HISTORICAL REPORT

OF THE

CHIEF ENGINEER

INCLUDING ALL OPERATIONS OF THE
ENGINEER DEPARTMENT

American Expeditionary Forces
1917 - - 1919

War 19-61

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The following publication, entitled "Historical Report of the Chief Engineer, Including all Operations of the Engineer Department, American Expeditionary Forces, 1917–1919," is approved and published for the information of all concerned.

[062.1, A. G. O.]

BY ORDER OF THE SECRETARY OF WAR:

PEYTON C. MARCH,

General, Chief of Staff.

OFFICIAL:

P. C. HARRIS,

The Adjutant General.

FOREWORD.

The Historical Report of the Chief Engineer, American Expeditionary Forces, consists of a main body and appendices. The aim has been to present within reasonable space limits in the main body of the report the salient features of the organization and operations of the Engineer Department, and to include in appendices technical discussion, departmental and special service reports, regimental histories, and material of a similar detailed character. The main body of the report, therefore, constitutes the History of the Engineers in France, and at the same time serves as a means of coordinating the various detailed technical and historical reports forming the appendices. As a convenience for the investigation of any special subject—Army water supply, for example—there is given at the end of each section of the main body of the history a list of references to appendices or other data useful for research. A list of briefed references to general orders, bulletins, and other documents affecting the organization and personnel of the Engineer Department and a tabulation of the appendices are given at the end of this report.

ARRANGEMENT OF MATERIAL IN ENGINEER HISTORY.

The detailed history of the Engineer Department consists of three main parts.

Part I deals with the organization and development of the department from the time of the appointment of the first chief engineer, American Expeditionary Forces, on May 18, 1917.

Part II is devoted to military engineering, and is subdivided into two main sections: (1) Staff operations connected with the several special engineer services, such as water supply, camouflage, etc., and with the training of engineer troops at schools and with divisions, and (2) operations of engineer units serving as divisional, corps, or Army troops.

Part III relates to engineer activities in the services of supply, and includes the three main subdivisions of supply, construction, and forestry.

Attention is invited to the chief engineer's observations and recommendations covering the future organization and activities of the Engineer Service. (See p. 397.)

For purposes of research reference is made in this report to appendices containing detailed reports which will be found in the files of the Chief of Engineers at Washington, D. C.

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STATISTICAL INDEX.

Engineer strength.—Number of officers and men under direct command or technical control of chief engineer, on November 11, 1918, was 174,000 distributed as follows: With armies, 86,400; miscellaneous, 18,500 (including troops in training, at schools, etc.); construction (in the service of supply under the division of construction and forestry), 43,000; forestry, 18,500; supplies, 7,600; total Engineer strength, 174,400.

Supplies.—Total tonnage of Engineer supplies received from all sources exceeded 3,000,000 tons. Total cost of Engineer supplies approximately $450,000,000. Total Engineer material received from the United States was 1,416,000 tons. Total value of material in Engineer depots and at light railway central shops, according to after armistice inventory, was $106,940,920.

Ports and docks.—Docks, aggregating 6,360 feet in length constructed, including ten 410-foot berths at Bassens, three berths at Montoir, and two at Brest. Lighterage facilities included 750-foot ammunition wharf at St. Loubes; total length of berths built by American Expeditionary Forces or acquired from French was 7 miles.

Railroads.—Total of 967 miles of standard gauge railroad built, most of the mileage being in storage depots. Railroad bridge 2,100 feet long built across Loire River as part of Nevers "cut-off."

Storage depots.—Total covered storage space in depots was 15,529,000 square feet. In addition there were provided 3,028,000 square feet of dock storage and 3,858,000 square feet of miscellaneous storage.

Hospitalization.—Space for 280,000 beds provided, of which 139,000 were in French buildings and 141,000 represented new construction, equivalent to 7,700 hospital barracks.

Troop shelter.—Total of 16,000 barracks erected.

Forestry.—Lumber production to May 1, 1919, was: Lumber, 218,211,000 feet board measure; standard gauge ties, 3,051,137; small ties, 954,667; miscellaneous round products, 1,926,603 pieces; piling, 39,095 pieces; fuelwood, 340,000 cords.

Light railways.—Total tonnage handled to February 1, 1919, was 860,652 tons. At armistice there were under American control 2,240 kilometers of light railway, of which 1,740 kilometers had been captured from the Germans, 200 kilometers were constructed outright by the American Expeditionary Forces and about 300 kilometers taken over from the French and rehabilitated.

Road construction.—After the armistice more than 100,000 troops under Engineer direction were engaged on road repair work.

ENGINEER STRENGTH IN AMERICAN EXPEDITIONARY FORCES.

On November 11, 1918, there were under the direct command or the technical supervision of the chief engineer, American Expeditionary Forces, 174,000 officers and men, distributed as follows:

Character of service.	Officers and men.
With armies	86,400
Miscellaneous (including troops in training, at schools, shops, etc.)	18,500
Construction (in the services of supply under the division of construction and forestry)	43,000
Forestry	18,500
Supplies	7,600
Total engineer troops under chief engineer American Expeditionary Forces	174,000

ENGLAND
NORTH SEA
GERMANY
BELGIUM
RHINE RIVER
THE FRONT NOV. 11, 1918
LONDON
BASE SECTION NO. 3
SOUTHAMPTON
PORTSMOUTH
PLYMOUTH
ENGLISH CHANNEL
CALAIS
BOULOGNE
SECTION NO. 4
CHERBOURG
HAVRE
ROUEN
BASE
VERDUN
ADVANCE SECTION
LORRAINE
DIST. OF PARIS
LIFFOL-LE-GRAND
PARIS
JONCHERY
NEUFCHATEAU
EPINAL
BREST
BASE SECTION NO. 5
INTERMEDIATE SEC. WEST
LE MANS
ORLEANS
BLOIS
ANGERS
CHAUMONT
LANGRES
MONTOIR
SAVENAY
TOURS
GIEVRES
VIERSON
IS-SUR-TILLE
DIJON
ST. NAZAIRE
NANTES
ST. AIGNAN
ISSOUDUN
MONTIERCHAUME
MEHUN
BEAUNE
NEVERS
DONGES
B.S. NO. 1
BOURGES
NEUVY PAILLAUX
VERNEUIL
MESVES
ALLEREY
LA PALLICE
LA ROCHELLE
AUTRE
AIGREFEUILLE
B.S. NO. 7
MACON
VICHY
BOURS
LIMOGES
LYON
TALMONT
BLAYE
ST. LOUBES
INTERMEDIATE
SECTION EAST
PERIGUEUX
BASSENS
ST. SULPICE
ST. PARDON
BEAU DESERT
BORDEAUX
BASE SECTION NO. 2
BASE
SECTION NO. 6
MARSEILLE
ATLANTIC OCEAN
SWITZERLAND
ITALY
SPAIN
MEDITERRANEAN SEA
LEGEND
GENERAL HEADQUARTERS
H'DQUARTERS. SERVICES OF SUPPLY
SECTION ENGINEER HEADQUARTERS
MAIN RAILWAY LINES OF COMMUNICATION FOR A. E. F.
SECTION BOUNDARIES
NATIONAL BOUNDARIES
OFFICE OF CHIEF ENGINEER. A. E. F.
ENGINEER SECTIONS, MAIN LINES OF COMMUNICATION AND LOCATION OF PRINCIPAL ENGINEER PROJECTS
0 20 40 60 80 100
SCALE IN MILES
OFFICE OF THE CHIEF OF ENGINEERS, U. S. ARMY
ILLUSTRATIONS FOR REPORT
TRAINING SECTION, TROOP DIV.
CHIEF ENGINEER, A. E. F.
ENGINEER SECTIONS, MAIN LINES OF COMMUNICATION AND LOCATION OF PRINCIPAL ENGINEER PROJECTS
TRACED FROM A. E. F. DRAWING
D. C. F. 12473-57
DRAWN
TRACED
CHECKED
2 SHEETS COMPLETE FOR 990
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Part I.

ENGINEER DEPARTMENT ORGANIZATION.

The Engineer Department of the American Expeditionary Forces comprised the personnel engaged in duties under the supervision, or the direction, of the chief engineer, American Expeditionary Forces. During the first three months the Engineer Department had no "organization," or fixed association of individuals, each performing specific duties and all systematically cooperating in well-defined functions. Personnel was at that time so insufficient that such an organization was impossible. It is, therefore, expedient merely to narrate the activities of the officers then on duty. A definite conception of the size and difficulty of the Engineer task will be furnished by a recital of the facts concerning the preliminary surveys, investigations, negotiations and arrangements.

Information furnished by the Joffre mission that France's greatest immediate needs were steel rails, locomotive stock, car stock, railway shop machinery and labor skilled in railway construction and rolling stock repair, was a controlling factor in the formulation of a policy for engineer operations in France. Other representations of both France and England indicated their urgent need of personnel skilled in forestry and in all branches of railway work.

Accordingly, on May 5, 1917, nine regiments of railway troops were authorized. Two were to be railway shop units; three, operating units; and the other four, constructing units; one shop regiment and two operating regiments to be sent to the British, and one shop regiment, one operating regiment and four construction regiments to the French.

A "Military Railway Commission" to France and England was authorized, also May 5, 1917. Its membership was: Majs. Wm. Barclay Parsons and W. J. Wilgus, both consulting engineers newly commissioned in the Engineer Officers' Reserve Corps; Maj. A. B. Barber, Corps of Engineers; and Mr. F. de St. Phalle and Mr. W. A. Garrett, civilians experienced in railway engineering. Its work was concerned principally in ascertaining for the Chief of Engineers, the immediate requirements of the Allies in France in the way of railway regiments and transportation equipment. However, some in-

vestigations and recommendations were made touching the broader subject of organization, equipment, and supply for the Engineer work of the American expedition on the basis of a 500,000-man Army. In all, the commission dispatched to Washington 23 cable reports in addition to several more detailed special reports sent by mail. Its final report was completed and dispatched to the Chief of Engineers June 22, 1917.

The Engineer Department of the American Expeditionary Forces had its beginning May 18, 1917, when Col. Harry Taylor reported for duty in Washington as chief engineer officer on the staff of the commanding general. He was informed that his list of assistants must be presented on the 21st, as the intention was to sail on the 24th. He was limited to two officers and three civilian assistants. From General Orders, No. 1, Headquarters, American Expeditionary Forces, Washington, May, 1917, is quoted the officer personnel of the Engineer Department, American Expeditionary Forces, as follows: Corps of Engineers: Col. Harry Taylor, chief engineer officer; Capt. Ernest Graves, assistant; Capt. Roger G. Alexander, assistant.

The three civilian employees whose services Col. Taylor had secured were Louis A. Jenny, civil engineer; James S. Wells, and W. J. Quillinan, clerks. This force of five assistants was obviously inadequate for the discharge of even a small part of the necessary duties in France.

The information concerning the ultimate rôle of the Engineers in the general operations of the American forces in France was at first very meager. Upon the definite placing of the line between the service of the interior and the theater of operations in France was dependent whether the Engineers or the Quartermaster Corps would be responsible for construction in and behind the line of communications in France. On Friday, May 25, the Chief of Staff, the Chief of Engineers, and the Quartermaster General, in conference, decided that all France would be the theater of operations. Col. Taylor was notified of this decision on the following day.

EN VOYAGE.

Gen. Pershing and his staff departed from New York for the scene of operations on Monday, May 28, 1917.

On May 31 the chief engineer officer was appointed a member of a board of five, the duty of which was "to consider the advantages and disadvantages of such ports as may be indicated as possible bases for the American Expeditionary Forces. These should include the adequacy of the suggested ports in space for anchorage, depth of water, protection from sea and submarines, docking and disembarking facilities, railways, rolling stock, etc., highways, dust, rain, and other

violent storms, shelter for troops or space, if necessary, to erect shelter, hospitals or space, if necessary, to erect the same, space for remount accommodations, storehouses and go-downs or space to erect them, ice plants and cold storage facilities, etc.—in short, the information necessary to enable the commanding general to reach a conclusion."

Col. Taylor and Capts. Alexander and Graves also began work on the tentative designs and estimates for structures and facilities for debarking and housing the personnel, supplies and equipment of one Army division. With one division as a unit an estimate of the requirements for 1,000,000 men was made and incorporated in the board's preliminary report to the commanding general. To some extent it later formed a basis for requisitions.

The commander in chief and his party arrived in London at 3 p. m., June 8. The same day he directed that the Board on Ports " proceed not later than June 10, 1917, to the following places: St. Nazaire, La Pallice, Bordeaux, and the Gironde Ports, Nantes, Nevers, and Marseilles, visiting Marseilles as the last port. The travel to Nevers should be to inspect the possibilities for a depot."

The board left London at 2 p. m., June 10, arriving at Paris on the 11th, where arrangements were made for French officers to accompany the board to the ports to be investigated.

FIRST WORK IN FRANCE.

Between June 12 and June 18, 1917, the board visited and inspected existing facilities, and possible sites for new ones, at Nantes, St. Nazaire, La Rochelle, La Pallice, Bordeaux, Bassens, Pauillac, and Le Verdon at the mouth of the Gironde. Upon completion of its study of the port facilities at Nantes and St. Nazaire, June 14, the board wired a preliminary report to Gen. Pershing at his new headquarters. Upon the conclusion of its entire tour a complete report was submitted by the board, together with its recommendations that—

1. The French plan of establishing concentration camps (instruction camps), and bases of supplies in the interior, and utilizing the ports as reshipping points, be accepted.

2. The initial agreement with the French Government relating to railroad facilities include a provision which will insure American control of railway lines of communication whenever the situation makes such control necessary for the successful supply and operation of the American Army in France.

3. The French Government turn over gradually to the American forces, for exclusive use, the following port facilities:

For permanent use: At St. Nazaire, berthage for 3 ships; at La Pallice, berthage for 6 ships; at Bassens, the present dock facilities and sufficient river front to extend these facilities for berthage of 10 ships.

For emergency use: At Nantes, berthage for 4 ships; at Bordeaux, berthage for 3 ships; at Pauillac, berthage for 2 ships.

4. Steps to be taken for the construction of wharves, storehouses, camps, etc., for the reshipping and transit accommodations indicated at the following points: At St. Nazaire, 150,000 men and 50,000 animals; at La Pallice, 350,000 men and 100,000 animals; at Bassens, 500,000 men and 200,000 animals.

5. American forces have absolute control at ports of all decking and warehouse facilities connected with the berths assigned the American ships; all other features of port control to be arranged through French military staff officers.

6. A general officer of the line of the American Army, with a sufficient staff, be sent to France without delay and detailed as commander for the service of the rear.

7. A definite understanding be had with the French Government at the present time relative to reimbursement for use of docks, wharves, railroads, etc.

8. Americans enlisted in the military forces of the United States be brought to France for the following purposes: Dock laborers; foresters; construction work, including bridge carpenters, masonry workers, plumbers, etc.

9. Personnel and material be sent to France without delay for the following purposes: Collecting and sawing of timber in the French forest; for the construction and operation of refrigerating plants; for the operation of slaughterhouses; and for the driving and operation of artesian wells.

10. There be accepted from the French Government, or the American Government immediately start the construction of, bases in the interior of France sufficient to provide ultimately for the maximum American forces to be sent to France.

OFFICE OF THE ENGINEER DEPARTMENT HEADQUARTERS, AMERICAN EXPEDITIONARY FORCES, AT PARIS.

Meantime, Majs. Graves and Alexander had gone to Paris and secured office space. The existence in France of the American Expeditionary Forces Engineer Department terminated the duties of the military railway commission, and on the 15th of June its members reported to the Chief Engineer for duty. Messrs. Garrett and de St. Phalle, now majors, Engineer Officers' Reserve Corps, departed for Washington within the next two or three days. On the 20th, Maj. H. S. Graves and Capt. Barrington Moore, Engineer Officers' Reserve Corps, forestry specialists, reported for duty. The office of the Chief Engineer then had nine officers, as follows: Col. Harry Taylor, chief engineer; Majs. Ernest Graves, R. G. Alexander, A. B. Barber, W. B. Parsons, W. J. Wilgus, H. S. Graves, Capt. Barrington Moore, and the former civilian engineer, Capt. Louis A. Jenny.

One of the first cables to the Chief of Engineers, June 20, requested the immediate dispatch to France of 12 officers, Corps of Engineers; 25 assistant or junior engineers, the latter to be either civilians or reserve officers. It was also requested that a purchasing agency and

depot be established in New York to furnish supplies and employees direct.

Among the matters most urgent for early consideration and action were:

1. The procurement of Engineer supplies:
   (*a*) The drafting of requisitions upon the United States.
   (*b*) Provision for timber supply.
2. Port and transportation facilities:
   (*a*) Construction of wharves and cargo-discharging facilities.
   (*b*) Construction of terminal facilities at points of debarkation.
   (*c*) Organization of a service for the repair and operation of railroads.
3. The provision of cantonments, storehouses, and hospitals.
4. Organization of special engineer services—a gas service, a searchlight service, a camouflage service, and a water-supply service.

Preliminary work upon some of those matters was inaugurated immediately, while others were required to wait for the arrival of additional officers.

PROCUREMENT OF ENGINEER SUPPLIES—REQUISITIONS ON UNITED STATES.

Requisitions for Engineer stores were prepared, and five were cabled to the Chief of Engineers on July 10. Requisition No. 1 called for 22,806 tons, consisting of camouflage material and I beams for dugout and cut-and-cover construction; No. 2 required 6,133 tons of material for water-supply projects; No. 3 specified an electric lighting plant complete, 395 tons; No. 4 for Engineer equipment and supplies for troops operating in corps and divisional areas; and No. 5 called for road building and quarrying equipment and machinery.

All of the requisitions stipulated the quantities required for initial stock and those required for a monthly supply, and each contained this explanatory note:

> Initial stock is required as soon as possible and must thereafter be maintained. Estimated monthly supply is required to be furnished automatically, after initial stock has been established, without further requisition. Bases of estimate is Army of 500,000 men. For larger Army quantities should be increased proportionately.

Requisition No. 6 was dispatched to Washington July 14. It called for 157,936 tons of railway tools and materials and followed the lines of the earlier requisitions concerning initial stock and monthly supply.

PRELIMINARY PLANS FOR FORESTRY OPERATIONS.

The British and French had established an association known as the "Comité Franco-Britanique des Bois de Guerre," to arrange for

the purchase of French timber to be cut by British and French forestry troops. Thereby all timber speculation was eliminated. The work of the Comité was most satisfactory. The necessity that the United States enter into this arrangement was apparent, for the open-market quotations on French timber were 140 per cent higher than the prices paid by the French Government. A start was made June 22 toward arranging for American participation, when an informal conference was held, at which explanations given by the British officers present permitted a clear understanding of the manner in which the problem of lumber supplies was handled by the C. F.-B. B. G.

Matters for immediate decision and early action were agreed to be:

(*a*) The completion of arrangements to furnish aid to the British in accordance with obligations already incurred.

(*b*) The determination of a policy regarding aid which had been requested by the French.

(*c*) The determination of forestry requirements of American forces.

(*d*) A decision as to the probable number of men needed to produce wood and timber for the American Army.

(*e*) The determination of a policy regarding the administration of forestry work and the early building of an overhead organization.

(*f*) The coordination of our timber production with that of the French and British.

(*g*) Arrangements with the French for standing timber.

At a second conference June 28 with the British, the relation to the British forestry organization of American forestry troops detailed to British work was discussed to some extent and it was decided that those units should operate in the Landes district. The British desired to be informed when they might expect the American units and urged that training and camp drill in the United States be cut to a minimum. The urgency of the American need for timber supplies was explained by the American officers and it was agreed that the first battalion to arrive in France, of the regiment promised the British, would be detailed to produce timber for American consumption, while the second battalion would go to the British, as originally promised. In that conference the opinion was unanimous that the United States must be represented in the Comité Franco-Britanique des Bois de Guerre.

Another conference was held at the office of Gen. Julien, chef du génie, July 5, for the purpose of making definite arrangements with regard to wood supply. Practically the only result was a promise of a formal invitation to the American Army to participate in the Comité Franco-Britanique des Bois de Guerre.

By the second week of July, it became evident that the French would be able to furnish to the American Army no lumber or timber except for camp construction, and therefore requisitions for all piles, heavy timbers, lumber, and ties for wharf and port terminal construction and all heavy bridge timbering required before the American forestry units could begin operations were immediately cabled to Washington. At the same time the timber negotiations with the French progressed so slowly that it was feared that operation districts might not be secured by the time the forestry units arrived.

On July 22 a letter from Col. Taylor to the commander in chief outlined the critical situation and requested him to take steps to secure immediate action by the French. It was urged that the French Government had the right of forest requisition and that it should be induced to use it. A strong letter from Gen. Pershing to M. Painleve, minister of war, elicited a request from that official for a conference, at which the American wood requirements and the difficulties encountered were set before the minister. Gen. Pershing requested that immediate arrangements be made to secure location for forestry troops in forests, to be purchased in cooperation with the French Government. M. Painleve agreed to Gen. Pershing's requests. On August 2 the bureau des eaux et forets of the ministry of agriculture advised that—

(*a*) The acquisition of private forests and the cutting rights in the State forests would be handled by Gen. Chevalier for the French Government. American negotiations would be directly with him.

(*b*) A list of State forests which would be placed at the disposal of the American Army was at the office of Commandant Herbillon, who would aid through the detail of an officer in making an examination of the timber at once.

(*c*) A reorganized French committee had been formed to consider wood problems in France. This committee was composed of the minister of agriculture as chairman, other ministers, representatives of the bureau des eaux et forets, of wood consumers, and of the lumber industry. There was a permanent subcommittee of which M. Antoni was a member.

(*d*) On August 1 that committee had finally decided that the French Government had the right to requisition on standing timber, and would exercise it when necessary.

Thus, after six weeks, and only upon the determined intervention of the commander in chief, was the forestry dilemma straightened out. The desired results attained were: A definite arrangement to deal in forestry matters directly with a single authorized agent; the use of the power of requisition in acquiring private timber; permission and plans for the immediate examination of State forests for the location of the first American forestry troops.

PROVISION FOR PORT AND TRANSPORTATION FACILITIES.

Transportation necessarily includes port facilities for cargo discharge, storage, classification, and routing, as well as intermediate and advance base facilities for storage and distribution.

Although base port facilities and transportation are, in a sense, inseparable, sketches of the early work in each of those lines are presented separately.

Port facilities.—At a conference which Col. Taylor had with M. Claveille, under secretary of state for transport, on June 26, the latter suggested that, at the different ports where the American forces contemplated making improvements, certain existing facilities might be used pending the construction of additional accommodations. A point advanced for consideration was whether the United States should continue the use of French facilities for the period of the war, and turn over new improvements, upon completion, to the French, or use the French accommodations only pending the completion of American construction. The American choice of those alternatives was expressed as being quite immaterial. The question of payment by the French for American port improvements when the end of the war should discontinue their need by the United States was tentatively considered, but not definitely decided.

It was learned at the conference that an officer under M. Claveille had prepared complete plans showing the French idea of what port extensions should be made by the Americans. They were offered simply as suggestive, and plans called for actual construction to be done by the Americans, but stipulated that all earth filling would be done by the French. They proved of help later.

