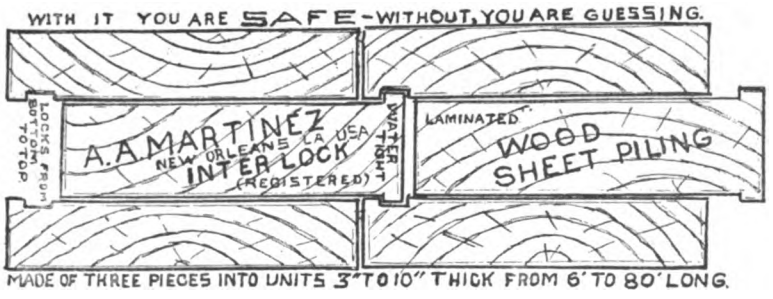
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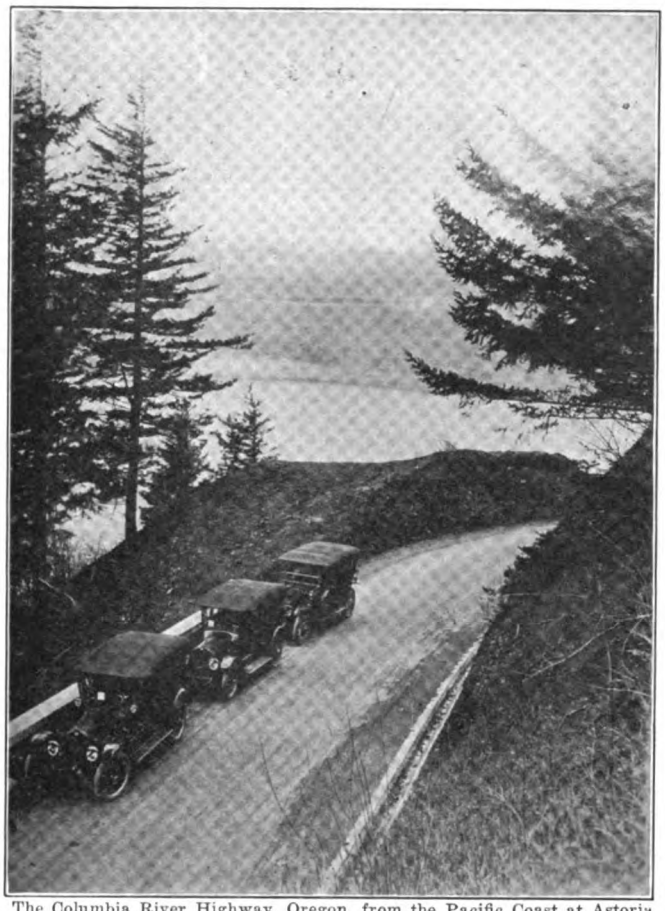
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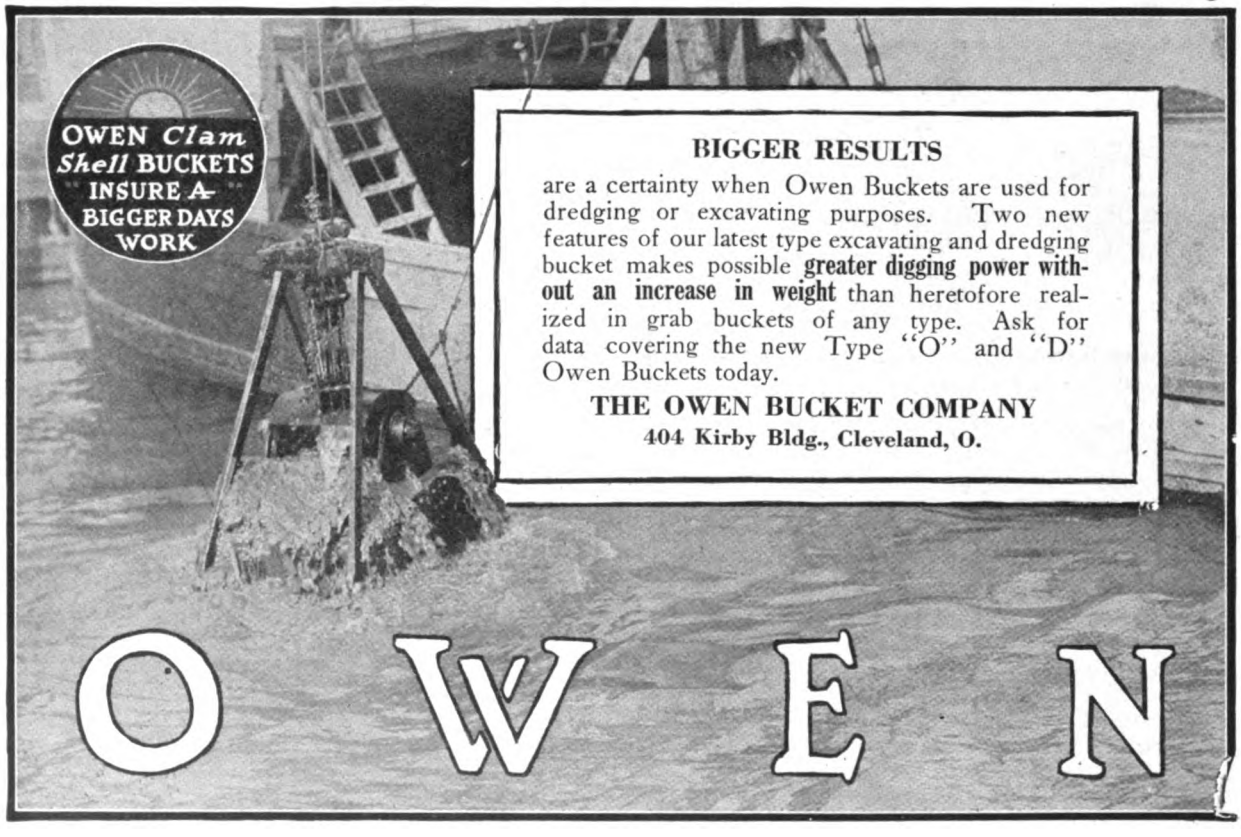
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The height of the crane is 235 feet, while the derrick is equipped with a boom 252 feet long.
Both the crane and the derrick were designed and built by THE McMYLER INTERSTATE CO.