On July 2 a conference as to port facilities was held between Col. Taylor and Col. Maurier, chief of the fourth bureau of the French general staff, and the latter submitted a memorandum from which the following is quoted:

SPACE OF THE PORTS.

In proportion to its requirements the American Army can make use of—

(*a*) At St. Nazaire, 5 postes (berths), 4 in the basin of St. Nazaire and 1 on the Quai de Maree.

(*b*) At Nantes, 4 berths along the Quai des Antilles.

(*c*) At Bassens, 7 berths, ready or about to be finished.

(*d*) At Pauillac, 2 berths.

(*e*) At La Pallice, 2 berths, and besides the poste (berth) with the 40-ton crane when necessary.

These berths can not all be reserved at this time without crippling the French movement of supplies by sea, but they will be turned over as needed.

It is of the greatest importance that, according as these berths are made use of by the American Army, they should construct new ones at Bassens, at La Martiniere, at L'Usine Bruleie, as agreed upon.

The American Army will have the use of all tools and equipment existing in the ports at the places assigned to it. They must do their own unloading and warehousing.

They need only comply with the general port regulations in accord with the French transport manager of that port.

The docks belong to private individuals, to chambers of commerce, or to the Government. Those used by the American Army will be rented to them on terms to be especially agreed upon in each particular case. The same applies to the cranes and other working implements.

The question of the different port and dock charges has not yet been considered.

On July 7, 1917, a communication was sent to the French ministry of war announcing the acceptance of the Bassens facilities tendered by the French pending the construction at that place of a new 6-berth wharf by the United States. The probability of increasing the project to 10 berths was stipulated, as well as the provision of the necessary cranes, tracks, sheds, and the connection with the main line of the Paris-Orleans Railway.

A general study of the inspections and surveys thus far made toward a solution of the port question resulted in the following recommendations to Gen. Pershing:

(*a*) That tentative approval be given for the building of the entire 10 berths for which designs have been made at Bassens, together with the necessary tracks and accessories.

(*b*) That provisional approval be given for the building of 5 of the 10 berths for which designs have been made at La Martiniere, together with the necessary tracks, branch line to a connection with the railroad between Paimboeuf and Nantes, and accessories.

(*c*) That an energetic attempt be made to have these matters settled and the work laid out on the ground, so that our railway construction regiments may be placed at work on grading as early as possible after their arrival.

(*d*) That an immediate examination be made of wharf facilities in actual use by the British at Rouen, Havre, Boulogne, Calais, and Dunkirk, so that in the light thereof we may cable to the United States for the necessary cranes, capstans, etc., for the above-mentioned 15 berths, or possibly purchase all or a portion of them in Great Britain.

(*e*) That, should the investigation under way as to the merits of the new deep-water port on the east bank of the Gironde River, near its mouth, prove to be favorable, 8 berths, under our exclusive control, be created there in lieu of that number which the French have intended to allot to us among the existing ports, the total of 23 berths under our exclusive control (10 at Bassens, 5 at La Martiniere, and 8 at a new deep-water port) therefore filling our needs as first outlined by the French, with the use of the existing French facilities for our initial needs in excess of that number.

Considerable study was given at this time to the possibility of wharfage development on a site at Talmont, near the mouth of the Gironde River, for port uses. The geographic location of that point suggested that survey be made, and in company with French officials an inspection of the place was made July 18. The shore was gener-

ally rock, with high vertical bluffs between wide tide flats, where the bottom appeared to be rock, covered with a thin layer of mud. Near the upper end of the deep channel was a stretch approximately 6,000 feet in length, where it might be possible to develop docks, and behind it were excellent facilities for yards and camps. Nothing more was immediately done on the Talmont proposition. A few weeks later, however, to establish definitely the feasibility of entering on a project of development at Talmont, Maj. Hugh L. Cooper, who arrived in France in late July, directed the driving of some test piles there. As a result of his investigation it was decided that port facilities at Talmont could be arranged only by the expenditure of a very large sum of money and a great amount of time, and the idea of development there was abandoned. Nevertheless, the project was later revived, and work started at a somewhat different location.

With a view to profiting by the experience of the British in their use of French ports, Havre, Rouen, Dieppe, Calais, Dunkirk, and Boulogne were visited. The quay space, ship berthage, tonnage handled, crane equipment, storage capacity, yard and siding facilities at each of these ports were especially noted.

A review by Col. W. J. Wilgus, Transport Corps, of the aggregate performance of the ports inspected by him led him to conclude that, with the various restrictions at the French ports occupied in part by the British, such as duality of control, multiplicity of departmental management, inferiority of labor, poor track layouts, congestion through use of space for storage purposes, hindrance to efficient use of forces, inadequacy of suitable car supply, and main-line limitations, the average quantity of freight passed between vessel and quay was 1½ tons per day per linear foot of quay, or approximately 600 tons per day per 410-foot berth. It was suggested by him that, unhampered by the above-mentioned restrictions and with four modern electric gantry cranes of wide radius for each 410 feet of berth, supplemented by a few special cranes of high capacity working in three shifts, in connection with ships of large tonnage, it would be possible to attain an average continuous output of 20 tons per hour, or 500 tons per 24 hours per crane—equivalent to 2,000 tons per day per 410-foot berth, or 5 tons per day for each linear foot of quay. It is of interest to note that, in accordance with these views, gantry cranes were later installed at Bassens, but for various reasons the output above suggested was not attained.

Recommendations were accordingly presented to the commander in chief and the chief of engineers along these lines, as follows, but (*h*), (*i*), and (*j*) are omitted as not affecting the operations of the Engineer Department:

(*a*) That new ports, exclusively for American occupancy, be created as quickly as possible at Bassens, with 10 berths, accommodating vessels drawing

24 feet to 25 feet; at La Martiniere, with 5 berths, capable of future increase to 10, accommodating vessels drawing 22 feet to 23 feet; and at some point, to be selected, near the mouth of the Gironde, with the capacity of about 10 berths, for vessels of the deepest draft.

(*b*) That all operations at each port be under the management of an experienced and able American terminal superintendent, aided by a competent staff of assistants and foremen, by an adequate force of skilled cranemen, repairmen, mechanicians and stevedores, and by a force of high-class labor, all in sufficient number for continuous operation in three 8-hour shifts.

(*c*) That track layouts of ample capacity be planned, with proper provision for orderly expansion, and so designed on the circulatory system as to avoid conflict of in and out bound movements, these principles already having been observed in the plans outlined for Bassens and La Martiniere.

(*d*) That storage of freight in the port proper be avoided through the establishment of warehouses and open areas near by, at which freight not immediately to be forwarded to the interior might be held without clogging the port.

(*e*) That shed and platform areas be paved with smooth surfaces for efficient trucking; that labor-saving devices be installed, such as steel, ball-bearing, unloading skids, electric-driven warehouse platform trucks, with extra platform cars, movable platforms for transferring crane loads into box cars; chutes for horses, mules, and live stock, and such other special devices as would best suit the handling of miscellaneous materials, and that very light locomotives be supplied for moving cars on the wharves in lieu of horses and capstans.

(*f*) That the electric installations be made ample for vivid night illumination and for running various electric devices, and that a repair shop be established at each port for the combined uses of all branches of the service.

(*g*) That one 10-ton, one 5-ton, and two 3-ton electric gantry cranes be provided for each berth, except at one of the end berths, where a 20-ton crane can be provided at each port, preferably of the self-propelled, floating type or otherwise of the fixed-dock type; and that the cranes be equipped with an assortment of hooks, grab buckets, slings, trays, and magnets for handling various commodities, such as coal, crushed stone, bagged goods, boxes, barrels, steel rails, timbers, crossties, ammunition, locomotives, cars, and guns.

Transportation.—M. Claveille had charge of matters relating both to railways and to port facilities, so that many of the early negotiations carried on by the Engineer Department were conducted with his office. On June 26, in an interview with Col. Taylor, this French official laid stress on the early construction of terminals at seaboard points selected for the debarkation of American troops and supplies. He suggested that the first arriving Engineer troops should be assigned immediately on that work with material furnished by the French, but that, if the material was not forthcoming, the American troops should be placed in the forests to cut the necessary timber, and that the first shop regiment to arrive should be stationed at the Nevers shops, then under construction by the French. These shops were to be turned over to the Americans, who were to furnish the necessary shop machinery and equipment. Plans of such equipment had already been sent to Washington.

The subject of the organization of a permanent board of the representatives of France, England, Italy, and the United States to consider transportation matters was also broached and favorably considered.

The result of another conference with Col. Maurier, of the French general staff, was a memorandum containing data on transportation, outlining the views of the French ministry, thus:

The control of transportation over the line of communications can be carried out by the American Army in the following manner:

(*a*) The bureau of transportation at American headquarters should keep in constant communication, on the one hand, with the direction des transports militaires in the interior zone (general headquarters of the army, fourth bureau), and, on the other, with the direction des transports militaires in the zone of the armies (grand quartier général). In this way all the details of transportation can be mutually agreed upon.

(*b*) As to the actual transportation itself, an American officer will be stationed with the commission regulative (the controlling commission) and in each important station on the line of communications (stations terminal, supply stations, warehouses, meal stops, base, etc.).

The American officer who is attached to the French controlling commission should address to them all his requests for transportation in the zone of that commission, and should collaborate with them in the handling of such transports.

The American officers detailed to the important stations, near the "Commissions of the French railway stations," should inform them of their requirements. They serve as liaison between them and the American troops and departments, also superintend the actual transportation itself.

As to the cost of railway transportation, that is covered by a special agreement between the French Army and the companies, and will apply to the American Army.

On July 3 a newly-formed international committee on transportation convened, under the presidency of M. Claveille; Col. Taylor, representing the interests of the United States. The subjects discussed had relation almost entirely to French needs. In telling of the increased number of locomotives and cars becoming unfit for use due to the lack of repairs, M. Claveille expressed the desire that the French might secure American repairmen in addition to the first shop regiment already promised. He brought up the urgency of the early delivery of the locomotives, rails, and equipment ordered from America by the French. The advisability of the American Army furnishing operating forces for 150 miles of railway in the advance and rear areas of the American front was also urged.

The whole problem of transportation was a few days later again considered in more detail in a conference with M. Claveille and representatives of all the railroads in France interested in the movement of American troops and supplies. Based on an Army of 1,000,000 men, the United States officials assumed a tonnage of 50,000 per day,

based on 100 pounds per man per day. The French railroad officials present outlined a plan for routing this tonnage, thus: 25,000 tons via Bourges, Nevers, Chagny, Dijon, Is-sur-Tille; 15,000 tons via Bourges, Cosnes, Laroche, Nuis-sous-Raviere, Chatillon, Chaumont; 10,000 tons via Orleans, Montargis, Sens, Troyes.

That arrangement was accepted by the chief engineer with the reservation that, should military necessity or other reasons make a change necessary in the routing of the traffic, it would be done.

The desire was expressed by the French that a commission representing the American and the French interests be appointed to consider the general question of necessary changes in the existing railway lines to carry the American traffic, and to adopt a general plan of railroad operation. From the French viewpoint the questions to be taken up by such commission were:

(*a*) Work to be done on the line of communications to permit the transportation of the tonnage stated, and the relative urgency of the various portions of the work.

(*b*) Installations to be made in the zone of the interior and in the zone of the armies for the warehouses, depots of munitions, of material, and regulating stations. These regulating stations to be near enough to the front to allow the American railway troops to be intrusted with the operation of the lines situated on the Army side.

(*c*) Necessary personnel to execute this work to be furnished by the American Army.

(*d*) Locomotives, cars, and personnel with which it will be necessary to provide each of these lines to transport its tonnage.

(*e*) Reduction of French military traffic which can be expected on the same lines.

Throughout August the Engineer Department continued the preparation of plans covering railway construction projects, making estimates, preparing requisitions on the United States, and conferring with general headquarters American Expeditionary Forces, and the French war ministry on matters having direct relation to transportation problems then pending.

Transportation service.—A transportation department was authorized by General Orders, No. 8, Headquarters American Expeditionary Forces, July 6, 1917. It was not created until two months later, and the Engineer Department in the meantime therefore gave considerable attention to the formulation of a transportation organization. Thorough studies of the British and French systems were made.

It was then known that troop and supply transport from debarkation points to the front would involve long hauls of 400 to 500 miles over railway lines which also served a large French and British

demand. The plan deemed preferable was modeled after that of the British, that of more or less decentralized branches of the service, each in charge of an expert. It permitted the ready selection of suitable officers, disposed of the need of seeking personnel of extraordinary versatility, and left each branch head unembarrassed by any need of dissipating his time in supervising matters other than his own specialty. This plan followed methods already familiar to the French in their dealings with the British, and its adoption was intended to minimize the likelihood of misunderstandings arising when American operations started. The French divisional system was also studied but was rejected.

The chief engineer officer accepted a commission as brigadier general, National Army, on August 31, 1917. On the same date Mr. W. W. Atterbury reported to Gen. Pershing with a view to his assuming charge of the transportation service as director general of transportation in accordance with General Orders, No. 8, and his appointment announced in General Orders, No. 37, Headquarters American Expeditionary Forces, September 14, 1917, which established a transportation department and detailed Mr. W. W. Atterbury, director general of transportation; Maj. W. J. Wilgus, deputy director of railways; Brig. Gen. William C. Langfitt, manager of light railways: Brig. Gen. C. H. McKinstry, manager of roads.

EARLY SURVEYS FOR INTERMEDIATE AND ADVANCE DEPOTS.

Although the Engineer Department was charged with the constuction of all depots and distributing points, other branches of the service were also concerned. Since the Engineer Department had been working mostly on ports, transportation matters, and timber supply, little attention could be given to intermediate and advance depots until June 29, 1917, when Col. Taylor, accompanied by Col. Wilkins, Quartermaster Corps, Maj. Logan, general staff, Capt. Taylor, Signal Corps, and Commandant Laval made an inspection of existing French depots in the intermediate zone, expected to be taken over by the American organization. The party visited Ambrais, Sabris, Bourges, Avord, and Nevers, and depot facilities at each of these places were inspected. From Nevers the officers went to Cosne and Montargis. At the former place a French ammunition depot under construction was examined, and at Montargis a large supply and engineer depot was inspected.

Nothing further in the way of a depot program could be accomplished until the arrival in France of the first Engineer regiment. The 15th Engineers, recruited for standard gauge railway construction, debarked at Le Havre, July 26, 1917, and immediately moved to Vierzon, in the intermediate zone. Col. Edgar Jadwin, commanding

the 15th Engineers, became, under a system similar to that of the Engineer Department in the United States, chief engineer in the zone covered by his regiment—the intermediate zone or section.

Col. Taylor and Gen. Biddle on July 28, 1917, made an inspection of the depot facilities in the vicinity of Vierzon. It was discovered that no work had been done on the shops at Nevers since the agreement that all work was to be completed by the French as early as possible in order to prepare it as a station for the first shop regiment. It was learned, however, that a contract had been let for the early completion of the work and that it would be started within a few days. Two companies of the 15th Engineers had already begun the construction of a 9½ mile branch line from Issoudun to the site of the projected aviation camp near that place. Col. Jadwin was given instructions to obtain further information regarding certain sites in the vicinity indicated by the French for possible storage depots.

The commander in chief on August 4 made a definite decision upon the amount of storage space to be provided. His decision made provision for not only the immediate present but the ultimate future, and embraced not only the intermediate zone but the base and advance zones. The decision made possible the immediate construction of depots.

Col. Jadwin examined seven sites which had been suggested for depots on the St. Nazaire-Bourges line in the intermediate zone and recommended Gievres and Mehun as the most suitable, and they were approved as sites. The country on the Tours-Orleans line was also examined and a site tentatively chosen near Blois.

On August 6, a survey party from the 15th Engineers left for Gievres. A survey was made by them of the ground between Villefranche and Selles and a site chosen there for a general depot. At the same time a survey was made by another party from the regiment of the ground between Foecy and Mehun, from which a site for an ammunition depot was chosen. On August 15, Company B of the 15th Engineers left for Luneville where it engaged in the survey for an advance depot and camp sites in the first and second divisional areas. Another party made a survey of about 10½ square miles in the vicinity of Blois, a location which was intended to be used as a general depot. Col. Jadwin, assisted by Capt. Somerville, examined sites in the vicinity of Chateauroux and Issoudun on the Bordeaux-Bourges line in the intermediate zone which had been suggested for depot sites. Surveys of these sites were made. Thereafter extensive examination of the country between Neufchateau and Chaumont was made. Sites at Liffol-le-Grand and Sousey were recommended as the most suitable in that area for advance depots. A later decision was, however, made to locate the advance depot at Is-sur-Tille.

ORGANIZATION OF SPECIAL ENGINEER SERVICES.

Except requisitions Nos. 1 and 2, for camouflage and water supply material, respectively, nothing was done toward organizing the gas, searchlight, camouflage, and water supply services prior to the appointment of their permanent chiefs. With the exception of the gas service, which like the transportation department, was later divorced from the Engineer Department, the organization and operations of the special Engineer services from the time of the appointment of their chiefs are described in subsequent parts of this report.

GAS SERVICE.

Information supplied the commanding general, American Expeditionary Forces, by Dr. G. A. Hulett, of the American scientific mission, emphasized the need of a gas service, and the Engineer Department was accordingly charged with its organization. Dr. Hulett, a specialist in chemical research work, had accumulated considerable data concerning the use of gas and flame in both offensive and defensive warfare.

In the general organization project of the expedition the formation of a gas and flame regiment was included, and cable No. 108, received August 15 from the War Department, advised that orders had been issued authorizing the organization of a gas and flame regiment. However, it was obvious to the chief engineer that if matters were delayed to await the organization of that regiment, the work which should be done immediately in France would be neglected. Therefore, in a memorandum to the Chief of Staff on August 17 he pointed out that the service was of extreme importance and recommended that Lieut. Col. Amos A. Fries, Corps of Engineers, be designated as chief of the gas service. On August the commander in chief appointed Lieut. Col. Fries "director" of the gas service, American Expeditionary Forces.

Conferences were held by the chief of the gas service with the chief engineer officer and members of the general staff, with a view to coordinating his efforts with those being made in the United States, and effecting more speedily a gas and flame service for the American Expeditionary Forces. On August 24, upon Col. Taylor's recommendation, cable No. 122 was sent to the Chief of Engineers requesting that the Bureau of Mines and other departments then carrying on gas experimental and research work send to the chief of the gas service at general headquarters biweekly reports of their activities and such information as might be useful to the service in France.

On September 3, by General Orders, No. 31, Headquarters American Expeditionary Forces, a gas service was established as a "Staff Department" of the American Expeditionary Forces, to operate in-

dependently of the chief engineer, although that officer was charged with its supply of all such material and appliances as are usually furnished by the Engineer Department. The Engineer Department was also required to furnish all such personnel as was not acquired from other sources.

BEGINNING OF A DEFINITE ORGANIZATION—FUNCTIONS OF CORPS OF ENGINEERS.

The original functions of the Corps of Engineers in the American Expeditionary Forces, broadly, comprised military engineering, engineer supply, general construction, and service of military railways.

The term "Military engineering" embraces all duties of the Engineers assigned or attached to a tactical command, including those of the chief engineer, American Expeditionary Forces (his headquarters, American Expeditionary Forces, staff duties), of the chief engineers of Armies and Army corps, of division engineers, and of the engineer officers and men subject to the command of each. Engineer supply includes the procurement, storage, and issue or distribution of such materials as are specified as Engineer property or equipment. The scope of the two functions, general construction and service of military railways, is well covered in the following quotation from Army Regulations regarding the duties of the Corps of Engineers within the theater of operations:

> * * * 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.

Assigned to other than Engineer Department.—Headquarters, American Expeditionary Forces, General Orders, No. 37, September 14, 1917, creating the transportation department, assigned to it the service of military railways, and charged it with the operation, maintenance, and construction of all railways under American control, and with the construction and maintenance of wharves and roads, and of shops and other buildings for railway purposes. The transportation department discharged the foregoing construction duties only at the ports of St. Nazaire and Bordeaux, and during the period September 14, 1917, to March 12, 1918. On the latter date, also, it relinquished direction of American light railway operations.

Certain construction was also done by the Air Service and the Ordnance Department. Air Service construction was taken over by the Engineer Department on December 31, 1917, and that of the Ordnance Department, January 17, 1918.

Retained by Engineer Department.—After the arrival of sufficient personnel, an organization of the Engineer Department was formulated and changed from time to time to correspond to the varying assignment of duties to the department. As finally decided by higher authority, these duties were military engineering, engineer supply, general construction, and, from March 12, 1918, light railways. During the 15 months subsequent to the previously described preliminary period of three months the organization naturally falls into three periods, thus:

FIRST PERIOD—AUGUST 13, 1917, TO MARCH 12, 1918.

I.

Function: Military engineering.
Head: Chief engineer, American Expeditionary Forces.
Organization: Office of the chief engineer, American Expeditionary Forces.

II.

Functions:
(*a*) Engineer supply.
(*b*) General construction.
Head: Chief engineer, line of communication.
Organization: Office of the chief engineer, line of communication.

SECOND PERIOD—MARCH 12, 1918, TO JULY 11, 1918.

I.

Functions:
(*a*) Military engineers.
(*b*) Engineer supply.
Head: Chief engineer, American Expeditionary Forces.
Organization: Office of the chief engineer, American Expeditionary Forces.
(*a*) Office at general headquarters.
(*b*) Office at headquarters, S. O. S.

II.

Functions:[1]
(*a*) General construction.
(*b*) Light railways.
Head: Chief of utilities.
Organization:[1] Office of chief of utilities.
(*a*) Department of construction and forestry.
(*b*) Department of light railways and roads.

THIRD PERIOD—JULY 11, 1918, TO NOVEMBER 11, 1918.

Functions:
(*a*) Military engineering.
(*b*) Engineer supply.
(*c*) General construction.
(*d*) Light railways and roads.

[1] As originally organized, the service of utilities included also the department of transportation and that of motor transport.

Head: Chief engineer, American Expeditionary Forces.
Organization: Office of chief engineer, American Expeditionary Forces.
(*a*) Office of assistant chief engineer, American Expeditionary Forces at general headquarters.
(*b*) Division of Military Engineering and Engineer Supplies.
(*c*) Division of Construction and Forestry.
(*d*) Division of Light Railways and Roads.

FIRST PERIOD—AUGUST 13, 1917, TO MARCH 12, 1918.

I. Military Engineering, Chief Engineer, American Expeditionary Forces.

As to military engineering, the chief engineer, American Expeditionary Forces, had a threefold relation. He served as Engineer adviser to the commander in chief, as technical supervisor of all Engineer services directed by chief engineers of lesser commands, and he commanded the office of the chief engineer, American Expeditionary Forces.

As adviser to the commander in chief it was his duty to collect and furnish complete information concerning all Engineer services in the American Expeditionary Forces; to submit recommendations for obtaining necessary Engineer personnel from the United States and for assignment to duty of all Engineer personnel of the American Expeditionary Forces, and to formulate and submit general plans, projects and policies for all Engineer services and the necessary organization and equipment thereof.

Being responsible to the commander in chief for the work of personnel engaged in the performance of the Engineer duties of lesser commands, it was the duty of the chief engineer, American Expeditionary Forces, to exercise technical supervision and to maintain technical inspection over all Engineer services of such commands. Although the chief engineers of tactical and territorial commands were under the direct orders of their immediate commanders and responsible to them for the proper performance of their duties, the chief engineer, American Expeditionary Forces, maintained a supervision over their operations that was partly direct and partly indirect. Direct supervision was exercised by written or verbal communication through "Engineer channels"; that is, through the chief engineers of successively subordinate commands. Indirect supervision was exercised through regular military channels, beginning in a recommendation to the commander in chief and passing down through the headquarters of successively subordinate military commands. Technical inspection of Engineer units was maintained by direct action. All Engineer staff officers were authorized to communicate directly with the chief engineer, American Expeditionary

Forces, concerning the personnel under their charge, matters of supply and technical details of their work.

The chief engineer, American Expeditionary Forces, as head of the office of the chief engineer, American Expeditionary Forces, was commander of all Engineer troops not assigned or attached to tactical or territorial commands, and with them he was required to discharge all Engineer duties not otherwise provided for.

OFFICE OF THE CHIEF ENGINEER, AMERICAN EXPEDITIONARY FORCES.

The station of the chief engineer, American Expeditionary Forces, was changed from Paris to that of headquarters, American Expeditionary Forces, at Chaumont, on September 1, 1917.

Although a comprehensive organization of the office was being formulated, due to lack of personnel, for two months it was not placed in operation, as most of the Engineer officers available in France for staff duty had been assigned to other services. Officers on duty in the office at that time were detailed, thus: Maj. G. A. Youngberg to coordinating the activities of the various special Engineer services then being formulated and maintaining liaison with the general staff; Maj. R. G. Black as administrative officer; Maj. F. F. Longley to the organization of a water-supply service; Maj. A. S. Peck to duties in connection with a forestry service; Capt. G. W. Semmes as personnel officer.

By November 1, 1917, the office of the chief engineer, American Expeditionary Forces, had assumed an organization in four divisions along the following lines:

1. The accounts and contracts division charged with keeping of all accounts, making contracts, and all auditing.

2. The administration division engaged in the executive control of the office and handling of all routine work. It had four sections: (*a*) Personnel section for the classification of Engineer officers and the supply of such personnel upon requisition; (*b*) military-information section, engaged in the collection and dissemination of military engineering information to all arms and departments; (*c*) inspection and training section for the supervision of training of Engineer units; (*d*) motor-transport section, for the management of the engineer motor transport, which at that time existed. The equipment was later placed in the general pool and the section abolished.

3. The operations division had six sections: (*a*) Technical military engineering section, engaged in the collection, compilation, and proper distribution to Engineer units of current information on military engineering. The five following engaged in surveys, drafting of requisitions, and the formulation of appropriate policies; (*b*) electrical and mechanical section; (*c*) water supply and sewer-

age section; (*d*) camouflage section; (*e*) searchlight section; and (*f*) geologic section.

4. The supply division, while concerned in the general supervision of engineer supply, was engaged principally in the active supervision of purchases in Europe (through the engineer purchasing officer) and of requisitions on the United States.

II. Engineer Supply—General Construction, Chief Engineer, Line of Communications.

Organization of the line of communications was begun on August 13, 1917. Since the far greater portion of Engineer duties in the immediate future were necessarily in the line of communications, most of the engineer officer personnel available in August was assigned to that service. The number of engineer officers in France was increased in August by more than 30 unattached officers from the United States. Another source of officer supply during that period was the field and staff personnel of arriving engineer regiments, many officers being immediately detached from duty with their regiments for headquarters duty.

The need of Engineer troops for construction work was extremely urgent. As the regiments of Engineers reached France they were immediately assigned to the most pressing duties. The first 12 Engineer regiments debarked in French ports in the summer and autumn of 1917 in the following order:

Regiment.	Character.	Arrived.	Commanding officer.
15th Engineers	Railway construction	July 26	Col. Edgar Jadwin.
11th Engineers	do	Aug. 6	Col. C. H. McKinstry.
17th Engineers	do	Aug. 17	Col. John S. Sewell.
13th Engineers	Railway operation	Aug. 18	Col. W. C. Langfitt.
12th Engineers	do	do	Col. C. McD. Townsend.
14th Engineers	do	do	Col. W. P. Wooten.
1st Engineers	Divisional	Aug. 21	Col. M. M. Patrick.
16th Engineers	Railway construction	Aug. 29	Col. H. Burgess.
18th Engineers	do	Aug. 30	Col. J. B. Cavanaugh.
19th Engineers	Railway shops	do	Col. Herbert Deakyne.
10th Engineers	Forestry	Oct. 7	Col. J. A. Woodruff.
2d Engineers	Divisional	Oct. 8	Col. J. F. McIndoe.

The 11th, 12th, and 14th Engineers were detailed to the construction and operation of light and standard gauge railways with the British expeditionary forces, the 13th Engineers to the operation of French Army railways, while the 19th engaged in the operation of French railway shops. The 1st and 2d Engineers engaged first in divisional training area camp construction in territory eventually included in the advance section, and later took up front-line training with French divisions. The 10th Engineers immediately began the felling of timber and the erection of sawmills.

With the commanding officers in charge of construction therein, the other four regiments took up the construction in the areas, as follows:

15th Engineers in the Gievres district (later intermediate section); 16th Engineers in the Is-sur-Tille district (later part of advance section); 17th Engineers in the St. Nazaire district (later base section No. 1); 18th Engineers in the Bordeaux district (later base section No. 2).

Among the first offices of headquarters, line of communication, to be established was that of its chief engineer. Beginning with a skeleton staff, it had grown to a force of 30 by the middle of September, and increased gradually with the scope of operations. As had been related, the main functions of the chief engineer, line of communication, and the engineer staff and forces subject to his direction, were construction and Engineer supply. Therefore, his organizatiton had those two main divisions. However, the distribution of the minor functions to the sections under those divisions was, for the first three months, in a condition of continuous evolution, both in duties and in personnel. Lieut. Col. Charles W. Kutz reported to the chief engineer, American Expeditionary Forces, on August 14, 1917. The latter immediately detailed him chief engineer officer, line of communication. He was relieved August 24 by Brig. Gen. Charles H. McKinstry. On September 17, having been appointed manager of roads, transportation department, Gen. McKinstry was relieved as chief engineer, line of communication, by Brig. Gen, Mason M. Patrick. He served as chief engineer, line of communication, until the discontinuance of the office in March, 1918; also as commanding general, line of communication, from November 2 to 27, 1917.

To the chief engineer, line of communication, the following Engineer officers were assigned as assistants: Lieut. Col. T. H. Jackson, Maj. L. V. Frazier, Maj. Ernest Graves, Maj. H. L. Cooper, and Maj. H. S. Graves. A few days later, Maj. Cooper was transferred to the transportation department.

ENGINEER SUPPLY.

Col. Jackson was placed in charge of the organization of the division of engineer supply, in the office of the chief engineer, line of communication, and on August 30 the chief engineer, American Expeditionary Forces, also appointed him engineer purchasing and disbursing officer. In the latter capacity he became engineer member of the general purchasing board, reporting to the general purchasing agent. Subject to the supervision and approval of the chief engineer, American Expeditionary Forces, he was charged with the

purchase in Europe and with the acquisition from the United States of all Engineer materials and equipment, the approval of the general purchasing board being also required on purchases in Europe. The duty of supervision and approval of certain classes of purchases and requisitions, however, was delegated to the chief engineer, line of communication, by the chief engineer, American Expeditionary Forces, and, in fact, most requisitions leading to purchase or to supply from United States subsequent to Requisition No. 6 originated in the supply division of the office of the chief engineer, line of communication.

As engineer purchasing officer, Col. Jackson established purchasing offices in Switzerland, Spain, France, and England, most European purchases being in the two last named. Capt. T. B. Whitted was placed in charge of the Paris office for French purchase and Maj. R. G. Powell of the purchasing office in London.

As Engineer supply officer, line of communication, Col. Jackson designated Capt. J. H. Graham depot officer and charged him with the organization and operation of the Engineer supply depots in the line of communication. He also detailed Capt. J. H. Wickersham to draw up requisitions on the United States, and because of the necessity for cooperation in planning the receiving and storage facilities for the enormous quantities of material named in such requisitions, the latter's work was placed under the supervision of the depot officer. In organizing his depot section, Capt. Graham placed Capt. Stephen Orlop in liaison at the French engineer depot at Angouleme, and designated Capt. J. A. Sargent depot officer at Gievres, Capt. C. H. Harrell at Is-sur-Tille, Capt. C. A. Rothwell at St. Nazaire, and Capt. L. L. Clarke at Bordeaux. In late September, 1917, each depot officer took over such stores of general Engineer material as had been accumulated at those stations by supply officers of Engineer regiments there, and immediately began provision for increasing stock and storage space. On December 22, 1917, Lieut. L. C. Millar was made Engineer depot officer at La Pallice, and about the middle of January Capt. J. C. Moore took station at Le Havre in a similar capacity.

As part of the supply division of the office of the chief engineer, line of communication, a forestry section was organized in September, 1917, under Maj. H. S. Graves, forestry assistant, first to the chief engineer, American Expeditionary Forces, and from August 29 to the chief engineer, line of communication. Col. J. A. Woodruff having debarked his forestry regiment, the 10th Engineers, on October 7, placed it in various cutting areas. Until December 22, 1917, he remained in command of its operations, when he established his regimental headquarters in the office of the chief engineer, line of

communication, and superseded Lieut. Col. Graves as chief of the forestry section. In addition to his duties as chief of the forestry section and in command of the 10th Engineers, Col. Woodruff relieved Col. Jackson, and from December 24, 1917, to February 14, 1918, served as engineer purchasing officer, American Expeditionary Forces. He also assumed the duties of engineer supply officer, line of communication, from the former date until the discontinuance of that office January 15, 1918.

From January 15, 1918, until the end of this period the chief of the forestry section, Col. Woodruff, and the depot officer, Capt. Graham, operated directly under the chief engineer, line of communication, and not through an intervening supply officer.

ENGINEER CONSTRUCTION—OFFICE ORGANIZATION.

Majs. L. V. Frazier and Ernest Graves were assigned to the construction division, line of communication. Maj. Frazier was charged with the direction of hospital and warehouse construction until October 2, 1917. Maj. Graves became administrative officer. He was also charged with the supervision of the construction of camps for American troops in process of building by the French, with Maj. T. M. Newton in local charge. Upon Maj. Frazier's relief, Maj. Graves assumed his hospital and warehouse construction duties, and from that time until he left the office for general staff duty, January 20, 1918, he was in charge of its construction division.

Maj. Graves received promotion to the rank of lieutenant colonel on October 25, 1917. At about that time he had completed the organization of the various sections of his division, as follows:

(*a*) Administration section: Handling personnel, correspondence, contracts, project plans and reports, and coordinating the other sections.

(*b*) Barracks and camp section: Charged with requirements, design, and technical supervision of barrack and camp layout and structures, Maj. W. N. Denman.

(*c*) Hospitalization section: Requirements, design, and technical supervision of hospital layout and construction, Capt. R. M. Coomer.

(*d*) Oil storage and plant section: Requirements, design, and technical supervision of the construction of oil-storage facilities and of various plants, Maj. H. L. Van Zile.

(*e*) French camp section: Requirements, design, and technical supervision of camps being built by French authorities for United States Army, Maj. T. M. Newton.

(*f*) Water supply and sewerage section: Requirements, design, and technical supervision of such installations, Capt. T. H. Wiggin.

(*g*) Drafting and reproduction section, Capt. L. W. Hall.

ENGINEER CONSTRUCTION—FIELD DIRECTION.

The field direction of construction in the Is-sur-Tille district was exercised under the chief engineer, line of communication, by Col. H. Burgess, commanding the 16th Engineers, until December 20, when Col. McIndoe, commanding officer of the 2d Engineers, became chief engineer of the advance section. Col. McIndoe discharged those duties until he was relieved about February 15, 1918, by Brig. Gen. Jadwin. The latter continued in charge during the remainder of the period.

From the time of the arrival of his regiment, the 15th Engineers, in the intermediate section until he was promoted and relieved by Col. Ernest Graves, February 14, 1918, Col. Jadwin, having investigated and recommended the storage depot sites, directed the Engineer construction in that section. Col. Graves then continued those duties during the remainder of the period.

Dock and railway construction in base sections No. 1 and No. 2 were administered by the commanding officers of the 17th and 18th Engineers, respectively, reporting directly to the director general of transportation. Although the work was done by men from the 17th and 18th Engineers, the direction of all engineer construction in those sections not connected with docks or railways was assumed by Col. Ernest Graves, in addition to his other duties under the chief engineer, line of communication. On December 18, 1917, those duties in base section No. 1 were taken over by Maj. R. E. Fowler, and on December 29 they were assumed in base section No. 2 by Capt. C. W. Cook.

LABOR.

Beginning with approximately 4,000 Engineer and other troops in late August, 1917, the construction forces operating under direction of the chief engineer, line of communication, had gradually increased to 31,000 on March 12, 1918. They included 6,500 Forestry Engineer troops, 18,500 Engineer troops and troops of other arms, and 6,000 civilians. The labor during the period was very inadequate.

SECOND PERIOD—MARCH 12, 1918, TO JULY 11, 1918.

I. Military Engineering, Engineer Supply—Chief Engineer, American Expeditionary Forces.

General orders published in February and March, besides changing the designation line of communications to that of service of the rear, and then to services of supply (S. O. S.), changed the distribution of duties so that a general outline of such reorganization as affected Engineer Department duties now becomes necessary.

Four major changes were effected:

(1) The office of the chief engineer, line of communication, was abolished.

(2) The chief engineer, American Expeditionary Forces, in addition to his American Expeditionary Force functions, became chief of a newly created Engineer Department at headquarters S. O. S.

(3) The service of utilities was created, its chief, under commanding general S. O. S., being charged with the coordinating direction of four departments: Transportation, construction and forestry, light railways and roads, motor transportation.

(4) The director general of transportation, American Expeditionary Forces, was transferred from general headquarters, and with its duties limited to operation and maintenance of standard gauge railroad, his department became a service under the commanding general, Service of Supply, through the chief of utilities.

Upon the creation of the Engineer Department of the Service of Supply in March, 1918, the chief engineer American Expeditionary Forces was charged under the commanding general, Service of Supply, with all duties concerned with the supply, storage, and issue of Engineer materials, and this was his only defined function in the Service of Supply. While becoming Chief of the Engineer Department, Service of Supply, the chief engineer, American Expeditionary Forces, retained his former American Expeditionary Forces functions at general headquarters—except that of supply procurement in which he was made responsible to the commanding general, Service of Supply, although certain matters concerning requisitions upon the United States and large purchases required general headquarters' approval.

For the proper discharge of his duties under the commanding general, Service of Supply, and under the commander in chief, the chief engineer, American Expeditionary Forces, maintained two offices—one at headquarters, Service of Supply, and one at general headquarters.

OFFICE AT GENERAL HEADQUARTERS.

Upon the division of the duties of the chief engineer, American Expeditionary Forces, between general headquarters and headquarters, Service of Supply, and the establishment of an office at each, Col. M. L. Walker, Engineers, United States Army, was designated as "assistant to chief engineer, American Expeditionary Forces," with headquarters at general headquarters, and was empowered to act as the personal representative of the chief engineer.

His duties were as follows:

(*a*) To maintain suitable contact with all engineer troops of tactical commands, including division, corps, and Army engineers, and all other special engineer services in the zone of the Armies, to an-

ticipate their demands for engineer supplies and make all necessary arrangements therefor.

(*b*) To act as adviser in all matters pertaining to construction and technical operations of military field engineering an field fortification work.

(*c*) To maintain technical liaison between the Engineer Department and the general staff.

(*d*) To serve as a means of immediate communication between the chief engineer and the commander in chief, with a view to expediting business pertaining to the Engineer Department.

He was assisted by the following officers, with duties indicated:

Col. G. A. Youngberg, in general administrative charge of operations division and engineering intelligence division. In immediate charge of all matters pertaining to changes or organization of Engineer Department and Engineer troops, and liaison with section of the general staff.

Col. F. B. Wilby, in charge of operations and engineering intelligence division. In immediate charge of engineering intelligence connected with field fortifications and allied combat engineering services.

Lieut. Col. J. G. B. Lampert, in immediate charge of engineer intelligence matters pertaining to communication agencies, and liaison with office of director of light railways and roads on matters pertaining to that service.

Lieut. Col. J. B. Cress, in immediate charge of all routine matters pertaining to engineer personnel and under the direction of Col. Youngberg in charge of matters connected with the camouflage and searchlight services. In immediate charge of engineering intelligence pertaining to organization, equipment, and technical training of Engineer troops.

Maj. F. W. Herman, in general administrative charge of local office, clerks, personnel, etc. Recorder of the board on military engineering, and in charge of confidential records of board and of military engineering library.

Lieut. Col. A. S. Peck, in charge of forestry, including statistics (attached to this office from Service of Utilities, but later released from reporting to the Engineer Department).

Lieut. Col. A. H. Brooks and Maj. Le Croix, in charge of matters connected with geologic research and water supply studies, and assistants to Col. Wilby on matters pertaining to excavation and earthworks.

Maj. R. W. Chaffee, in immediate charge of drafting and statistical sections and of liaison with G–4 on construction and matters other than supply pertaining to G–4.

Lieut. Col. J. H. Wickersham, assistant to Col. Walker on matters of supply. Later deputy engineer supply officer at general headquarters.

Second Lieut. E. P. Burrus, in charge of motor transportation attached to office of chief engineer, at general headquarters.

Second Lieut. C. A. Wackwitz, in command of civilians and enlisted personnel attached to the office. In charge of discipline and police offices; assistant to Maj. Herman in administration of the office and in connection with records of engineer intelligence section.

The office at headquarters, Service of Supply, had three divisions—Operations, Administration, and Supply—although the office of the engineer purchasing office at Paris constituted, practically, a fourth division. The operations division functioned directly under the assistant to the chief engineer, American Expeditionary Forces, Cols. C. W. Kutz, J. B. Cavanaugh, and W. A. Mitchell, successively. Its sections were:

Water supply and sewerage section, Col. F. F. Longley in charge.

Electrical and mechanical section, Capt. George W. Semmes in charge.

Personnel section, First Lieut. W. N. Thomas, Maj. J. B. Cress, and Col. S. C. Godfrey, successively, in charge.

Recording section, First Lieut. G. A. N. Thall in charge.

Under Maj. G. B. Holloway, head of the administration division, were the office service section, Capt. A. L. Philbrick, in charge, and accounts and contracts section, Capt. C. R. Stanley, in charge.

Capt. J. H. Graham, formerly depot officer of the office, chief engineer, line of communication, became and continued as supply officer until relieved by Capt. C. A. Rothwell, April 9, 1918. Capt. Rothwell was in charge during the remainder of the period to July 11, 1918. The division had three principal sections:

Procurement section, First Lieut. W. J. Shea in charge, handled requisitions on the United States and the preparation of bills of material for purchase by the engineer purchasing officer.

Depot section, Capt. R. C. Limerick in charge, handled storage and forwarding through the depot officers at the individual engineer depots.

Port-receipts section, Capt. B. L. Barns in charge, handled the receipt, checking, classification, and forwarding of material at the ports, and general reports and statistics.

The engineer purchasing officer, Col. C. McD. Townsend, who, on February 14, 1918, had relieved Col. Woodruff, then in charge of that office, and his organization continued at Paris. Subject to the chief engineer American Expeditionary Forces, and the coordination of his purchases with those of other staff departments by the general purchasing agent, the engineer purchasing officer and his

organization served as the purchasing agency of the supply division. All materials required through purchase by the procurement section of the latter were billed as requisitions upon the engineer purchasing officer, who then made the purchases.

Because of the necessity for its close coordination with the enormous purchases of cement an additional function of the engineer purchasing officer was the cement section, operating several mills for the manufacture of cement, with Maj. H. S. Spackman in charge.

The other sections of the engineer purchasing office were the administration, barracks, and contract section, the procurement section (including the purchasing offices in England, Spain, and Switzerland), and the disbursing section.

II. Chief of Utilities.

GENERAL CONSTRUCTION—LIGHT RAILWAYS.

Maj. Gen. W. C. Langfitt was appointed Chief of Utilities March 10, 1918. Arriving in France as colonel of the 13th Engineers August 17, 1917, he was relieved of his command on the 21st, and as brigadier general served as first chief of staff, headquarters line of communication, from August 29 to September 28, 1917. From the latter date until his appointment as chief of utilities Gen. Langfitt (major general after Feb. 8, 1918) served simultaneously as manager of light railways under the director general of transportation and commanding general of the American troops with the British expeditionary forces.

As originally authorized the service of utilities included the transportation department, the motor-transport service, forestry service, and lumber and tie production and all construction under the commanding general service of supply.

Two of the four original divisions of the service of utilities were, in the reorganization of July 11, 1918, again formed into separate staff departments. These were the transportation department and the motor-transport service, with which the Engineer Department was therefore no longer concerned, except that all work of construction for both these departments, including docks, warehouses, railroads, yards, shops, motor parks, motor repair shops, etc., was done by the Engineers. These two services are therefore not further discussed.

ENGINEER CONSTRUCTION, OFFICE ORGANIZATION.

To the department of construction and forestry the chief of utilities confided all construction and all lumber production in the service of supply. In personnel and the assignment of duties thereto the

new utilities department of construction and forestry consisted of the former office of the chief engineer line of communication.

Under Gen. Patrick, as director, the department of construction and forestry operated with five sections, as follows:

(1) Forestry section, Col. J. A. Woodruff, chief.

(2) Plant construction section, Maj. H. L. Van Zile, chief.

(3) Hospitalization section, Capt. R. M. Coomer, chief.

(4) Warehouse and barrack construction section, Capt. George Sykes, chief.

(5) Water supply section, Capt. T. H. Wiggin, chief.

Gen. Patrick, having been appointed chief of air service, was relieved as director of construction and forestry by Gen. Jadwin on May 16, 1918. Gen. Jadwin reorganized his department, which form it maintained to the end of this period, as follows:

Brig. Gen. Edgar Jadwin, director of construction and forestry.
Col. J. A. Woodruff, deputy director.
Lieut. Col. E. A. Gibbs, chief of general construction section.
Lieut. Col. J. H. Graham, chief of railroads and docks section.
Lieut. Col. W. B. Greeley, chief of forestry section.
Maj. H. W. Gregory, chief of administration section.

ENGINEER CONSTRUCTION, FIELD DIRECTION.

Under the director of construction and forestry, the section engineer officer of each territorial section of the Service of Supply was in direct charge of all construction therein. In all, there were nine territorial sections in France and one in England.

Forestry operations in the field were directed by forestry district commanders under the chief of the forestry section, in turn under the deputy director of construction and forestry.

LABOR.

During the period March 12 to July 11, 1918, the construction forces under direction of the director of construction and forestry increased from 31,000 to 75,000, including 39,000 Engineer and other troops, 13,000 forestry Engineer troops, 21,000 civilians, and 2,000 prisoners of war. Even with this force the labor was far below requirements.