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THE QUICK SHIFT feature saves a day's time and labor every time a move has to be made from one floor to another.

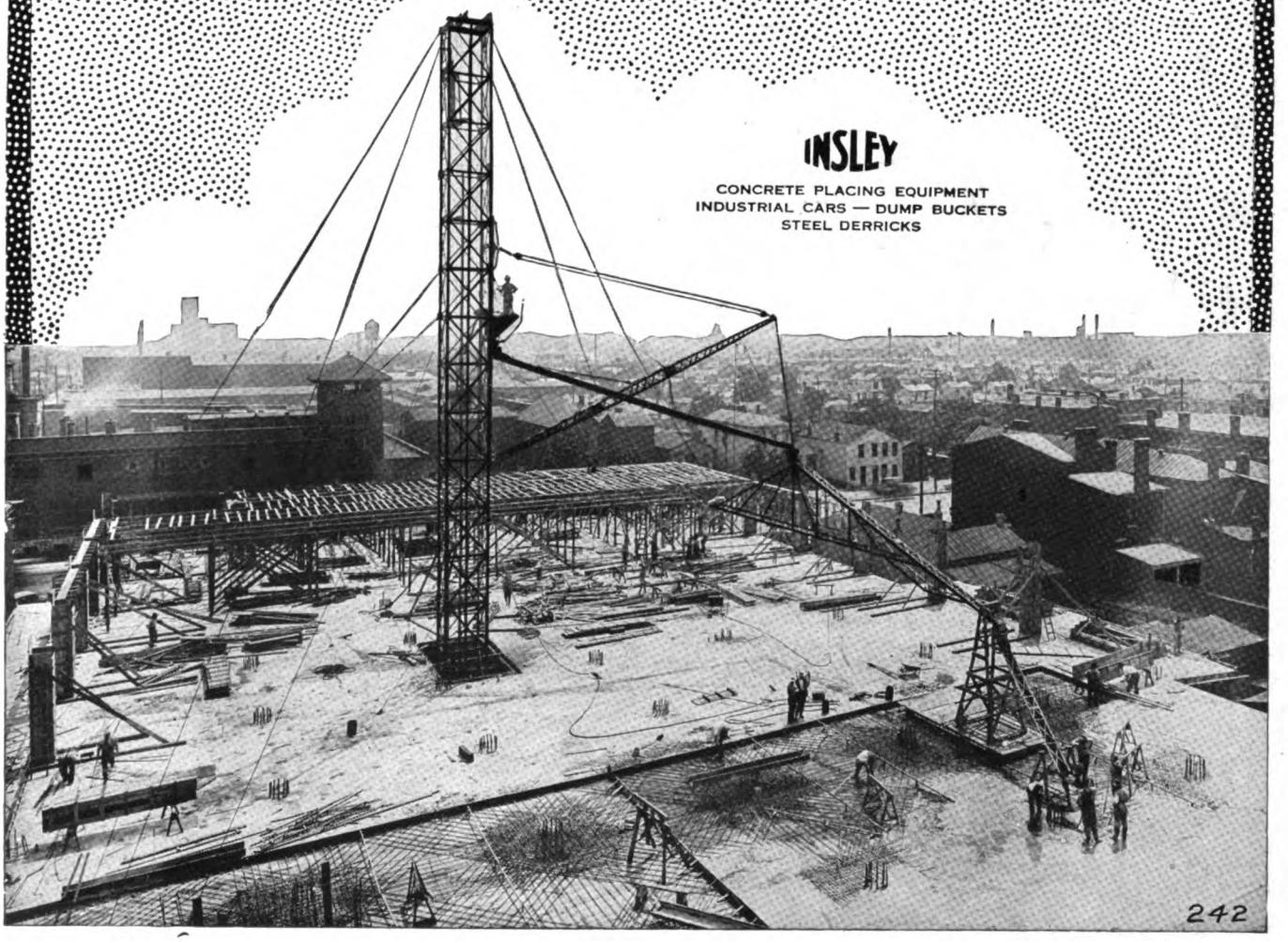
THE COUNTERWEIGHT CHUTE eliminates the time and labor which would otherwise be required for moving chutes on the job.

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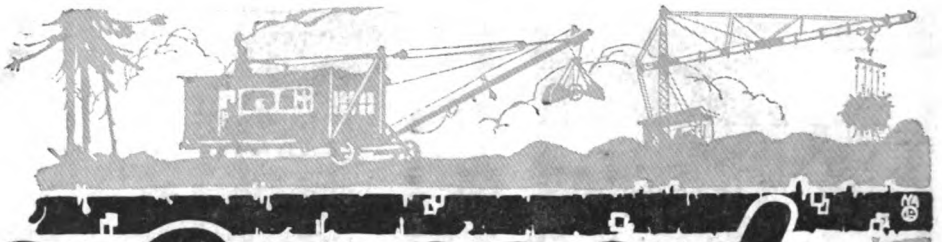