DEPARTMENT OF LIGHT RAILWAYS AND ROADS.

Prior to the creation of the service of utilities the three American light railway regiments—the 11th, 12th, and 14th Engineers—had been operating with the British under command of Gen. Langfitt. Also, Gen. Langfitt was manager of light railways; that is, director of the light railway division of the transportation department. On

March 19, 1918, as chief of utilities, Gen. Langfitt created, with Brig. Gen. Edgar Jadwin as director, the utilities department of light railways and roads by combining the former light railways division and the former roads division of the transportation department. The department of light railways and roads was originally made responsible for the construction, equipment, maintenance, and operation of all narrow-gauge railways in advance of the normal gauge railheads and for the construction and maintenance of all roads in American-occupied territory, together with the quarrying of material therefor. However, the department was relieved of the greater part of that responsibility within the first two months of its existence. After April 1, 1918, all road and quarry duties in the base and intermediate sections, Service of Supply, were discharged by the department of construction and forestry; after April 12, 1918, all light railway, road, and quarry work in the Army zone was carried on under tactical command, but with departmental technical supervision; after May 7, 1918, all road and quarry work in the advance section, Service of Supply, was carried on by the department of construction and forestry, under technical supervision of the department of light railways and roads. In light railway and road operations in areas under various tactical commands the department maintained technical supervision through officers detailed to the staffs of the chief engineers of those commands. In the advance section, Service of Supply, the section engineer, department of construction and forestry, was made engineer, light railways and roads, for the section, and technical supervision passed through him.

The function of the department of light railways and roads after May 7, 1918, therefore became primarily that of technical supervision and of estimating and making provision for requirements in trained personnel and in construction and operation equipment.

During the period, March 19 to July 11, 1918, the office of the director of the utilities, department of light railways and roads, had the following organization:

Director: Brig. Gen. Edgar Jadwin until May 16, 1918, then Col. Herbert Deakyne.

Manager of light railways: Lieut. Col. A. T. Perkins.

Manager of roads: Lieut. Col. H. W. Hodge.

Chief Engineer: Maj. F. G. Jonah.

General superintendent of transportation: Maj. D. S. Brigham.

General superintendent of motive power: First Lieut. G. J. Richers.

General superintendent of construction: Maj. S. A. Robertson.

Supply officer: Lieut. C. R. Gamble until April 20, 1918, then Capt. W. M. McKee.

THIRD PERIOD—JULY 11, 1918, TO NOVEMBER 11, 1918.

Chief Engineer, American Expeditionary Forces.

MILITARY ENGINEERING, ENGINEER SUPPLY, GENERAL CONSTRUCTION, AND LIGHT RAILWAYS.

On July 11, 1918, the service of utilities was dissolved and its chief, Gen. Langfitt, was appointed chief engineer, American Expeditionary Forces. The utilities department of light railways and that of construction and forestry were transferred to the office of the chief engineer, American Expeditionary Forces. With Gen. Taylor as director, the office organization of the former chief engineer was designated the division of military engineering and engineer supplies of the new office of the chief engineer, American Expeditionary Forces. The general headquarters office organization became the military engineering branch of the division of military engineering and engineer supplies. Upon Gen. Taylor's departure for the United States, September 11, 1918, the general headquarters office was placed in charge of the assistant to the chief engineer, American Expeditionary Forces.

Gen. Langfitt's immediate office organization consisted of:

(*a*) The deputy chief engineer, Brig. Gen. T. H. Rees, until October 15, 1918, then Brig. Gen. Charles Keller.

(*b*) The adjutant, Capt. S. M. Felton, jr., until October 21, 1918, then Capt. E. A. Kane.

(*c*) The personnel and operations section, Col. S. C. Godfrey, until October 20, 1918, then Col. J. P. Jervey, with Maj. C. Van Deventer as assistant to both.

(*d*) The administration section, Capt. E. J. McGrail.

(*e*) The historical-technical section, First Lieut. G. A. N. Thall, until September 1, 1918, then Capt. R. K. Tomlin, jr.

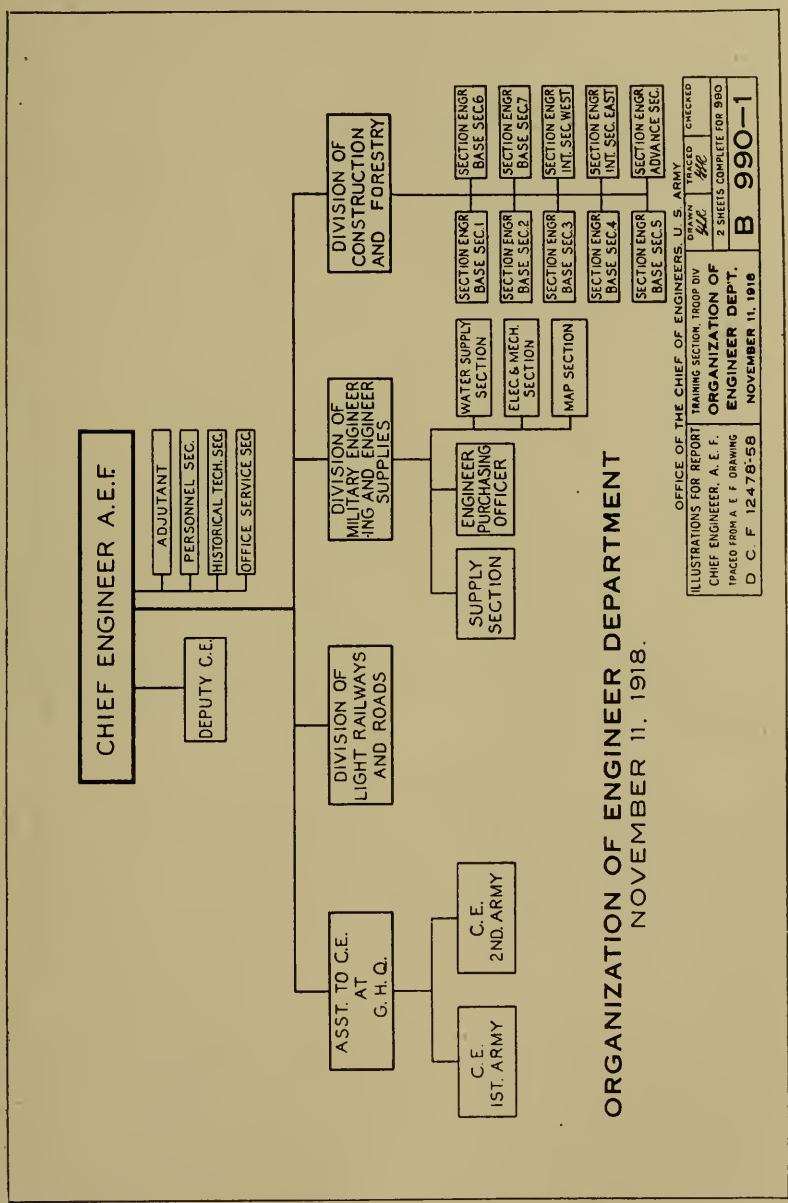
The personnel section and the historical section had been taken over from the office of the former chief engineer, American Expeditionary Forces, and reorganized as (*c*) and (*e*).

OFFICE OF THE ASSISTANT TO THE CHIEF ENGINEER, AMERICAN EXPEDITIONARY FORCES, GENERAL HEADQUARTERS.

The organization and duties of the office of the assistant to the chief engineer, American Expeditionary Forces, at general headquarters continued during the period, July 11, 1918, to November 11, 1918, practically without change, except in personnel.

Col. Walker was relieved from duty as assistant to the chief engineer at general headquarters July 11, 1918, to assume charge of the Motor Transport Corps. He was succeeded by Col. S. A. Cheney, Engineer, United States Army, who had arrived in France shortly before that time in command of the 110th Engineers. He served as

senior member of the board on military engineering and carried on the numerous troop inspections and technical conferences as the representative of the chief engineer. Due to continued ill-health, his



duties as officer in charge of the office were temporarily assumed by Lieut. Col. J. W. Stewart, who had reported for duty in October, 1918, as chief of the engineer intelligence division thereof.

ENGINEER SUPPLY.

The office of the director of the division of military engineering and engineer supplies was constituted as follows:

Director, Brig. Gen. Harry Taylor, until September 11, 1918, then Col. F. C. Boggs until October 15, 1918, then Brig. Gen. J. F. McIndoe.

Supply section, continued until September 16, 1918, with the organization of the former supply division, Capt. C. A. Rothwell, in charge. After this date, Col. F. A. Molitor, in charge, effected a reorganization described in detail elsewhere.

Water-supply section, continued as previously organized, Col. F. F. Longley in charge.

Electrical-mechanical section, continued as previously organized, Maj. George W. Semmes in charge.

Office service section, continued as previously organized, Capt. A. L. Philbrick in charge until August 18, then Capt. W. N. Thomas until September 5, then Capt. E. B. Wade.

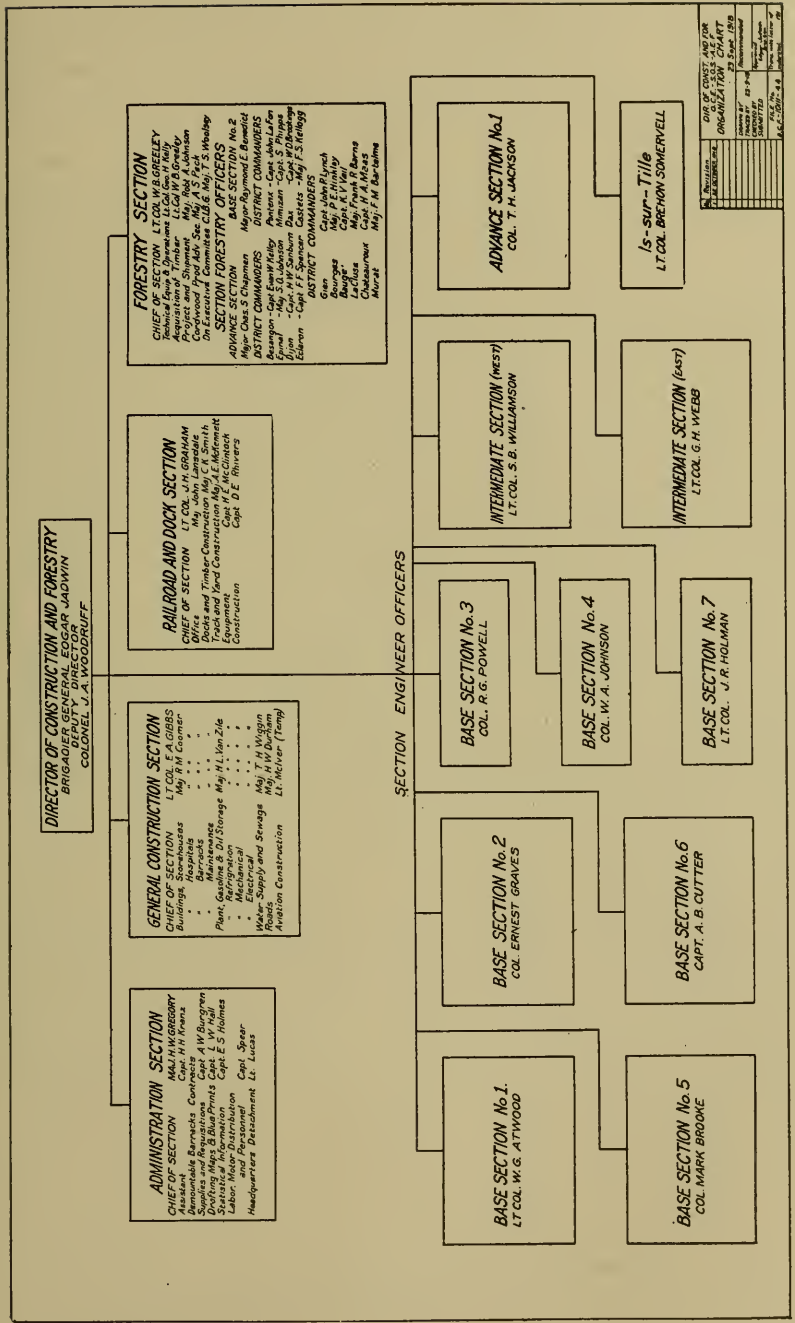
Accounts and contracts section, continued as previously organized, Capt. C. B. Stanley in charge until October 4, then Capt. E. B. Wade.

The engineer purchasing office, during the last four-month period, under the chief engineer, American Expeditionary Forces, continued to function as the purchasing agency for the supply section of the division of military engineering and engineer supplies. Its constitution, too, remained as in the previous period, except that Col. Townsend was relieved as engineer purchasing officer by Col. F. C. Boggs on October 15, 1918.

GENERAL CONSTRUCTION.

The general form of Gen. Jadwin's office organization for the former utilities department of construction and forestry was retained under him as director of the division of construction and forestry of the office of the chief engineer, American Expeditionary Forces (Engineer Department, S. O. S.). Col. Woodruff continued as deputy director.

The general construction section, Lieut. Col. E. A. Gibbs, chief, had four subsections: (1) Maj. R. M. Coomer in charge of storehouse, hospital, and barrack buildings; (2) Maj. H. L. Van Zile in charge of gasoline and oil storage and refrigeration plants and plant electrical and mechanical installations; (3) Maj. T. H. Wiggin in charge of water supply and sewerage; and (4) Maj. H. W. Durham in charge of roads. The railroad and dock section continued under Lieut. Col. J. H. Graham with Maj. John Lansdale as assistant. Maj. H. W. Gregory, with an assistant, continued as chief of the administration section. That section had four subsections: Supplies and requistions


DIRECTOR OF CONSTRUCTION AND FORESTRY
BRIGADIER GENERAL EDGAR JADWIN
DEPUTY DIRECTOR
COLONEL J. A. WOODRUFF
ADMINISTRATION SECTION
CHIEF OF SECTION MAJ. H. W. GREGORY
Assistant Chief H. W. Evans
Demountable Barracks Contracts
Supplies and Requisitions Capt. A. W. Burgess
Construction Work & Requirements Capt. J. V. Wilkins
Statistical Information Capt. E. S. Holmes
Labor, Motor-Distribution and Personnel
Headquarters Detachment Lt. Lucas
GENERAL CONSTRUCTION SECTION
CHIEF OF SECTION LT. COL. E. A. GIBBS
Buildings, Storehouses Maj. R. M. Cosmer
" Hospitals
" Barracks
" Warehouses
Plant, Gasoline & Oil Storage Maj. H. L. Van Zile
" Refrigeration
" Mechanical
" Electrical
Water-Supply and Sewage Maj. T. W. Wiggin
Roads Maj. J. W. Duncan
Aviation Construction Lt. McIver (Temp)
RAILROAD AND DOCK SECTION
CHIEF OF SECTION LT. COL. J. J. GRAHAM
Maj. John Lamsdale
Docks and Timber-Construction Maj. C. R. Smith
Track and Yard Construction Maj. A. E. Mattmott
Locomotives Chief Mechanic Hewitt
Construction Capt. D. E. Rivers
FORESTRY SECTION
CHIEF OF SECTION LT. COL. W. B. GREELEY
Technical Equip & Operations Lt. Col. Geo. H. Kelly
Acquisition of Timber Lt. Col. W. B. Greeley
Project and Shipment Maj. Wm. Greenwood
Contracts and Personnel Sec. Maj. Alex. Park
On Executive Committee Col. B. G. Maj. T. S. Wooldrop
SECTION FORESTRY OFFICERS
ADVANCE SECTION BASE SECTION No. 2
Major Chas. S. Chapman Major Raymond E. Benedict
DISTRICT COMMANDERS DISTRICT COMMANDERS
Besançon - Capt. Frank Kelley Pontarlier - Capt. S. Phillips
Dôle - Capt. Edward Lowe Nantua - Capt. A. L. Lewis
Dijon - Capt. H. W. Sanborn Pax Montreux - Capt. R. D. Brodrigg
Eclaron - Capt. F. F. Spencer Castelets - Maj. F. S. Kellogg
DISTRICT COMMANDERS
Gondrecourt - Capt. Hughes
Bourges Maj. P. E. Hinkley
Bauge Capt. K. V. Van
LaClaye Maj. H. A. Barns
Coetquidan Capt. H. A. Mc. Lean
Muret Maj. F. M. Bartelme
SECTION ENGINEER OFFICERS
BASE SECTION No. 1
LT. COL. W. G. ATWOOD
BASE SECTION No. 2
COL. ERNEST GRAVES
BASE SECTION No. 3
COL. R. G. POWELL
BASE SECTION No. 4
COL. W. A. JOHNSON
BASE SECTION No. 5
COL. MARK BROOKE
BASE SECTION No. 6
CAPT. A. B. CUTTER
BASE SECTION No. 7
LT. COL. J. R. HOLMAN
INTERMEDIATE SECTION (WEST)
LT. COL. S. B. WILLIAMSON
INTERMEDIATE SECTION (EAST)
LT. COL. G. H. WEBB
ADVANCE SECTION No. 1
COL. T. H. JACKSON
Is-sur-Tille
LT. COL. BRENON SOMERVELL
DIR. OF CONST. AND FOR.
ORGANIZATION CHART

(on D. M. E. and E. S.); drafting and reproduction; statistical information; and labor, motor, and personnel distribution. The forestry section continued its organization as follows:

Chief of section, acquisition of timber, Lieut. Col. W. B. Greeley.
Technical equipment and operations, Lieut. Col. George H. Kelley.
Production and shipment, Lieut. Col. R. A. Johnson.
Cordwood production, advance section, Maj. A. S. Peck.
Member interallied forestry committee, Maj. T. S. Woolsey.

ENGINEER CONSTRUCTION, FIELD DIRECTION.

The system of field direction of construction which obtained under the chief of utilities, namely, that of having section engineers in charge of all construction within their sections, was continued under the chief engineer, American Expeditionary Forces.

The number of forestry operations districts were steadily increased during the period. There were, in all, 14 district commanders directing forestry work in the field, one of whom was charged with cordwood production in the advance section.

LABOR.

Total labor forces under the direction of the director of construction and forestry during the period increased until on the date of the armistice they reached a figure of 145,000. Forestry troops had jumped to 18,500; Engineer and other troop strength had increased to 77,500; civilian labor reached 34,000; and prisoner-of-war labor touched the 15,000 mark. Still the available labor was far short of requirements.

LIGHT RAILWAYS.

The organization for performance of the duties of the division of light railways and roads remained unchanged in form during the period July 11 to November 11, 1918, except to provide for a deputy director. There occurred, however, the following changes in personnel:

Director, Col. Herbert Deakyne was relieved by Brig. Gen. C. H. McKinstry, July 27, 1918.

Deputy director, Col. E. M. Markham from August 10, 1918.

Manager of roads, Lieut. Col. H. W. Hodge was relieved by Maj. Bert Baldwin September 17, 1918, and he in turn relieved by Lieut. Col. E. P. Conway October 14, 1918.

General superintendent of transportation, Maj. D. S. Brigham was relieved by First Lieut. C. W. Loomis September 28, 1918.

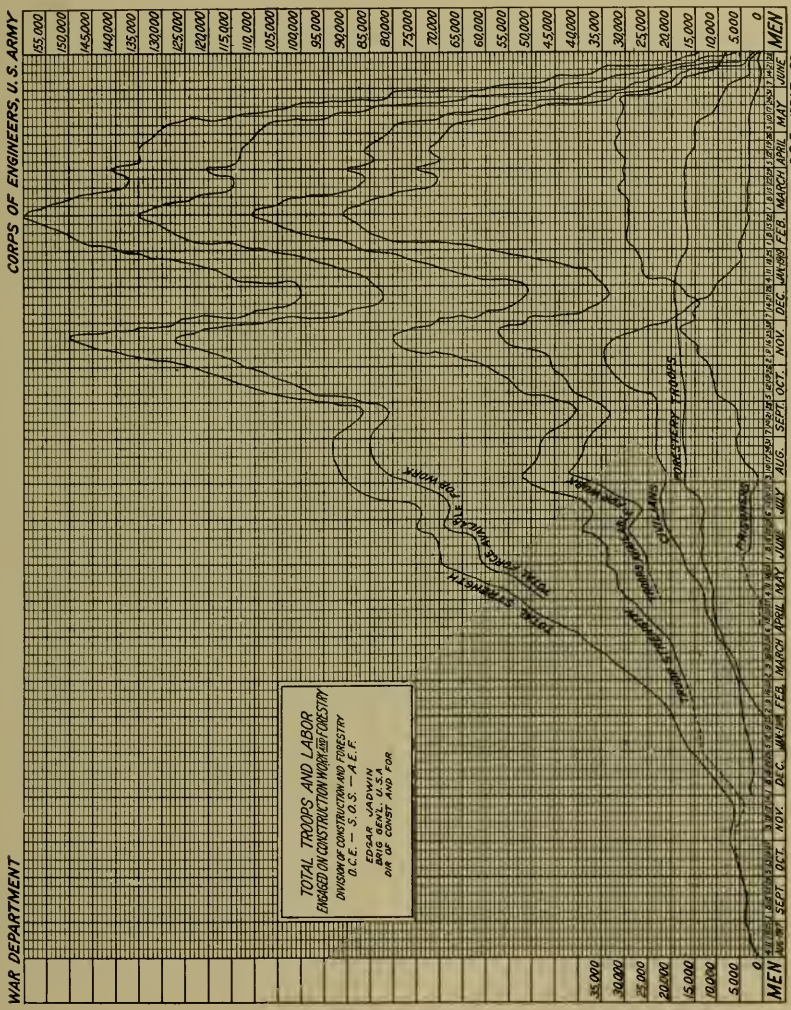
Supply officer, Capt. W. M. McKee was relieved by Capt. W. O. Hickok August 25, 1918.

ORGANIZATION CHANGES SUBSEQUENT TO NOVEMBER 11, 1918.

After the signing of the armistice the following officers served as deputy chief engineer, American Expeditionary Forces:

Brig. Gen. Charles Keller, continued until November 16, 1918.

Brig. Gen. J. J. Morrow, November 16 to December 20, 1918.



Brig. Gen. S. A. Cheney, December 26, 1918, to January 2, 1919.

Col. G. B. Pillsbury, January 10 to February 5, 1919.

Brig. Gen. Charles Keller, from February 5, 1919.

Brig. Gen. Charles Keller relieved Brig. Gen. S. A. Cheney as assistant to the chief engineer, American Expeditionary Forces, at general headquarters, November 16, 1918, taking over his duties

from Col. J. W. Stewart, temporarily in charge. Gen. Keller was relieved to become deputy chief engineer, American Expeditionary Forces, by Col. George R. Spalding on February 5, 1919.

Due to the cancellation of Service of Supply construction, and the change in Army activities to mere occupation and training, the demand for engineer supplies, after November 11, 1918, was so reduced that only a small part of the supply section personnel, division of military engineering and engineer supplies, was needed. Accordingly, the greater part of the section became an organization for inventory purposes. The division of military engineering and

RANNES BARRACKS, TOURS.

Engineer headquarters, containing offices of chief engineer, A. E. F., director of construction and forestry, and director of military engineering and engineer supplies.

engineer supplies was abolished January 27, 1919, and its duties divided and reassigned.

All engineer supplies, depots, and personnel of the supply section were transferred to the engineer purchasing officer, with the effect of making him engineer supply officer under the chief engineer, American Expeditionary Forces. All personnel of the military engineering sections (water supply and electrical and mechanical) was transferred to the immediate office of the chief engineer, American Expeditionary Forces, and placed under the direction of the deputy chief engineer, American Expeditionary Forces.

With the cessation of operations the process of engineer supply was reversed—the function of procurement was largely replaced by that of disposition. Engineer materials had to be disposed of by sale as soon as possible in order to avoid loss due to deterioration. The engineer purchasing officer was appointed engineer sales officer in accordance with General Orders, No. 66, Headquarters, S. O. S., December 17, 1918, which created the general sales board under a general sales agent. As engineer member of the general sales board the engineer sales officer effected sales of engineer material in cooperation with the other members and under the supervision and direction of the general sales agent in a manner identical to that employed in effecting his purchases under the general purchasing agent.

General Orders, No. 54, Headquarters, Service of Supply, published November 14, 1918, reduced the construction and forestry operations of the Engineer Department to a minimum. Consequently a material reduction was made in the personnel of the division of construction and forestry. The form of organization was retained, however, and a roads section, with Col. J. H. Graham as chief, was added upon the assignment to the division January 2, 1919, of the duty of repairing and maintaining all American-used roads in France and Luxembourg.

Upon the signing of the armistice the duties, lines, equipment, and personnel pertaining to the service technically supervised by the director of light railways and roads were withdrawn from tactical command and passed to the director of light railways and roads. The latter's headquarters was moved from general headquarters to Neufchateau, November 12, 1918. The director, Gen. McKinstry, was detailed to duty with the Peace Commission, November 20, 1918, and on January 25, 1919, he was relieved from further duty with the division. In the interim Col. E. M. Markham, until December 27, 1918, then Col. A. T. Perkins, served as acting director. The latter was appointed director January 25, 1919.

On December 21 the roads section of the division of light railways and road was abolished and the road functions and troops assigned thereto were reassigned to the chief engineer, advance section. The designation of the division was then changed to that of light railways.

As a unit of the office of the chief engineer, American Expeditionary Forces, the division of light railways ceased to function after February 20, 1919. Its director and a large part of its personnel was then relieved and the remainder transferred partly to the chief engineer, advance section, for the operation of certain quarry lines and partly to the engineer purchasing officer for salvage purposes.

Part II.

MILITARY ENGINEERING.

STAFF OPERATIONS.

SPECIAL ENGINEER SERVICES.

Water Supply Service.

Water supply activities in the American Expeditionary Forces were divided into three groups: (1) Water supply work for the Armies; (2) water supply work for the Service of Supply; (3) supply of materials for water supply, both for Armies and Service of Supply. It was obvious that in the beginning that the water supply work of the Service of Supply would constitute by far the larger volume of work. Active work in the field for the water supply service of the Armies would commence only when the Armies came into being. For a number of months, therefore, the water supply activities consisted of developments for hospitals, small towns, camps, depots, railways, port developments, etc., and on these projects the entire water supply force was engaged, including the first companies of the 26th Engineers, Army Water Supply Regiment.

As the volume of work in the Service of Supply increased, as the organization for Service of Supply work became more definite, and as studies and investigations relating to prospective Army work developed, a division of functions was made along the lines above indicated. Water supply for the Armies and certain functions relating to supply of materials and equipment were handled in the office of the chief engineer, American Expeditionary Forces, while water supply in the Service of Supply was assigned to the office of the chief engineer, line of communication (later director of construction and forestry).

A water supply section was therefore formed in the office of the chief engineer, American Expeditionary Forces. Col. F. F. Longley, as its head, was charged with the responsibility of investigating the water supply practice of the allied armies, of inquiring into water supply needs for the American Army, of outlining a suitable organization and procedure to be followed, of indicating needs in the way

of personnel and material, and in fact, of covering all lines of necessary activity related to water supply of Armies.

Inquiries regarding water-supply programs of the allied armies were started at an early date, in connection with which the water-supply needs of our Army were considered with care. The question of organization and of relations and duties of the Army water-supply officers was inquired into at length with numerous officers whose opinions were considered of value in fixing a policy. The result of this work was the issue of Bulletin No. 55 and of General Orders, No. 131, General Headquarters, 1918, which have since formed the basis of procedure in Army water-supply work.

Following changes in the organization of the Engineer Department fixed by general headquarters in July 1918, the water-supply section of the chief engineer's office became a part of the office of the director of military engineering and engineer supplies. In view of the division of functions referred to above, whereby the Service of Supply water-supply work was handled by the director of construction and forestry, this arrangement was consistent in that the other two groups of functions, namely, the Army water-supply work and the matters relating to water-supply materials both fell within the functions of the division of military engineering and engineer supplies. That office, however, was located at headquarters, Service of Supply, too far from the front for the efficient handling of the military engineering in the Armies, and as a consequence a branch of the chief engineer's office which had been established at general headquarters was strengthened, and as time went on the functions of military engineering came to be handled from that office, and less and less from the office of the division of military engineering and engineer supplies at headquarters, Service of Supply.

The Army water-supply supervision was undoubtedly a military engineering function and should logically have been attached to the office of the assistant to the chief engineer at general headquarters. The earlier development of activities in the office at headquarters, Service of Supply, however, involved the various officers of the section in both lines of work, Army water-supply supervision and the supply of materials, and in the absence of any pressing demands to change this procedure the Water-Supply Section remained continuously with the division of military engineering and engineer supplies at headquarters, Service of Supply.

CONTROL OF QUALITY OF WATER.

One of the most important questions in the determination of a policy regarding water-supply work involved a division of duties between the Engineer Department and the Medical Department

with respect to control of the quality of water supplies. Representatives of the two departments discussed this matter, and after concurrent approval by the chief engineer and the chief surgeon, General Orders, No. 34, General Headquarters, 1918, was issued, and was later modified by General Orders, No. 131, General Headquarters, 1918. These general orders charged the water supply organization with the responsibility of making available at water points adequate quantities of water in as pure a state as practicable, using filtration, disinfection, or both. Officers of the Medical Corps attached to tactical units were charged with the duty of such subsequent disinfection in Lyster bags, water wagons, tanks, or reservoirs, as the water might require. This division of responsibilities was a logical one, since the activities of the water-supply organization in the construction of works and the handling of water terminated at the water points, whereas the responsibility for the transportation of water from water points to the final point of use in cans, pails, water wagons, etc., rested with the tactical units themselves.

To control the quality of water a laboratory division was established with headquarters at Paris. When headquarters, Service of Supply, were moved to Tours a branch laboratory was established there, and other water-supply laboratories were subsequently placed in operation, either as parts of Medical Department laboratories or as independent laboratories under the water-supply section, at the following points: St. Nazaire, Bordeaux, La Rochelle, Dijon, Neufchateau, Brest, Nevers, Le Mans, and London. Several mobile laboratories were established in the Army zone. The personnel for the laboratory branch of the water-supply section was obtained partly from the Engineer Department and partly from the Sanitary Corps of the Medical Department, as officers and soldiers having the required special training and experience were found in both departments.

SUPPLY OF MATERIALS.

At the very outset, in preparation for the water-supply work in the American Expeditionary Forces, it was recognized that the service would stand or fall on the question of supply of materials. The first projects undertaken in the American Expeditionary Forces, such as the development of base ports, the construction of camps and of hospitals, required the development of water-supply systems. Many of these were most urgent in order to take care of the needs of moving troops, and of the development of activities which were rapidly expanding.

A requisition for water-supply material of all sorts was developed at the War Department during the summer of 1917 which resulted

later in the delivery in France of large quantities of useful equipment and supplies.

This requisition was based upon a far-sighted statement, given by the chief of the French Service des Eaux, of the requirements of water-supply materials for the armies. The French statement was expanded in Washington, conforming to the American market and to the ideas of the water-supply officers who had taken up this work. In general, the list was sound, and the materials later delivered from that list formed the most substantial part of our water-supply material for many months.

This material, of course, was not delivered in France until long after various other activities were well under way, but the engineer purchasing officer in Paris was then purchasing large quantities of water-supply materials in such European markets as were available. Both French and British markets yielded considerable quantities of water-supply materials which proved of great value and enabled much work to be done. These supplies, however, were not such as would have been selected in a normal market. There have, however, been certain important items of material procured in French and British markets which have been entirely satisfactory in every respect. Conditions of delivery from European markets might have been expected to be much better than from the United States, but these markets for water-supply material have been exceedingly uncertain and in numerous special cases have been disappointing. The most important deliveries of useful material from them were in the items of pumps, cast-iron pipe, valves, and fitttings, with lead and jute for joints.

In the fall and early winter of 1917, or as soon as personnel became available, a systematic and comprehensive study of the prospective needs of materials of every kind for the water-supply service was undertaken. In this study, as throughout the history of the water-supply work in the American Expeditionary Forces, the Water Supply Section of the office of the chief engineer American Expeditionary Forces (later water-supply section, division of military engineering and engineer supplies), and the water-supply section of the office of the chief engineer, line of communications (later water-supply section, division of construction and forestry of the S. O. S.), continuously and closely cooperated. This cooperation was essential to the well-being of the water-supply services of both the Army and the Service of Supply.

The work of the water-supply section with reference to the supply of materials during the latter months of the war covered in general the following principal lines:

(*a*) Study of the various demands for water-supply stores and preparation of forecasts of needs as a basis for procurement. This

included long-time forecasts as an indication of future tonnage requirements as a basis for the American production program and as a guide to the placing of orders for both exceptional and automatic supply in Europe.

(*b*) Preparation of monthly priority tonnage schedules of water-supply materials to be shipped from the United States during the next following month; also the preparation of monthly forecasts of the materials which would probably be required from the United States during the third following month for the guidance of the general engineer depot in assembling materials at the ports.

(*c*) Initiating special American and European purchases as needed and initiating the manufacture in the depot shops of certain apparatus which could not be had with sufficient promptness from commercial sources.

(*d*) Maintaining liaison with the Army water-supply officers with the water-supply section of the division of construction and forestry, and as far as possible with other large users of water-supply stores, in order to keep in touch with their prospective needs and to advise them of materials which might become available.

(*e*) The standardization of equipment and the preparation of standard stock lists and standard specification of water-supply stores with a view to minimizing the number of sizes and kinds of material to be carried in depot stock, while at the same time providing everything strictly necessary.

(*f*) Reviewing the monthly requests for credits of water-supply stores submitted by the armies, and recommending action to be taken thereon.

(*g*) The collection and distribution of information as to materials and methods used by the water-supply services of other armies, the preparation of bulletins of information or instruction for officers handling water-supply stores, and the collection and distribution of trade catalogues.

(*h*) Following up deliveries on United States priorities and on the more important European purchase orders.

(*i*) Locating European sources of supply for water-supply material to expedite action on recommended purchases.

FIELD OPERATIONS.

The water-supply service for Army work consisted of certain officers and special Engineer troops (26th Engineers) experienced in water-supply work. These troops operated as Army Engineer troops, for it was of fundamental importance to assure the permanence of this highly special personnel. The functions of the Army water-supply organization included the investigation of water resources, the development of water supplies, and the construction and opera-

(378–T8) PORTABLE PUMPING PLANT NEAR ROADSIDE AT BETHINCOURT, OPERATED BY 26TH ENGINEERS. SEPTEMBER 29, 1918.

(720–T8) CANVAS RESERVOIR FOR DRINKING WATER AT BETHUNE (MEUSE). OCTOBER 5, 1918.

tion in Army zones of such works as were necessary to make water available at water points for troops and animals, including conveniences for filling water carts, water-tank trains, buckets, canteens, and other containers. Upon tactical units devolved the responsibility for transporting water from water points to the final point of consumption.

The 26th Engineers was the first water-supply regiment to be organized for service with the United States Army. It provided personnel and equipment for supplying water in large quantities, primarily for the use of troops and animals in the field, but also for other needs incident to military operations. The nature of the service was such that the regiment never operated as a unit. To a large extent the work of supervision of Army water supply was done by the officer in charge of the water-supply section (who was also colonel of the 26th Engineers), under the division of military engineering and engineer supplies, office of the chief engineer American Expeditionary Forces.

The establishment of water points for Army use involved the provision of piping, pumps, tanks, reservoirs, and other facilities. One of the most important items in the program was the supply of water for animals, involving the construction of horse-watering points and troughs. To control the quality of drinking water, laboratories of two types, fixed and mobile, were employed, the latter being mounted on motor trucks. In addition, water-tank trains and motor trucks equipped with purification apparatus in the form of filters and chlorinators were operated. Light railways were employed whenever available for the transport of water in tank cars.

The field service of the water supply organization began about February 1, 1918, with reconnaisances, including the front of the French Eighth Army, from the Moselle River westward to the Cotes de Meuse and of the French Second Army from Cotes de Meuse, around the St. Mihiel salient, to Troyon, on the Meuse. During this period American divisions were operating tactically under French corps and the the French Army water services were carrying the water supply responsibility.

The first responsibility of the American water-supply service was that of the First United States Corps, which utilized first half and then all of Company B, 26th Engineers, on the Toul front from the middle of May to the middle of June, 1918.

From the middle of July, 1918, to the middle of August, 1918, the Second Army took over the functions of the First Army in the Toul area, continuing to about the middle of August. About August 1 water supply troops, consisting of about 80 men of Company B, 26th Engineers, and all of Company A, 27th Engineers, took over partial

water supply responsibility in the divisional area in the neighborhood of Baccarat.

Likewise, about August 1 the First Army water supply service began to function in areas in the Chateau-Thierry region occupied by American corps, operating tactically, however, under the French Sixth Army.

About the middle of August the First and Second Armies' headquarters organizations changed places, and the First Army began its St. Mihiel operation as covered in detail in the water supply service report of that Army. The Second Army headquarters organization, on the other hand, operating as the "Paris group," became of decreasing importance in the Chateau-Thierry region until about September 10, 1918, the last of Company D, 26th Engineers, was entrained and brought into the Argonne-Meuse area.

At about this time the Second Army took over independent responsibility for a portion of the American front in the Toul sector, and the available personnel, equipment, and material for Army water supply work was apportioned between the two Armies in general accordance with the magnitude of the contemplated military operations.

When the Third Army was created, two companies of Army Water Supply troops, with certain companies of other special service, Army Engineer troops, were assigned to form a provisional regiment, and the water supply work of the Third Army was handled by that organization for a time, until it became evident that its services were no longer necessary.

St. Mihiel operations.—In preparation for the St. Mihiel offensive, water supply installations by the First Army had been made, including 7 pumping plants, 12 reservoirs or tanks, and 25,000 feet of piping. In addition, new installations for filling carts and watering animals were made and existing installations improved and enlarged. The facilities provided were sufficient for the troops during concentration.

Following the attack on September 12, water supply troops moved forward to make immediately available captured water installations and to set up canvas reservoirs to receive water hauled forward by motor tank trains. At three points, captured German plants were converted to American use, and temporary plants installed, including 12 canvas reservoirs, 7 hand pumps at springs or wells, 3 animal-watering points with troughs, 2 sterilab installations with storage tanks, and 5 mobile purification truck sites. Between the 13th and 19th of September, 250,000 gallons of water were delivered to advance water points by tank trucks. Water was also sent forward by light railway in 2,000-gallon tank cars.

Argonne-Meuse operations.—In preparation for the Argonne-Meuse operations there were installed by the First Army at 8 sites water points equipped with pumping plants, storage and purification systems as required by local conditions. The installations were sufficient during the period of concentration. After the attack water-supply troops followed the advance. In the area beyond the former "No man's land" there were installed temporarily 26 hand pumps at springs or wells, 23 canvas tanks, of which 12 were filled from local sources and 11 by water-tank trains; 10 horse-watering points with troughs additional to those found undamaged, 2 watering points prepared at streams and 10 mobile purification truck installations.

Semipermanent or permanent installations in this same area, consisting of power pumps with elevated tanks, piping, facilities for filling water carts, etc., were made at 23 sites. Gravity installations with storage and facilities for filling carts and canteens and watering animals were made at 7 places.

Following the advance made between November 1 and November 11, semipermanent and permanent installations included 22 hand pumps at springs or wells, 8 canvas tanks filled by water-tank trains, and 9 horse-watering points. Permanent installations consisting of power pumps with pipe lines to elevated tanks were made at 8 places. In addition a number of installations were made by the water-supply service for narrow and standard gauge locomotives.

Second Army attack.—Preparatory to the attack of the Second Army November 10 and 11 the water supply-work consisted of the improvement and repair of existing facilities in St. Mihiel and seven other towns. German systems were restored and operated at six places. Two purification plants, each of 50 gallons per minute capacity, consisting of sedimentations basins, rapid sand filters, chlorinating devices, and clear-water basins were installed. Railway and cart-filling stations and shower baths were put in operation.

No actual construction of new water points in the advance area was necessary before 11 a. m. November 11, when operations terminated.

Water-supply activities in the service of supply, conducted by the division of construction and forestry in connection with its various authorized construction projects, resulted in the provision of adequate water supplies at camps, hospitals, depots, and, in fact, wherever a new or an increased supply of water was indicated as necessary, the work being done as an integral feature of the various projects. The Service of Supply water-supply work is described under the operations of the division of construction and forestry.

REFERENCE DATA, WATER SUPPLY (ARMY).

	Appendix number or file reference.
Report, chief of water-supply section, division of military engineering and engineer supplies	8
Monthly report and history 26th Engineers	R–26
Report, chief engineer, First Army	A–1
Report, chief engineer, Second Army	A–2
Report, material collected for research	9
Report, water service, Second Army (French)	11
Report, water analysis laboratories	13
Report, notes on Army water supply	12

Electrical-Mechanical Service.

An electrical-mechanical section was established in the office of the chief engineer, American Expeditionary Forces, in August, 1917, and charged with responsibility in all matters of an electrical-mechanical nature. The need for such a section had been indicated by information from the British and French.

The electrical-mechanical section of the American Expeditionary Forces engaged in the establishment of an electrical-mechanical service and in the development of an organization therefor. The American Expeditionary Forces was divided into districts, with an officer in responsible charge of all electrical and mechanical matters within each district. These districts were coordinated by the electrical-mechanical section, office chief engineer, American Expeditionary Forces.

In general, the zone corresponding to the line of communications (Service of Supply), and the zone of each Army comprised the respective districts. These were further divided into subdistricts as developments required. They were determined by territorial rather than military jurisdictional boundaries in order to avoid shifting control of plant or overlapping of effort.

As the electrical-mechanical work developed there came about a clear division between the electrical-mechanical section, office chief engineer, and the plant construction division of the division of construction and forestry. The activities of the former were limited to operations within the Army zones, while electric-power developments within Service of Supply areas were carried out under the division of construction and forestry, as described elsewhere in the report (see p. 356).

The functions of the electrical-mechanical service comprised the installation, operation, maintenance, inspection, transfer, and salvage of all stationary electrical and mechanical plant other than that controlled by staff departments and other services not included within the Engineer Department. All plant of an unusual nature which would not otherwise have been specifically cared for was thus definitely placed, as well as the usual plant for lighting, power, etc. The func-

tions also included the performing of all service of an electrical-mechanical nature and the installation, operation, maintenance, etc., of pumping plant for the water-supply service in the advanced areas, the electrical-mechanical and water-supply services cooperating where they thus came in contact.

With the growth of the American Expeditionary Forces and of the electrical-mechanical requirements of the troops, authority to form an electrical-mechanical regiment for service as Army troops, with personnel of specialized training and the necessary special tools and equipment, was requested. Accordingly the 37th Engineers, authorized in December, 1917, was organized and sent to France May–June, 1918. This regiment was at first divided, part being in the Service of Supply and part in the advance areas, until the First Army was formed, when it was entirely utilized in the First Army area. Later, when the Second Army was formed, the 24th Engineers, originally a shop regiment, was assigned as its electrical-mechanical regiment. When the Third Army was formed the 37th Engineers was divided again, part going to the Third Army. Additional electrical-mechanical troops, totaling approximately two regiments, were later included in the troop program to take care of rapidly increasing work in the Service of Supply and in the advance areas. The armistice rendered it unnecessary to send these additional troops to France.

The electrical-mechanical organization was extended to the district comprising the line of communication (Service of Supply) in January, 1918, when arrangements were made with the chief engineer thereof to establish an electrical-mechanical section in his office, to which officers of suitable qualifications were assigned. Later, under the division of construction and forestry, this section was included in the plant-construction section. In February, 1918, the subdistrict comprising the advance section was also supplied with an electrical-mechanical section. As these extensions were made, the electrical-mechanical section, office of chief engineer, imparted all necessary information and assistance, and certain work in these fields which had previously been done by it was turned over to the corresponding organization.

While the organization was in progress, and before any special electrical-mechanical troops were available, the American Expeditionary Forces needed certain electrical and mechanical work in the advance areas. Headquarters and schools were being established, camps and hospitals were being constructed, and all had to be provided with light and power. This early work was done by the electrical-mechanical section, office of chief engineer, under adverse circumstances, operating personnel being borrowed from shifting units and supplies obtained wherever procurable. The early work

consisted of some 30 separate plants, ranging in size from 1 to 200 kilowatts, with an approximate aggregate capacity of 600 kilowatts, together with the necessary wiring of buildings.

The advantages of utilizing all available French sources of power for the needs of the American Expeditionary Forces were early seen and a complete investigation was made of all French power plants and transmission lines within the French zone of the Army, along the front from Chateau-Thierry to the Swiss border. This information was later distributed in the form of complete maps.

An investigation was made of European markets with a view to securing all possible electrical-mechanical supplies therefrom so as to relieve congestion in tonnage and to overcome difficulties due to delays in the receipt of supplies from the United States. As a result a great part of the early supplies were obtained in Europe. A systematic record of electrical-mechanical supplies was established and maintained until the armistice.

In February, 1918, when the technical staff services were placed under the chief engineer Service of Supply and moved from general headquarters to headquarters Service of Supply, the reorganization brought about certain changes in the duties of the electrical-mechanical section, office of the chief engineer American Expeditionary Forces. Its duties then developed more fully into the actual provision of electrical-mechanical materials. Theretofore actual provision for supply had not been a duty of the electrical-mechanical section, and its supply activities had been confined to cooperation with the engineer supply department in an advisory capacity. The question of supply was then studied. Specific standards of method and materials were developed through comparison of the needs and experiences of the respective districts. Former initial supplies were not renewed, but a standard stock list of electrical supplies was developed and placed on the United States for the automatic procurement of the supplies needed to meet conditions in the American Expeditionary Forces. In addition, large exceptional requisitions were initiated for purchase both in the United States and in Europe.

Among its other activities the electrical-mechanical section prepared and issued to all concerned an electrical-mechanical manual, in which was included technical information needed in the field, and a complete catalogue of standardized supplies.

Standard lighting outfits, including generator set and all material necessary for lighting corps and division headquarters and for dugouts and evacuation hospitals were developed and issued from the depots as complete units.