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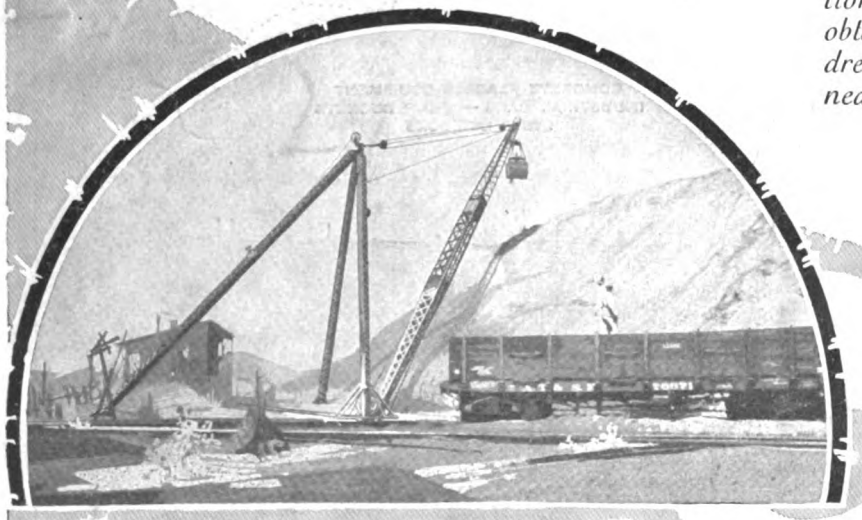
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Shown below is a Clyde Stiff Leg Derrick, operated by O'Conner & Gilkison of Cleburne, Texas, tackling a big job. Motive power is furnished by a Clyde 45 H. P. three drum gasoline hoist.

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