Under the reorganization of the Engineer Department in July, 1918, when the division of military engineering and engineer supplies was created as a subdivision of the office of the chief engineer, the electri-

cal-mechanical section was attached thereto. It, however, retained its former duties and its relations with the chief engineer American Expeditionary Forces, as well as with the division of military engineering and engineer supplies, and kept in touch with the electrical-mechanical activities in the field. In addition, it also maintained liaison and cooperation with the French, British, and Belgium electrical-mechanical services through frequent conferences. Liaison was also maintained with the technical board, thus facilitating cooperation on the question of power in the S. O. S. Many requisitions to cover power plants were initiated, always, however, in concurrence with the technical board and the division of construction and forestry, who were principally concerned. Numerous complete power plants were requisitioned in Europe, this being done whenever possible to save tonnage. However, in order to meet the rapidly increasing demand for power which the markets of Europe could not supply, designs and specifications of certain suitable standard steam electric power plants complete were made, and requisitions placed on the United States for a total of 56 of them, in sizes of 125, 350, and 500 k. v. a.

The signing of the armistice brought to a close most of the electrical-mechanical activities, and shortly afterwards provisions for practically all elctrical-mechanical supplies were canceled. Only a small quantity of supplies from European requisitions were excepted.

At the time of the armistice the activities of the electrical-mechanical section American Expeditionary Forces were covered as follows:

Office of chief engineer American Expeditionary Forces, division of military engineering and engineer supplies, electrical-mechanical section as central headquarters office with four officers, engaged in supply of electrical-mechanical service throughout American Expeditionary Forces.

Armies: Electrical-mechanical troops, with special equipment, shops, etc., engaged in actual execution of pumping, lighting and power plants, etc., within the Army areas.

In the First Army, the 37th Engineers (electrical-mechanical), operating as a complete regiment took care of all electrical-mechanical work. In the Second Army, the 24th Engineers (Shop Regiment assigned as electrical-mechanical), operating as a complete regiment took care of all electrical-mechanical work, except a part which the 37th Engineers performed during the first half of November. For the Third Army, part of the 37th Engineers was assigned for electrical-mechanical service. Officers were attached as electrical-mechanical assistants in office of chief engineer of each Army. Curtailment of electrical-mechanical activities after the armistice brought about corresponding changes and reduction in all electrical-

mechanical personnel. When the division of military engineering and engineer supplies was abolished the electrical-mechanical section of the division of military engineering and engineer supplies was reattached directly to the office of the chief engineer, American Expeditionary Forces. The principal duties of this section since hostilities ended have been intelligence work as to German electrical-mechanical material and apparatus used in the war. This collection includes French, British, and German material for shipment to United States for historical and research purposes.

Electric-power development in the Service of Supply, which was under the direction of the division of construction and forestry, is discussed in the section of this report dealing with the division of construction and forestry activities (see p. 356).

REFERENCE DATA, ELECTICAL-MECHANICAL (ARMIES).

	Appendix number or file reference.
Report electrical-mechanical section, division of military engineering and engineering supplies	Appendix No. 14
Report chief engineer, First Army	Appendix No. A–1
Report chief engineer, Second Army	Appendix No. A–2
Monthly reports chief engineer, Third Army	Appendix No. A–3
Monthly reports and history, 37th Engineers	Appendix No. R–37
Report technical board	Appendix No. 58

Camouflage.

The first step toward developing camouflage in the American Expeditionary Forces was taken by the intelligence section of the General Staff when, in the latter part of June, 1917, it obtained permission from the French military mission for Mr. Herbert Haseltine, an artist, who had lived in Paris for years, to visit and report on French camouflage workshops and installations.

After this report had been submitted camouflage was made a function of the chief engineer, involving the supply of troops in the line with camouflage products and the maintenance of a personnel sufficient to insure proper use of that material. Mr. Haseltine was employed to work directly under the chief engineer, American Expeditionary Forces, in making plans and preparing requisitions for future operations. On August 10 he was commissioned a captain in the Engineer Officers' Reserve Corps. At the same time Francis Jaques, another artist of ability, was commissioned a first lieutenant, and these two officers, with one enlisted man, formed the first organizations of the camouflage section. When general headquarters moved to Chaumont, the camouflage section remained at Paris, and its administration was assigned to the chief engineer, line of communications.

The camouflage personnel was, from time to time, augmented by the assignment of officers from the Engineer Corps by recruiting a

few privates especially for camouflage work and by attaching enlisted men from various Engineer regiments stationed in France. At the close of 1917 the personnel of the camouflage section consisted of 12 officers and 32 enlisted men.

The enlisted men were on detached service from various Engineer regiments, with the exception of six privates, who had volunteered in France and who were carried as Engineers, unassigned. With that limited personnel, the camouflage section had operated a small workshop at Paris—opened in late September, 1917, in an old dance hall; had furnished instruction details at Army Engineer and Artillery schools, and had supervised all camouflage operations undertaken in Army areas.

That line organizations knew little of the functions, or even of the existence of the camouflage service, soon became apparent. American units had even ordered camouflage supplied direct from the French and British camouflage sections. A request that all organizations be informed of the duties and functions of the camouflage section, and that all requests for camouflage material seek proper channels was duly acted upon. But the request for authority to go to different engineer organizations in France to secure men for specialist service was deferred, both because of the expected early arrival of camouflage troops from the States and because the line of communications needed the services of all the technical troops then employed by it. Therefore, until the camouflage section was invested with military identity and provisions were made for recruiting camouflage troops, through an indorsement from The Adjutant General's Office to the Chief of Engineers on December 4, 1917, the camouflage section lacked sufficient personnel.

Material was being furnished organizations needing camouflage through the engineer supply officer at Paris, Capt. Hazeltine being considered only in charge of field preparations. There was need for more extensive production of camouflage materials than the small Paris workshop and the limited personnel could produce. Accordingly, a letter was transmitted from the commander in chief to the chief of the French military mission regarding the establishment of a workshop for the American camouflage service.

CAMOUFLAGE SHOPS AT DIJON.

The site had to be chosen with regard to railroad facilities, provision for women workers, and space for expansion. A conference between a representative of the French military mission, one from the American general staff, and the commanding officer of the camouflage section was arranged. Capt. Haseltine was designated to attend that conference, but in the meantime Maj. H. S. Bennion had

been assigned to command the camouflage section and to him fell the necessity of examining possible sites adequate to the needs of the service.

Maj. Bennion investigated three sites, of which Dijon proved the most acceptable. After a conference between Commandant La Valle, of the French war office, Col. (later brigadier general) George Van Horn Moseley, of the American general staff, and Maj. Bennion, the Americans were assigned the use of the drill ground of the permanent French Army Barracks at Dijon and several buildings contained in the Forage Park, until adequate facilities could be constructed for them.

On December 4, 1917, authority was given for the organization of the camouflage section, to contain a detachment for investigation and instruction in the United States, and one company of camouflage troops for service in France. The United States detachment was to consist of 2 commissioned officers and 50 enlisted men; the company in France was to be the same as other companies organized under General Orders, No. 108, War Department, 1917. Camouflage troops were to be designated as the 40th Engineers, the company heretofore known as Company F, 24th Engineers, to be hereafter designated as Company A, 40th Engineers.

The output of the camouflage section during 1917 was small, a fact attributable to lack of materials, poor factory facilities, and lack of personnel and experience. There were supplied: Fifteen hangar covers to the air service; a number of silhouettes, dummy heads, observation posts, fish nets, and wire sets for instructional work at Gondrecourt and Langres. In each case officers and men from the camouflage section were sent to install the material and to instruct line troops in its use.

In addition a store of materials was accumulated at the workshop. This included 4,000 snipers' suits, several thousand wheel covers, 6,000 square yards fish nets, 11 hangar covers, 200 dummy heads, etc. A painting machine and a stripping machine were built. Great experience was also gained in fabricating camouflage material and the handling of woman labor.

Very cordial relations were established with both British and French during the latter part of 1917. Eight officers visited the British front and two officers remained there for a month attached to various corps camouflage officers for instruction. In supplying samples, drawings, and information connected with all phases of the work the British proved a valuable aid to the American Expeditionary Forces.

Four officers visited the French front and one of them remained there about six weeks, attached to the French camouflage troops. All officers visited the French workshops in and near Paris. A

French liaison officer had been attached to the camouflage section since August 24, 1917.

LARGE REQUISITIONS PLACED.

Several large requisitions were placed during 1917, three of the most important being:

(1) A four months' supply placed with the French camouflage section based on the French requisitions for their workshops.

(2) A six months' supply placed in the United States and based on the British Army needs for a similar period.

(3) Unit equipment for a camouflage company, to be carried to France by the camouflage troops. There was also purchased in France 300,000 kilograms of chromaline paint and 300,000 square meters of burlap.

The year 1917 was productive of several interesting and instructive papers on camouflage, three of them being—

"Principles and Practice of Camouflage," by Lieut. Col. Wyatt, R. E., chief of the English camouflage service;

"Digest of Camouflage Experiences," by First Lieut. Homer St. Gaudens, Engineers, United States Reserves; and

"Report on French Camouflage," by Capt. Henry Haseltine.

These technical reports outlined the rules to be adhered to by American camoufleurs as a result of British and French experience; they did not contain information as to the activities of the American camouflage section.

Late in 1917 a plan of organization for the camouflage section was submitted by Maj. Bennion that called for a central workshop at Dijon, an advanced workshop for each Army, and dumps in each corps area. Plans drawn for the Dijon factory called for an initial construction large enough to supply one army and a later expansion to provide for an output equal to that of the British camouflage section.

CAMOUFLAGE DURING 1918.

With the opening of the new year plans for a broader organization than then existed had been formulated; sites for adequate factories had been investigated; and recommendations as to the extent to which camouflage should be developed during the expected extensive American operations had been made. As the number of combatant units in the American Expeditionary Forces increased, and as camouflage personnel became more familiar with camouflage needs and more experience in the use of materials, camouflage activities followed defined lines of organization and administration, including instruction and training, production and supply, and field operations.

ORGANIZATION AND ADMINISTRATION.

Company A, 40th Engineers, arrived at Dijon January 23, 1918. The company, composed of 5 officers and 250 enlisted men, was put to work on the erection of the camouflage factory at that place. The arrival of Company A swelled the total number of camouflage troops

(29-M8) FRENCH WOMEN EMPLOYED IN PRODUCTION OF CAMOUFLAGE MATERIAL AT THE FACTORY IN DIJON.

to 16 officers and 285 men. Up to that time all camouflage troops in France were those who had been carried as on detached service from Engineer organizations in France.

April 30, Special Orders, No. 120, paragraph No. 26, General Headquarters American Expeditionary Forces, was issued, authorizing the increase in camouflage personnel by the addition of a battalion

headquarters and a second company to be formed from troops at the headquarters of the camouflage section. Pursuant to that authority, the 1st Battalion Headquarters and Company B were organized May 1. Three officers and 47 enlisted men reported for duty and were included in Company B. The men in this detachment had been in the experimental section in the United States. Headquarters of the 40th Engineers were at all times maintained at the central workshop at Dijon.

When the American First Army was organized all camouflage troops assigned to divisions in this Army came under the supervision of the Army camouflage officer. The same condition prevailed for those troops stationed with divisions in the Paris groups before the organization of the American Second Army. Tactically the troops were directed by the chief engineers of the Armies, while the two Army camouflage officers, Maj. Bragdon, of the First Army, and Capt. Homer St. Gaudens, of the Second Army, were responsible for the technical camouflage efficiency.

On October 21, upon telegraphic instructions from the chief engineer, American Expeditionary Forces, a replacement and training center was organized at Dijon from among the troops of the First Battalion Headquarters at Dijon, and in accordance with approved Tables of Organization for a "Replacement unit type 'L,' replacement and training center, camouflage section, Corps of Engineers." The headquarters newly formed were designated as "Headquarters, 40th Engineers, replacement and training center," and the companies were designated as Companies "I" and "K," 40th Engineers. The personnel of the headquarters detachment was obtained largely by transferring to it the men of the First Battalion handling the administration of the camouflage section. Company "I" was organized from among other men on duty at the Dijon factory and Company "K" from among those forming instruction details at the various engineer schools.

Authority was requested from general headquarters, American Expeditionary Forces, to organize at headquarters, American Second Army, the Second Battalion of the 40th Engineers from among the troops of the First Battalion attached to the Second Army, and this was given per Tables of Organization approved in War Department cablegram 1948–R, paragraph 14.

No further change in the organization of camouflage troops was made. At the time of the signing of the armistice and upon the organization of the Third Army, several officers and men of the camouflage section were attached, but they were recalled November 24, when telegraphic orders were issued for the assembly of all camouflage troops at Dijon, preparatory to embarkation for the United States. The 40th Engineers sailed for the States January 5, 1919.

INSTRUCTION AND TRAINING.

No extensive training for camouflage troops was given at the Army Engineer School. Camouflage instruction and use, moreover, were supervised by personnel from the 40th Engineers, this personnel being scattered among Army and corps schools and Artillery organizations and training centers. Camouflage specimens were shipped to these various schools and to Artillery centers.

During April two officers and seven enlisted men were stationed at Langres as an instruction detail. Two additional enlisted men were sent there in May. A detail of one officer and seven noncommissioned officers was sent to various Artillery organizations and training centers during June. Experience of the French and British indicated that a wide dissemination of information as to the proper use of camouflage was better than restriction of such knowledge to a few specialists. At the end of June, 1 officer and 12 noncommissioned officers were instructing Artillery at Souge, Valdahon, Morbihan, Angers, Coetquidan, Limoges, and Clermont-Ferrand. Line troops were being constantly taught uses of camouflage and, in general, instruction was made as extensive as possible.

PRODUCTION AND SUPPLY.

At the beginning of 1918, the small Paris factory was manufacturing all the camouflage material produced by the 40th Engineers. Men were employed on the erection of the large factory at Dijon late in January. During the month approximately 10,000 square yards of material was furnished by the Paris factory, in addition to numerous small camouflage specimens.

During February, the Paris factory was closed down and the Dijon factory began operations. On January 28, the day when the Paris factory closed, an advanced workshop began operations at Nancy, so urgent had the need for camouflage material become at the front.

During the spring and summer camouflage production greatly increased, and at the time of the signing of the armistice the Dijon and Nancy factories, with French women supplying the labor and camouflage troops the administrative service, were turning out camouflage material for the supply of all American troops at the front, besides supplying specimens to various engineer and corps schools and Artillery organization and training centers.

Dumps were placed in each corps area for camouflage material. The most approved method by which combat units were supplied with camouflage was founded on a system of credit, such credit being based on a maximum of 20,000 square yards of camouflage material per month per division in the line. Material could be drawn to the full extent of such credit directly from the Dijon factory.

During 1918 more than 3,000,000 square yards of camouflage material, including wire netting, fish nets, garlands, hangar covers, sniper suits, painted burlap, and coco matting, were manufactured, approximately 15 per cent of which amount was on hand unused at the time of the signing of the armistice. In addition, both the Nancy and Dijon factories contributed other material, such as wire sets, observation posts, umbrella frames, shell holes, dummy heads, helmet covers, and rifle covers.

Beginning with April, 1918, following are the principal production figures of the Nancy and Dijon factories, and the number of women workers employed during each month:

Month, 1918.	Square yards of material.	Average number of women workers.
April	76,900	315
May	151,715	306
June	81,920	354
July	259,475	495
August	621,486	775
September	658,993	888
October	628,246	836
November	493,747	534
Total	2,972,482	.....

After November 11 preparations were made for the closing of the Nancy factory, and the force of women workers at Dijon was materially reduced. From November 15, from 25 to 50 women were discharged daily, until a working force of 125 women had been reached. These were used in salvaging and in cleaning up the factory. Upon the completion of that duty the factory was closed.

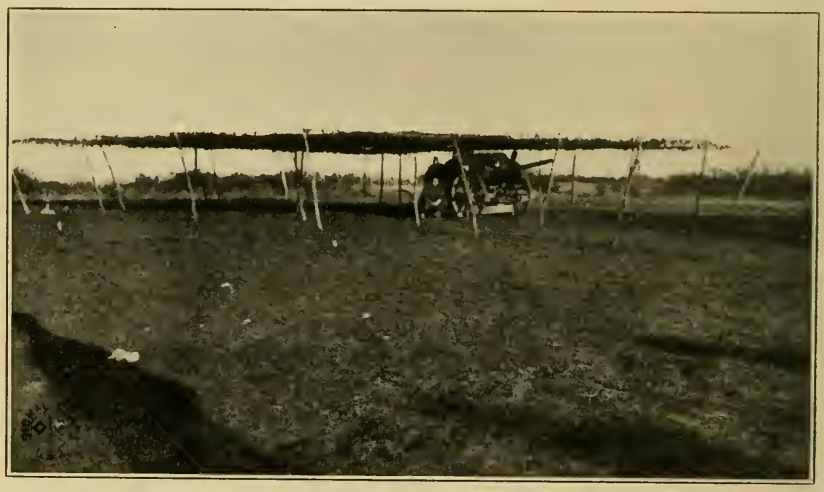
FIELD OPERATIONS.

The first field operations were undertaken by the camouflage section when a camouflage officer was sent to the 1st Division early in January, 1918. He camouflaged several battery positions, as well as certain old French positions for the divisional Artillery. His work was extended during February, involving a concealment of 36 battery positions of which a large number were out in open fields. Machine gun positions and posts of command were also given technical attention.

February 29, 2 officers and 12 enlisted men were attached to the 42d Division, and on March 16, 2 officers and 6 enlisted men were detailed with the 2d Division. The work during this month consisted mostly in camouflaging machine gun positions, installing a number of observation posts, posts of command, and work on a few new battery positions.

With the arrival in the line of the 26th Division in April, camouflage personnel operating with the four divisions numbered 6 officers and 93 enlisted men. They continued their operations with these divisions during May, and in addition, on May 17, 10 enlisted men were added to camouflage troops with the 1st Division. May 27, eight enlisted men were sent to the 26th Division and on May 31, the same number were detailed to work with the 2d Division. With minor changes in personnel occurring during the month, a total of 7 officers and 119 enlisted men were on duty with these four divisions at the end of May.

During June the number of divisions operating on active and stable fronts had been increased to seven, necessitating assignment of additional camouflage troops to line organizations. Enough action



(3243–V8) FLAT TOP CAMOUFLAGE CONSTRUCTION FOR GUN POSITION.

had been seen to elicit from Lieut. Col. Bennion the following recommendation as to the use of camouflage troops:

Fighting on a moving front indicates that camouflage personnel under such conditions should be attached to the smaller units of each division. In the case of Artillery there should be one camoufleur with each battery. He is then on hand to reconnoiter for location of positions, to mark out paths and roads to be used, to locate and hide piles of ammunition, latrines, and kitchens, to camouflage the guns themselves, and then maintain the camouflage. If 18 camoufleurs are detailed with Artillery, then a satisfactory detachment for a division would consist of 1 officer and 25 men, 5 of these men being used to camouflage machine-gun positions and engineer working parties.

During July the number of divisions in the line increased from 7 to 10, necessitating an increase in assignment of camouflage personnel thereto. Little increase was made in the number of camouflage troops sent to the front during early August, though

upon the organization of the American First Army there were detailed therewith 8 officers and 117 men.

During September all camouflage troops operating in the field were assigned to the First Army. This personnel totaled 26 officers and 307 enlisted men, and was divided into approximately 23 detachments, 16 with divisions, 4 with corps, and 3 with Army Artillery. The corps camouflage officer had technical supervision over his divisional camouflage officers. His detachment handled camouflage for corps Artillery and other corps troops.

In the St. Mihiel and Toul sectors during September a great deal of camouflage work was done. In the operation of September 12 the Artillery reinforcements were so great as to give an average of 66 batteries per division. For the field artillery most of the camouflage work was done simply with natural material or natural material and fish nets. In general very good results were obtained and this large amount of artillery was gotten into position with few signs of detection. This condition was greatly aided because of the fact that during three or four days prior to the attack weather conditions hindered aerial photography.

When the advance in the sector stopped it became necessary to do a great deal of camouflage work because the German artillery fire made unconcealed positions untenable. Though the work was done promptly and satisfactorily, some difficulty was experienced because of lack of proper transportation and of trained personnel.

In the front west of the Meuse a slightly different situation arose. The field artillery was often not put into position until the night it was to fire. No camouflage work was necessary, because artillery could be hidden in the woods. After the advance began the concentration of artillery was so great and the fire of the Germans so general that it was considered useless to try any measures of camouflage. In that operation camouflage officers acted largely as police, reporting anything that would reveal activity in any locality to the enemy.

On October 10, when the Second Army began active operations, all camouflage troops operating with units in the Second Army were put under the supervision of Capt. St. Gaudens. His personnel consisted of 10 officers and 138 enlisted men, making the total at the end of the month operating with the two armies and at the advanced workshop at Nancy 31 officers and 322 enlisted men.

Camouflage troops with the First Army early in November had little to do, the movement of troops being so fast that in general only portable camouflage could be used. There was also a great amount of natural camouflage at hand, many battery positions being installed in woods. In the Second Army preparations were being made for an offensive, and camouflage officers were used extensively.

When the Third Army organized, six officers and nine enlisted men from the camouflage section were attached thereto, the officers for emergency technical service and the enlisted personnel as chauffeurs, etc.

The camouflage section operated in the face of numerous difficulties, two of which deserve mention: Lack of experienced and sufficient personnel and failure of line organizations early to recognize principles of efficient camouflage. In general, assumption was made that the duties of camouflage officers lay in covering positions as laid out. Under these conditions unsatisfactory results were obtained, and numerous recommendations were made that camouflage officers be consulted as to choice of positions as well.

An enunciation of the functions of camouflage personnel, made by Lieut. Col. Bennion, is contained in the following quotation:

> Under the present warfare the rôle of camouflage troops becomes: Erection of road screens and other camouflage works for the benefit of the entire Army and not for any special organization that could properly be charged with doing the work itself; reconnoissance to locate dumps, posts of command, artillery positions; and inspection to report on violation of secrecy orders and camouflage principles. Hence, their main functions became counterintelligence work on a broader scale than before, when camouflage troops were assumed to be specialists, who were the only ones capable of executing the works of camouflage.

REFERENCE DATA, CAMOUFLAGE.

	Appendix number or file reference.
Letters	D. M. E. and E. S.; file Nos. 13–2–3, 13–2–5, 13–2–4, 13–1–11, 13–1–9, 13–2–12, 13–1–62, 13–1–82, 13–1–67.
Monthly operations reports of the 40th Engineers	Appendix No. R–40.
History of camouflage during 1917 by Col. H. S. Bennion	Appendix No. R–40.
Intelligence reports on camouflage	Appendix No. R–40.
Report of chief engineer, First Army	Appendix No. A–1.
Final report of camouflage service	Appendix No. —.

Searchlight Service of the American Expeditionary Forces.

Before our entry into the war in France the United States Army had no searchlight service for field employment. General searchlight practice was, however, well understood from experience with large searchlights installed at our coast defenses, and to the extent permitted under appropriations available, efforts had been made at the Engineer School to develop the material and the proper technique of a searchlight service. For lack of means and of definite knowledge of the developments since 1914 comparatively little had been accomplished at the time we entered the war.

The first definite impulse toward the organization of a searchlight service came when in June, 1917, the First Engineer Train was organized at Washington Barracks. This unit formed the nucleus of our searchlight service in France, and under "Tables of Organization, 1917," its equipment consisted of the following: Eight limber and caisson, 24-inch "Sperry" searchlights; 4 limber and caisson supply units for the above lights; 2 power units for "Strauss" 36-inch trench searchlights mounted on F. W. D. trucks; 72 Edison storage batteries and 11-inch trench searchlights; and 1 limber and caisson charging set.

On August 7, 1917, this train with 4 officers and 170 men sailed for France, having had since its organization about two months of military and technical training.

It was under the command of Capt. John C. Gotwals, Corps of Engineers, later promoted successively to major and lieutenant colonel. As will be described hereafter, this unit was merged into the 56th Regiment of Engineers, which finally constituted the searchlight service of the American Expeditionary Forces.

Capt. Gotwals proceeded to general headquarters, where he was instructed to attach a portion of the engineer train to the French searchlight station at Fort Mont Valerien at Paris for training. Accordingly, First Lieut. Ralph W. Lewis, with a detachment of 20 men, proceeded to Fort Mont Valerien, while Capt. Gotwals returned to the port of debarkation to await the arrival of his equipment. As soon as all equipment had been received and assembled the train proceeded overland to Paris. A total of 99 enlisted men was attached to the French searchlight section for instruction, the remaining men joining the First Regiment of Engineers.

Meanwhile visits were made to the searchlight sections of the French and British. These trips developed the need of strong organization for combating night bombing and of perfect coordination between antiaircraft artillery and searchlights, since it was recognized that to prevent bombing, which disturbs the morale of most seasoned troops, adequate antiaircraft batteries must be provided; that successful combating of enemy planes at night calls for close cooperation of gunners and searchlight operators; that at least one 36-inch light is required by antiaircraft defense for each 5 square miles in the zone of advance and twelve 36-inch lights, or larger, for each ammunition dump or other vulnerable point on the lines of communication; and that searchlights even unsupported by artillery are more efficacious in driving away planes than are antiaircraft guns.

The excessive bombing of British concentration centers and of all territory for several miles behind the British front line had made

extensive defense measures necessary. It was also found desirable in the interests of unity and efficiency in combating enemy airplanes that an artillery officer be placed in charge of all antiaircraft work and antiaircraft guns, an engineer officer in charge of all searchlights, and an officer of the machine-gun service in charge of all machine guns used in antiaircraft work. The immediate duty of these officers was to secure material and personnel adequate to the needs of such service and to advise various supply officers regarding the best location of ammunition dumps and other depots. The officer in charge of searchlights was, in addition, charged with training and equipping antiaircraft searchlight sections; with keeping in touch with British and French searchlight sections to keep abreast of the rapid changes made in night bombing; advising the engineer depot in the United States in regard to types and numbers of searchlights desired; and with altering in France searchlight material to make it suitable for use under new conditions imposed.

The requisite Engineer personnel to make this plan effective as to searchlights could be secured by a reorganization of searchlight personnel of the divisional engineer trains. The paramount importance of antiaircraft searchlights and the possibility of converting sections operating antisearchlights, into field searchlight sections, when necessity might arise, were apparent, but the British experience showed that little value was attached to the "Field searchlight service," all searchlight personnel being preferably engaged in combatting enemy planes.

The first definite schedule of personnel and equipment, necessary for the proper functioning of antiaircraft searchlight sections, submitted to the chief engineer, American Expeditionary Forces, was based on a searchlight section of 34 enlisted men, containing approximately 50 per cent noncommissioned officers, commanded by a first lieutenant.

Based upon the theory that our Army would occupy a front of 60 miles to a depth of 12 miles, a total area of 720 square miles, and allowing one light per 5 square miles, with the additional lights found necessary for the protection of five large dumps, it was estimated that area protection would call for 144 searchlights, 75 per cent, or 108, being 36-inch diameter, and 25 per cent, or 36, being 60-inch diameter, while the five ammunition dumps would call for 60 lights, of which 25 per cent, or 15, would be 36-inch and 75 per cent, or 45, would be 60-inch. Searchlights with diameters less than 36 inches were deemed inadequate.

Particularly strong defensive measures were deemed necessary for the protection of dumps, hence the percentage of 60-inch lights. Portability was a requisite for searchlights, operating on the congested

front, hence the high percentage for service there of 36-inch lights. In addition a 50 per cent of reserve stock of all lights was contemplated.

Each section was to be charged with the operation of either three 36-inch lights or two 60-inch lights, making the total number of sections 78. With one complete section doing instruction work at Langres and with 4 officers and 58 men at Fort Mont Valerien, it was estimated that by the time we were occupying 60 miles of front the searchlight service would consist of 84 officers and 2,344 men and would have in operation 204 lights at the front and at five large dumps or depots. In order to initiate this scheme it was proposed that the portion of the first divisional engineer train, at Fort Mont Valerien, be assigned to a "searchlight service" and divided into the "Fort Mont Valerien depot section" and the "Langres School section," and that searchlight troops with Second and One hundred and first Engineers then in France be ordered to Fort Mont Valerien for organization and training.

In a memorandum to the chief of staff, dated October 30, the chief engineer, American Expeditionary Forces, concurred in the above general scheme, but the general staff finally decided that although practically all personnel and equipment required should be provided for, it was inadvisable to organize a "searchlight section" as a separate technical service, but that it should rather be coordinated with other services with which it would be associated.

Thereafter the chief engineer, American Expeditionary Forces, sent to the operations section of the general staff, December 3, 1917, a project for the Engineer part of the proposed coordinated service which contained these broad proposals: That the manufacturing program of 1918 should include the delivery of 180 searchlights, 36-inch if practicable; that the personnel should be given thorough technical training in electricity, gas engines, and all involved accessories; that all searchlight equipment, supplies, and spare parts be sent direct from manufacturers to France, properly marked, and that necessary transportation for lights be sent proportionately; that four 60-inch lights, with power plants, be supplied as early as possible for training; that searchlight equipment and personnel move to France in the proportion of twenty-one 36-inch lights or fourteen 60-inch lights per company of 250 men. Equipment should, if possible, be sent ahead of personnel, but shipment of equipment should not be delayed to await development of latest type of lights; that units of equipment be retained in the United States for training personnel; and that lights in excess of the needs of field sections should be supplied for reserve in France.

It was upon the above proposals that the searchlight organization was ultimately based.

Adequate personnel for searchlight service was finally provided through "Table III, Tables of Organization, series B, American Expeditionary Forces," whereby two searchlight companies with a surveying and ranging company were to form the second battalion of each corps regiment of engineers. Counting on an army of five corps, this gave the searchlight troops a strength of 2,500 enlisted men and 70 commissioned officers for the First American Army. The tables provided for one company of field searchlight troops and one company of antiaircraft searchlight troops for each corps, but so urgent did the need for the latter service become that most of the personnel was used for that service.

During 1917 no field operations were undertaken by the searchlight troops. Instruction was received from the French at Fort Mont Valerien, and late in the year a detachment of 40 of these trained men, in command of Lieut. M. T. Cooke, United States Reserves, went to Langres to establish there a searchlight branch of the Engineer School. With them they took:

Four limber and caisson 24-inch "Sperry" searchlights.

Three French automobile-mounted 36-inch searchlights.

Two F. W. D. trucks, one of which contained the power unit of a 36-inch "Strauss" searchlight for a portable machine shop.

At the time the armistice put an end to active operations searchlight service had become a strong defensive resource in all forward areas occupied by the American forces. To adequately trace the development of this service it will be convenient to do so through separate discussions of—

A. Organization and administration.
B. Training and instruction.
C. Operations.
D. Research.

ORGANIZATION AND ADMINISTRATION.

During January, February, and March, 1918, searchlight troops in France numbered but two platoons, a part of the first divisional engineer train. These two platoons were stationed at Fort Mont Valerien, where instruction had been carried on, and a temporary depot for repair of searchlight material had been established; and at Langres, where a small detachment was undergoing training.

These troops had been designated as the "Provisional Battalion," Fifty-sixth Engineers. "Table III, Tables of Organization," early in 1918 stipulated that two companies of each second battalion of the corps regiment of engineers should be searchlight troops, and under this system several companies of searchlight troops were received at

the temporary depot at Fort Mont Valerien and assigned to training and afterwards to active operation in the field.

The need for coordination of all searchlight troops became, however, so urgent that a change was effected whereby the searchlight troops became a separate Army technical service. General Orders, No. 131, series 1918, General Headquarters, American Expeditionary Forces, Paragraph II, (*b*) ordered that—

> For each army there shall be organized a regiment of searchlight troops composed of the searchlight companies now included in the second battalion of the corps engineer regiments. The searchlight regiment shall have a regimental headquarters but no battalion headquarters. The number of companies of the regiment shall be variable, but based on two companies for each corps in the Army.

This order, issued August 7, was, on August 17, amplified by General Orders, No. 135, General Headquarters, American Expeditionary Forces. This later order authorized the organization of a searchlight regiment and designated as that regiment the 56th Engineers: Companies A, B, C, and D, to retain same designation; Companies D and E, 603d Engineers, to become Companies F and E, 56th Engineers, respectively; Companies D and E, 604th Engineers, to become Companies G and H, 56th Engineers, respectively; and Companies D and E, 605th Engineers, to become Companies I and K, 56th Engineers, respectively.

The latter order transferred appropriate officer and enlisted personnel of the respective companies to the 56th Engineers upon arrival in France. Accordingly the headquarters of the 2d Battalion, 603d Engineers was abolished and its officers and men attached to regimental headquarters of the 56th Engineers, pending assignment thereto. The small detachment of searchlight troops which had been part of the 1st Divisional Engineer Train was incorporated in Companies A and C, 56th Engineers, upon their arrival on March 28, 1918. With the arrival of Company C at the temporary searchlight depot on May 30, the searchlight personnel included, with attached officers, 35 officers and 995 enlisted men. At this time the inadequacy of the station at Fort Mont Valerien became apparent and on June 17 one officer and 50 men were sent to Gievres to establish a permanent depot there. About the same time two officers and 30 men were sent to Pont-sur-Siene, where an antiaircraft experimental station had been established. No more American material was received at Fort Mont Valerien, and shop equipment theretofore used at Paris was installed at Gievres. During August American equipment began to be received at the Gievres depot, though the receipt of searchlight material from the French and its repair and distribution to American units continued at the Paris depot. Besides the depot at Gievres a shop had been authorized at Langres, where

both the shop and a storeroom had been erected during August to serve as a repair center for searchlights operating in the Services of Supply. This Langres shop had no connection with the anti-aircraft school at that place. All shops were completed and in full operation before the close of September.

Soon after the completion of the Gievres depot and the removal there of equipment from Paris, the headquarters of the 56th Engineers was removed to Colombey-les-Belles, a site to be used as a supply and repair center for contiguous areas, as well as for training of personnel.

At the close of August there were 20 platoons all told in France, of which three were carrying on instruction work at permanent schools or were operating the depot; one was at the depot under instruction; and the remaining 16 were carrying on active operations in the field.

During September Companies G and H, 56th Engineers, arrived from the States, and by the end of the month this regiment had eight companies, all but four platoons of which had been trained and partly equipped. The arrival in October of Companies D and E, 605th Engineers, and their transfer to the 56th Engineers as Companies I and K, respectively, completed the 10 companies authorized for one army.

On November 1 three platoons were instructing at school or used as administrative force at depot; 15 were at Army school under instruction, and 33 in the field in active operation.

Upon the signing of the armistice plans were made for sending the searchlight troops home in three phases. Companies F, I, and K sailed for the States on January 4, 1919; Companies D, E, G, and H on February 25, and the remainder of the regiment after being stationed for sometime at St. Nazaire sailed for the United States on April 13, 1919.

TRAINING AND INSTRUCTION.

As soon as the searchlight troops of the first divisional train became installed at Fort Mont Valerien, preparations were made for their instruction, and this continued there for some time. However, late in 1917, extensive preparations had been made for the establishment of a searchlight school at Langres, and for sending small detachments of men to the British front for instruction and field training. Early in 1918 a detachment of 2 officers and 30 enlisted men were sent to Langres to establish a searchlight school, place field equipment for tactical instruction, and do the construction work necessary to care for both personnel and material. The first personnel to arrive at Langres for instruction reported the middle of April, being two platoons numbering 84 enlisted men and 2 officers. The

training of these first two platoons was completed by June 1, and upon the assembly of their field equipment these first platoons were assigned for service at the front. On June 11 the third platoon arrived for instruction and training, and from that date until November 11 the school grew to such proportions that additional instruction details were necessary, an average of approximately 600 searchlight troops receiving instruction there during the three months prior to November 11. On November 1 there were at the Langres School 25 officers and 707 enlisted men.

The course of training for the searchlight troops was most comprehensive. Each company of 250 men was divided into platoons of 1 officer and 50 men each, subdivided into three sections each. Gas instruction was given to all personnel at the first opportunity after arrival at the school. Platoons were then assigned for six weekly periods of training in the following subjects: Reception of equipment, including careful study of equipment received and in its proper care and upkeep; field searchlight training, including instruction in the use of the "Harle" 90-centimeter light, panoramic sketching, selection of sites for light emplacements, and the technical use and limitations of field searchlights; antiaircraft searchlight training, including complete crew drill for antiaircraft work, was included in period "3" and the following details were therein embraced: Choice of searchlight positions, setting up equipment, drill with sound-direction device, recognition of planes; motor transport and technical training, including thorough instruction in the care and operation of gas engines, electrical wiring, the construction and use of telephones, repair and driving of auto trucks; antiaircraft machine-gun training, including practical operation of the Lewis and Browning machine guns; guard and fatigue.

This six weeks' training was devised to fit any man for any specific duty with any searchlight section. Besides instruction gained at the depot and at the Army School, several details were, early in 1918, sent to the British for training.

ACTIVE OPERATIONS.

Although small detachments, placed with the British for training, had seen some service at the front early in 1918, the first sections of American searchlight troops to go into the field equipped with American material after completing their instruction at the Searchlight School, were sent to work with the French First Army in May. These sections comprised 6 officers and 200 enlisted men, equipped with 18 to 36 inch lights, and they continued in action for several months. These were the first antiaircraft searchlight troops the French had at the front, that service being undeveloped by the French during the entire four years of war.

During May four platoons, with seven 36-inch searchlights and two 60-inch searchlights, were sent to Is-sur-Tille, to establish anti-aircraft defenses there. They were designated as the first anti-aircraft battery, Is-sur-Tille.

July 4 three additional platoons were placed at the disposal of the French, bringing the total number of platoons on duty with the French to 10. These 10 platoons were formed into Companies C and B, the former going to the French First Army and Company B being assigned to duty with the French Tenth Army. Company C was engaged in the defense of Amiens during the entire month of July, and Company B was installed in the defense of Creil. On August 1 the number of searchlight troops actually engaged in field operations totaled 450.

Both Companies B and C continued their defensive work with the Tenth and First French Armies, respectively, during August. Company C moved forward from Amiens with the advance of the French troops. With the addition of personnel at Colombey-les-Belles, where an advanced training center was being installed, and with the sending of more troops to the British front searchlight troops actively engaged at the end of August numbered 600.

During September and October the operation of searchlight troops reached a maximum. Upon the organization of the American First Army, Companies A and B, 56th Engineers, comprising 7 officers and 250 men each, including medical personnel, were detailed early in September to duty with it. These two companies had a total of twenty 90-centimeter B. B. T. searchlights, five 36-inch Sperry lights, and one 48-inch British light and 20 Riker, 2 Quad, and 5 Mack trucks with generating sets attached. Company A was established around Dieulouard and Company B at Royaumeix.

In addition to the troops assigned to the American First Army, three platoons equipped with six 60-inch Sperry lights and power sets were moved on October 5 into position to defend the valley of the Moselle.

Company C continued to operate with the French First Army until October 12, when it moved to the American First Army area to cooperate with Companies A and B, already stationed there. These three companies, with a total of 41 lights, were able to throw a light band along the entire front of the First Army area.

When the American Second Army was formed three platoons of Company E, 56th Engineers, with six 60-inch lights, took station near Pont-a-Mousson.

Searchlight troops did effective service both at St. Mihiel and in the Argonne-Meuse sector. Upon the arrival of Companies A and B in the St. Mihiel sector the headquarters of the searchlight officer,

First Army, were established at Tremblecourt, near the headquarters of A and B Companies. During the St. Mihiel operations the 26 lights of these two companies illuminated 54 hostile aircraft for an average period of 2.5 minutes each. From these illuminations and from data secured from the operation of sound-locating devices it was possible to plot the courses of enemy planes. A composite chart made from observations during the St. Mihiel drive proved the efficacy of searchlights as defenses, for it was found that hostile planes either avoided the defended area or, when illuminated, became confused and turned back.

On September 23 Company B and two platoons of Company A moved to new positions along the Meuse. Telephone connections were installed between lights, and all had connection with a near-by town. Due to the lack of cooperation these companies had experienced with French antiaircraft batteries, the following plan for cooperation between searchlights and pursuit planes was formulated: Sufficient pursuit planes were placed at the disposal of the chief of the antiaircraft service to defend any area which the number of lights on hand can illuminate; antiaircraft batteries to be regrouped so as to make the antiaircraft defense beyond the area defended by pursuit planes more effective; to extend the length of front protected against enemy bombing planes; and to cooperate with pursuit planes in driving enemy planes into the center of the lighted area.

The 27 American searchlights available were placed so as to defend the important natural approaches from Verdun toward St. Mihiel and St. Menehould, the 8 French lights available to cover St. Mihiel and Clermont-en-Argonne on the extremities of the American lights and in liaison with them. This grouping had the following advantages: Important approaches were covered and important railheads, localities, and a great extent of rear were defended; the lighted area was far enough in the rear of the line to prevent the enemy listening posts from hearing pursuit planes—such a line could illuminate enemy planes for an average period of three and one-half minutes, while the pursuit aviators declared one minute to be sufficient for the attack; a hostile plane on striking the lighted area naturally swerved, thus giving the lights the effect of greater depth, so that illuminated planes could be passed from one light to another; if further experience revealed that the lighted area had insufficient depth, other lights, soon available, were to be placed to increase that depth.

On October 5 three platoons of Company E, equipped with six 60-inch searchlights, proceeded to the First Army area and relieved the three platoons of Company A, still on duty at Dieulouard, which proceeded to the Meuse sector.

Due to the progress of the offensive, the need for additional lights became pressing. It was therefore decided to add Company C to the searchlights in the First Army. Company C proceeded overland from the French First Army, with which organization it had been operating since the middle of May. It was in position by October 19.

Such disposition of personnel was found to seal very effectually the crowded areas just in the rear. However, a number of bombers penetrated to the rear areas by passing around the flank of the belt of lights. It was therefore decided to assign Company H to the Second Army. This company took its position and was ready for operation November 2. A regrouping of the lights of Company B gave a continuous light belt from the Argonne Forest to Dieulouard, affording protection for approximately 1,000 square kilometers. This was the position on November 11.

As a summation of the operations of the searchlight troops, Lieut. Col. Gotwals, their commander, has the following:

The achievements of this regiment in this, the major operation of the American Army, can be reviewed with justified pride. Four and three-fifths companies of searchlight troops were provided for the antiaircraft defense of the First and Second Armies. These companies met every demand of the changing operations; introduced the cooperation of pursuit planes and searchlights in the American Army; were enabled by their training to illuminate or turn back practically all enemy planes attempting to enter the American area; were provided with a highly complex technical equipment; earned the sincere praise of all who observed the work.

RESEARCH.

One of the most distinctive features of searchlight service carried on in the American Expeditionary Forces was the coordination between field-operating units and those assigned to experimental work. As a result of research with different arcs, types of projectors, mechanical appliances for operation, generating sets, generating-set carriages, and sound-direction indicators, the field units were supplied with theretofore unused devices.

A great deal of this experimental work was done in the United States after Lieut. R. W. Lewis had been sent there to cooperate with the searchlight depot. But research work was also carried on at the experimental station established at Pont-sur-Seine.

The principal achievements due to research and experimentation include the manufacture of a "dish-pan" type of 60-inch projector that combined utility with mobility, and a device for correcting sound lag, whereby the probable future course of planes could be projected and given the projector operator through readings taken by the man in charge of the sound-direction indicator.

A series of "intelligence reports" was prepared from time to time, indicating the latest developments in searchlight operation by searchlight personnel and forwarded to the chief engineer American Expeditionary Forces. A list of such reports, indicating the extent of research, follows:

On Spotting Aircraft at Night.
Searchlight Defensive Gas Training.
Telesitemeter Listening Device.
Chart for Identification of Aeroplanes.
New Plotting Board (scaler correction for sound lag).
Power Plant Shelter.
Emplacements for Antiaircraft Searchlights.
French Carbons Used in the Sperry Lights.
The Brande-Lampe.
Instructions for Fixing and Operating York Arc Control.
Telephones versus Megaphones.
Test to Determine Maximum Current to be used Practically in Sautter-Harle 90-Centimeter Searchlight.
The Lamp Mechanism of the 150-Centimeter Sperry Light.
Roue de Pointage.
The Enservissement Control.

Maj. Lorimer D. Miller, for the past 10 years in charge of design and purchase of Army searchlights in the United States, upon the completion of temporary duty with the American Expeditionary Forces, enunciated the latest accepted ideas on searchlights. In mid-November, 1918, his report to the chief engineer American Expeditionary Forces stated that the best type of arc still remained undetermined; that the size of the projector would depend upon its uses, though a 9-foot beam for less mobile lights was possible; that hand regulation of the carbon was necessary; that the beam could be occulted by improvising a small mask; that noiseless ventilation of the barrel would be most acceptable, as the noise produced by the ventilating motors was a serious handicap; that the Bausch & Lomb silvered mirror had proven the best mirror; that the projector carriage should be fitted with demountable wheels to save digging for light emplacement; that no better control of beam direction had been devised than the British "pipe control"; that the value of the synchronized telescope remained undetermined; that it was usually necessary to have machine guns independent of searchlights; and that no use had been found for live rheostats.

Lieut. Col. Gotwals concurred in these observations and added that the best type of light was, in his judgment, the 36-inch Sperry, and that the best truck unit was that of the Riker with attached generating set.

REFERENCE DATA, SEARCHLIGHTS.

	Appendix number or file reference.
Letters	D. M. E. and E. S., file Nos. 14–2–19, 14–2–25, 14–2–22, 14–2–37, 14–2–27, 14–2–66, 14–2a.
Tables of organization, 1918.	
General Order No. 135, general headquarters American Expeditionary Forces, 1918, Section IV.	
Intelligence reports	Appendix No. R–56
Monthly operations reports of the 56th Engineers	Appendix No. R–56
Report of chief engineer, First Army	Appendix No. A– 1

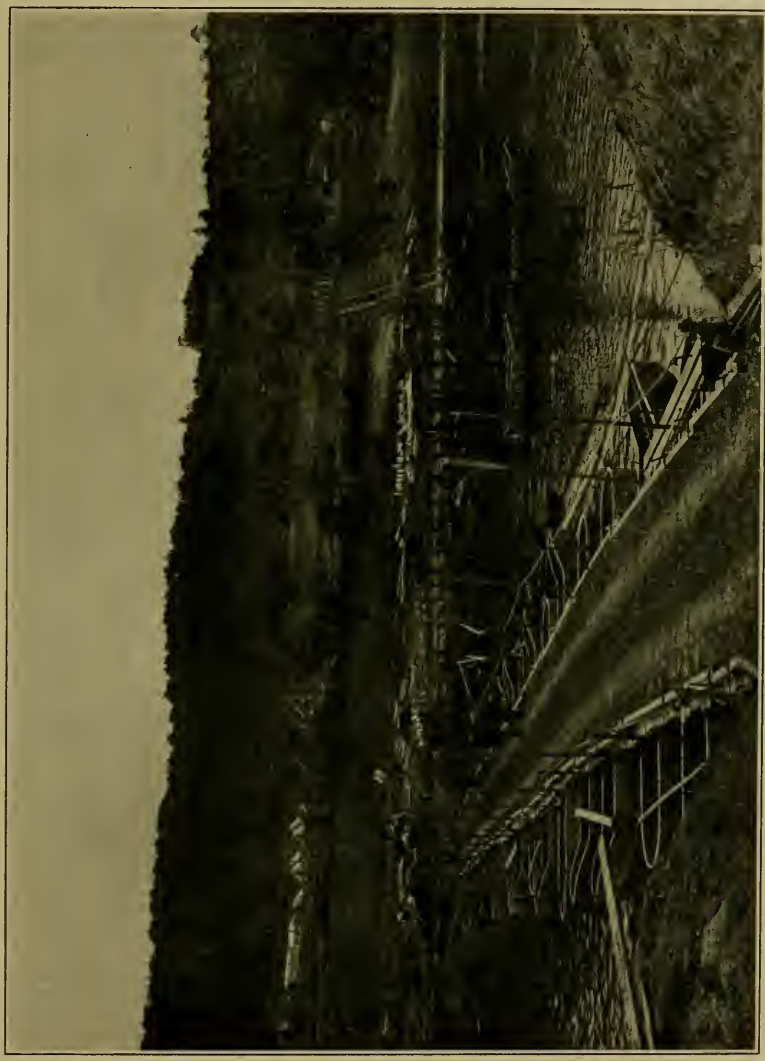
Bridges.

Technical control of pontoon and other bridge work carried out along the front by Engineer troops was exercised by the communications section, office acting chief engineer, at general headquarters. The general duties of this section covered the assigning, transfer, training, discipline, and equipping of pontoon trains and bridging battalions; investigation of the requirements and troubles as to bridges experienced by the division, corps, and Army engineers and the special engineer services, and the means of meeting them; the furnishing of technical advice to such departments as desired it; and the elaboration of final designs for such types of light and heavy timber and steel bridges as conditions and needs warranted.

As a preliminary to and basis for our bridging plans in 1918, a field reconnaissance party, consisting of six Engineer officers and an enlisted detachment, completed a reconnaissance of bridges along the front, covering an area about 20 miles wide, from a point opposite Epernay to the Swiss border. Besides obtaining data which would permit repairing and strengthening of such bridges as would be required to carry maximum loads in the event of operations in that sector, the investigation enabled the engineers to plan the demolition of these bridges in case of a retreat. It further provided information on which to base orders, operations, and requirements. The reconnaissance proved of vast importance, though authority was given by the French only upon our agreeing not to publish the results of this work.

Due to the lack of animals, it was necessary to experiment with tractors and trailers for hauling pontoon equipage. One hundred tractors were purchased in England, and a portion of them were shipped to the advance bridge depot at Abainville, but none was received prior to the cessation of hostilities. Tractors arrived in France from the United States and were used to excellent advantage for a short period. One hundred and fifty tractors (Cleveland) were

shipped from the United States in October, 1918, and 150 more were to be shipped in November. It was intended to utilize these with the corps, armies, and Army reserve. Numerous experiments were made with trailers (Troy), escort, and British wagons, with a view



(586-G8) PONTON BRIDGE ACROSS MARNE AT JAULGONNE. BUILT BY 6TH ENGINEERS WITH CAPTURED GERMAN MATERIAL.

of making such modifications as would better adapt them for hauling pontoon equipage.

In contemplation of an advance by our Army, a canvas type, floating footbridge was designed by Lieut. Col. J. G. B. Lampert which filled the need for a portable emergency unit. Each unit was 285 feet long and weighed about 4,500 pounds, so that it could be

loaded on one motor truck. This bridge was furnished the armies and various corps and was used to advantage.

The 464th and 465th Pontoon Trains were the only special pontoon troops which actually served with the armies. The 464th Pontoon Train operated originally during July and August, 1918, along the Marne, and salvaged a great deal of the captured German pontoon equipage, afterwards repaired and put to use in our advance. This German equipage was all of sheet-metal construction, differing therein from our standard types. After repairs at Abainville, two complete pontoon divisions were equipped with these German boats. In addition, 27 full boats and 59 bow sections and 52 stern sections were repaired.

The 465th Pontoon Train, which had undergone a course of training in handling French equipage at the Army Engineer School, remained there until ordered to the Second Army on November 6, 1918, and later replaced the 464th, with the Third Army.

The 401st Pontoon Park and the 466th, 467th, and 468th Pontoon Trains reached France, but saw no active service. Shortage of tonnage had prevented the shipment of their pontoon equipment to France and deliveries of pontoons ordered from the French were not made in time to equip these units. All of their personnel was therefore concentrated at the Army Engineer School and trained in handling French pontoon equipment. When it developed that they would not be needed for field service, they were returned to the United States.

HEAVY BRIDGES.

The First Battalion, 601st Engineers, was designated as Army heavy bridging troops. It was intended to train the battalion, one company at a time, at the Army Engineer School at Langres, but before the first company had completed the training course, the entire battalion was ordered there as a school battalion and ceased to function as bridging troops. Later the 27th Engineers (Mining), were used as heavy bridging troops in the advance of the First Army.

BRIDGES IN ARGONNE-MEUSE OFFENSIVE.

During the Argonne-Meuse offensive from the latter part of September to the signing of the armistice, 38 bridges were built or reconstructed in the First Army area by the 27th Engineers. As Army Engineer troops their function was to replace the more or less temporary bridges over which troops or light guns could pass by heavier bridges able to carry the heaviest tanks and artillery tractors. Of them 22 were highway bridges, 8 standard-gauge railway, and 8 narrow-gauge railway. Of the total, 26 were across the River Aire or its associated drainage, mostly in the region

Varennes Apremont-Grandpre. The remaining 12 were across the Meuse, its canal, or local drainage, in the region between Forges and Dun-sur-Meuse. The total length constructed was 2,748 feet, divided as follows: Highway total, 1,481 feet; narrow-gauge railway, 782 feet; standard-gauge railway, 485 feet.

In July, 1918, 225 spans, ranging from 19 to 90 feet in length, and aggregating 9,416 feet, were ordered from Washington, for delivery

(1038–V8) 303D ENGINEERS REPLACING, BY TIMBER STRUCTURE, DEMOLISHED MASONRY BRIDGE AT GRANDPRE, OCTOBER 29, 1918.

by January 1, 1919, for heavy bridging in the advance of the armies. Additional spans were also ordered to be exchanged against British material. None of this heavy bridge material, however, arrived before the armistice was signed.

Bridge material had originally been stocked at Gievres and Is-sur-Tille, but the haul to the front was so long that an advance bridge depot was established at Abainville under the direction of Col. H. W. Hodge. This depot was stocked and furnished bridge material to the armies, repaired captured German pontoon equipage, and acted as a base for all emergency bridge requirements. Its location at the terminal of the light railway system, over which material called for in requisitions was promptly dispatched to the front was admirable; a connection also was provided by good roads to the forward areas.

Three miles of wooden bridge (pile and trestle) were assembled at Gievres and Is-sur-Tille, and of this amount 1 mile of trestle and one-quarter mile of pile bridge complete were sent to Abainville, from which shipments to the armies were made. Two miles of road plank 5 by 10 inches by 11 feet were also prepared and a part of it delivered to the Abainville depot.

A few small pile drivers were purchased in France and others were ordered from the United States. Air-driven units were studied, both for driving piles and for driving miscellaneous wood-working tools for heavy timber bridge erection. Gasoline hoists were ordered shipped to France, but none were received in time for field use. Five hundred and forty-feet of rectangular and 624 feet of light Inglis bridge were purchased from the British. A small portion of the former and about three-fourths of the latter were delivered, but not used in active operations.

REFERENCE DATA, BRIDGING.

	Appendix number or file reference.
Report, assistant to the chief engineer, at general headquarters	Appendix No. 7.
Report, chief engineer, First Army	Appendix No. A–1.
Report, chief engineer, Second Army	Appendix No. A–2.
Report, chief engineer, Third Army	Appendix No. A–3.
Monthly reports and histories of engineer regiments with the Armies	Appendix No. R–27, etc.
Reports on engineer research (military bridges)	Appendix No. 19.
Report, Provisional Ponton Manual (French)	Appendix No. 14–a.

Map Making and Reproduction.

The preparation and reproduction of maps for Army use was carried on by battalions of the 29th Engineers, operating under the supervision of G–2–C, the topographical division, intelligence section of the general staff, of which Col. R. G. Alexander was chief. This organization was charged with the surveys of certain areas, with the preparation and reproduction of practically all maps in the Army zone, with the conduct of a base printing plant at Langres, and with the operation of mobile printing trains, consisting of presses and process equipment mounted on motor trucks, which accompanied

corps and armies. The mobile printing trains were a new development, and met the demand for speed in distributing information collected daily from prisoners, captured documents, aerial reconnoissance, and visual observations.

The first battle of the Marne was planned by the French on the general staff map of France, on a scale of 1/80,000, or three-fourths inch to the mile. Later, the enormous increase in indirect fire by the Artillery led to the demand for maps of the entire theater of operations on a scale of 1 to 20,000 (3 inches to the mile), and of the immediate battle line on a scale of 1 to 5,000 (or 12 inches to the mile). The improvement of aerial photography also made it possible to carry on detailed mapping in the enemy territory and to plot on maps the greater part of the enemy's trenches and Artillery. The variety of information led to the multiplication of the scales of maps in use, while the complication of modern warfare demanded an increased amount of graphic representation for simplification. In order to derive the greatest benefit from the increased accuracy and scale of the battle maps it was necessary that the Artillery using indirect fire from the map should have a network of triangulation and traverse points on the ground in order to determine the exact location of their batteries.

ORGANIZATION.

For the purpose of carrying on this work the following organization was established: At general headquarters, in each Army, Army corps, and division there was a staff officer (Engineers) in the G–2 section, who exercised supervision and technical control of the work of the following troops:

For general headquarters.—One battalion (topographical), 29th Engineers, operating a base printing plant and the drafting, map, and reproduction sections at general headquarters.

For each Army.—One battalion of three companies (topographical), 29th Engineers.

For divisions and corps.—Detachments from the Army topographiical battalion.

The surveying, drafting, and printing of base maps containing the natural topographic features was performed by the general headquarters, topographical battalion, and the base printing plant. The study, restitution from aerial photographs and over-printing of enemy organizations on these base maps to make the battle map, and the establishment of artillery firing data was a function of the Armies, and was performed by the Army topographical battalion. All topographic units were charged with the reproduction of intelligence information for the units to which they belonged.

TRAINING.

The troops for corps and Armies were organized, trained, and furnished technical equipment in a training center and depot at the base printing plant. The officer personnel was largely recruited from the United States Geological and United States Coast and Geodetic Surveys, and needed only training in adapting their technical knowledge to the military problems. The schools included courses in map-reading, topographical surveying, interpretation and restitution of airplane photos, artillery orientation and reproduction. Instructors were also furnished in these subjects to the intelligence school and to the corps schools.

PLANT AND EQUIPMENT.

In addition to the mobile printing trains and the portable equipment for corps and divisions, there were established the base printing plant at Langres and printing plants for the First, Second, and Third Armies. On June 15, 1918, the base printing plant was put in operation. At the close of hostilities that plant and the Army printing establishments occupied about 90,000 square feet of floor space and employed about 800 men, who operated 38 lithographic and 18 type presses and the necessary auxiliary machinery. The total impressions executed at the base printing plant was 22½ million, and in the Armies about 5,000,000.

MAP SUPPLY.

Until the base printing plant was completed June 15, 1918, American troops were supplied with French maps, obtained either from French units or from the service geographique. The proportion printed at the base printing plant gradually increased until the St. Mihiel offensive, September 12, 1918. All the maps for this operation, totaling 309,000, were printed by the 29th Engineers at Langres between August 20 and September 9, and were distributed through the topographic sections of Armies, corps, and divisions. From that time on the American Armies were independent in their map supply.

The Army printing plants assisted in the printing and particularly in overprinting enemy organizations and special information on base maps furnished from Langres. In one American Army alone, at the close of hostilities, there were 33 periodic maps produced, the time of publication ranging from daily to monthly, and the edition from 50 copies to 4,000. A rather liberal policy of distribution was adopted, since the map was about the only intelligence information which could reach the company and platoon commanders preceding and during an attack. Troops were at all times supplied with an abundance of excellent maps, the total used between July 1 and November 11, 1918, being in excess of 5,000,000.

SURVEYS.

When the American forces reached France, the theater of operations had been covered by a narrow belt of large-scale maps, on the scale of 1/20,000 with 1/10,000 and 1/5,000 maps for the battle lines. During the offensives of 1918 the Germans broke through this belt and American Expeditionary Forces topographic parties assisted the French Service Geographique by surveying about 400 square kilometers on the scale of 1/20,000. At the close of the war the Allies were on the point of breaking through on the other side. This possibility had been foreseen and surveying forces had been trained by the preparation of a number of 1/20,000 plan directeurs of training areas. Detailed surveys of limited areas were made in all parts of France for the American Expeditionary Forces organizations. Nevertheless, the actual amount of surveying done was relatively small, except in the Armies, where triangulation and traverse were carried on over large areas for the purpose of furnishing our Artillery with firing data.

USE OF AIRPLANE PHOTOGRAPHS.

The interpretation and restitution of airplane photos was a development of the present war, and instruction was conducted in the topographical school at Langres, using French and British photographs and documents. Beginning with the Chateau-Thierry operations in June, 1918, graduates of this school were furnished to the topographical sections of corps and Armies, and American data began to be used in the schools. Actual surveys made after the conclusion of the armistice showed a gratifying degree of accuracy in the study and mapping of enemy organizations. A large number of documents, photos, and studies were collected for future development and experiments were conducted with a view to the application of airplane photography to peace-time mapping.

MISCELLANEOUS.

Position warfare had brought the relief map into use in the French armies, and their methods were followed in the establishment of a relief map plant at the base printing plant. Nearly 2,000 relief maps were distributed to American organizations, of which about 500 were made by the 29th Engineers. At the close of hostilities the American Army was self-sustaining in this respect.

Visibility studies were made on these relief maps by means of French apparatus, and the results distributed.

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The reproduction of airplane photographs in quantity by photo-engraving was a decided innovation, and permitted distribution down to lower units.

Scaled panoramic photographs and sketches were produced for all the observation posts of divisions, corps and Armies, and of the Artillery and ranging service.

The total personnel employed in the topographic service at the close of hostilities was over 100 officers and nearly 1,700 men, organized in three battalions, of which two battalions had only one company each in France. Of the five companies, three had been organized in France by transfer from other Engineer organizations, from Engineer replacements, or from Engineer depot detachments.

REFERENCE DATA, MAP MAKING, AND REPRODUCTION.

	Appendix number or file reference.
Report, chief G-2-C.	
Monthly reports and history, 29th Engineers	Appendix No. R-29

Sound and Flash Ranging.

On the entry of the United States into the European War there existed no service in our Army analogous to those which, under the conditions of position warfare in Europe had been created for the purpose of accurately locating the positions of enemy artillery and for directing artillery fire on those positions. Location and ranging by means of sound was entirely new. Location by means of visual observation, though it might be regarded as an outgrowth of methods already practiced, was rendered so complicated by reason of the great artillery activity that special synchronizing devices had to be adopted and personnel especially trained in this new and more elaborate procedure.

This service was, in the United States, originally assigned to the Signal Corps, and its organization was directly intrusted to Maj. (afterwards lieut. col.) Augustus Trowbridge, an eminent physicist and engineer, who, after a preliminary inquiry into conditions in Europe, recommended to the chief signal officer that work be commenced on certain apparatus, and that he and one other officer be sent to France to study the problem of organization and return on completion of this duty to undertake quantity production of apparatus and enlistment and training of personnel. This recommendation was approved, and Maj. Trowbridge and Capt. Theodore Lyman arrived in France and reported to the chief signal officer in September, 1917.

Prior to this date General Orders, No. 8, American Expeditionary Forces, 1917, had placed the sound and flash ranging in the topo-

graphical division of the intelligence section of the general staff under the direction of Maj. (later col.) R. G. Alexander, Corps of Engineers. Maj. Alexander had sent the only men available at the time, two intelligent engineer soldiers, to the French school for sound rangers, and later to French sound-ranging sections at the front, and realizing the need of officers with expert knowledge of physics and mathematics in the sound and flash-ranging service, secured a commission as lieutenant for C. B. Bazzoni, who happened to be in Europe at the time. Lieut. Bazzoni was sent to visit a number of French sound-ranging sections, and later, in September, 1917, to visit the British sections, the organization and equipment of which had not at that time been studied by any officer connected with the establishment of a ranging service for the American Expeditionary Forces.

On the arrival of Maj. Trowbridge and Capt. Lyman at American headquarters they were ordered to report to Lieut. Col. (later brig. gen.) D. E. Nolan, assistant chief of staff, G–2. After visiting a number of French sound-ranging sections and two French flash-ranging sections they were ordered to British headquarters for a study of the British methods, organization, and equipment. As the result of the extended comparative study of the French and British ranging methods it was decided to recommend to the Chief of Engineers, Washington, that construction be begun on sound-ranging apparatus of the type in use by the British; that, as regards the flash ranging, the French system be copied by the American Expeditionary Forces. By mutual agreement between the Engineer Department and the Signal Corps, the two officers above mentioned were transferred to the Engineer Department to continue their most satisfactory work.

ORGANIZATION AND TRAINING.

The period from October, 1917, to March, 1918, was one of organization and the training of officers and enlisted men. There were no young Engineer officers nor any Engineer troops in France immediately available for this special service in the early autumn of 1917. There were, however, a large number of young Americans in France who had been in the American ambulance service with the French Army and many with the necessary education and qualifications were seeking enlistment or commissions in the American Expeditionary Force. A large number of these young men were interviewed and four valuable officers were secured. Three other efficient officers were released from other duty at general headquarters and one arrived from the sound and flash ranging detachment that had been established at Princeton. These officers were all sent to study sound or flash ranging at the British schools and for subsequent

front-line experience at the British ranging sections, where they remained until they were needed to train the first detachment of American sound and flash ranging troops.

On December 20, 1917, 40 enlisted men of the 116th Engineers were ordered to the Army Engineer School, Langres, to prepare a sound and flash ranging school for the instruction of personnel arriving from America. Under command of Capt. Lyman, assisted by Lieut. Bazzoni, the detachment was installed at Fort St. Menges, north of Langres, by January 1, 1918, and was trained in the theory and practice of ranging by the officers and the two enlisted men mentioned above as having had sound ranging experience with French sections. Instruments for both sound and flash ranging had been procured from the British and the French and the men had about six weeks' instruction in theory and practice before the first company of ranging troops arrived from the United States.

When this company (Company B, 29th Engineers) arrived in France in February, 1918, it was found to contain mixed ranging and printing and survey troops. Those with printing and survey experience were detached and the deficiency made up by the 40 men from the 116th Engineers mentioned above and additional replacements which were authorized. The officers of Company B, not technical printing or survey men, and about 20 casual officers who had been selected for attachment or assignment to Company B, were either sent to the British sound or flash ranging schools and subsequently to the front line or to French flash ranging sections after theoretical and practical training at the Army Engineer School. They were kept at the British and French fronts until they were needed for our own ranging sections as they were formed. In addition to the officers, a few of the best of the enlisted men were sent, after training at the American school, to British sound ranging sections at the front. This was sound ranging section No. 1 (under Capt. Bazzoni), which occupied a position in the sector of the First American division northwest of Toul. Early in March, 1918, the first American section was established at the front. About the same time a detachment of flash ranging troops under Lieut. (now Capt.) Wright was detailed with a French flash ranging section in the same sector with the object of ultimately taking over the responsibility for visual observation and flash ranging in this region.

Although the Sound and Flash Ranging School was officially a branch of the Army Engineer School, the training of the troops was planned and carried out by officers of G–2–C, general headquarters, and the necessary equipment, supplies, and labor were furnished by a battalion of the 29th Engineers operating under orders of G–2–C.

The reports of the officers of the sound and flash ranging service, for the most part made during the period of training prior to March,

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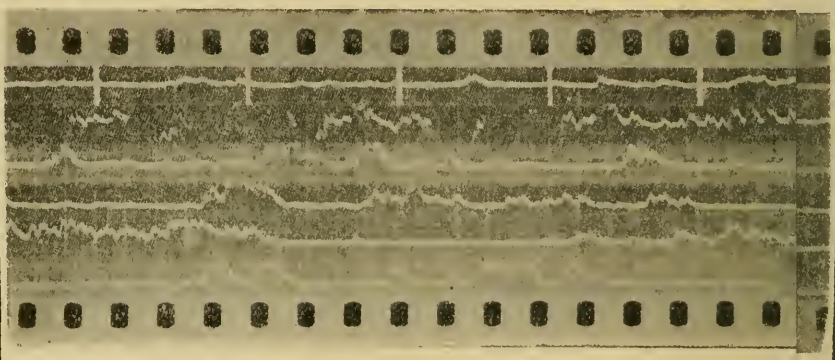

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Last record, by Sc

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1918, are accessible in the files of G–2–C, general headquarters, American Expeditionary Forces.

The list of these reports with the identification numbers assigned to them follows:

SOUND RANGING.

1. By Capt. Bazzoni: Visit to French Sound Ranging School and French sections August 29, 1918.

2. 3. By Capt. Bazzoni: Visit to three French sound ranging sec-section, January 19, 1918.

4. By Capt. Bazzoni: Preliminary report on British Sound Ranging Service.

5. By Lieut. Col. Trowbridge: Report on British sound ranging service with attached report from Maj. Lyman.

Other reports on instruction at the British school and in front line sections were made by Capt. French and Lieuts. Facht, Beckett, Nitten, and Wallower. The last-named officers submitted a report of personal experiences during the retreat with a section of the British Fifth Army in March, 1918.

FLASH RANGING.

6. By Capt. Wright: A full report on organization and operation of British flash ranging sections, January 21, 1918.

7. By Maj. Pendleton: On visit to a French flash ranging section, January 29, 1918.

8. By Capt. Whitney: Valuable report on the present and proposed organization of the British ranging service, October 18, 1918.

9. By Capt. B. A. Ross: Report on British school and front line section, January 19, 1918.

PERIOD FROM MARCH TO AUGUST, 1918.

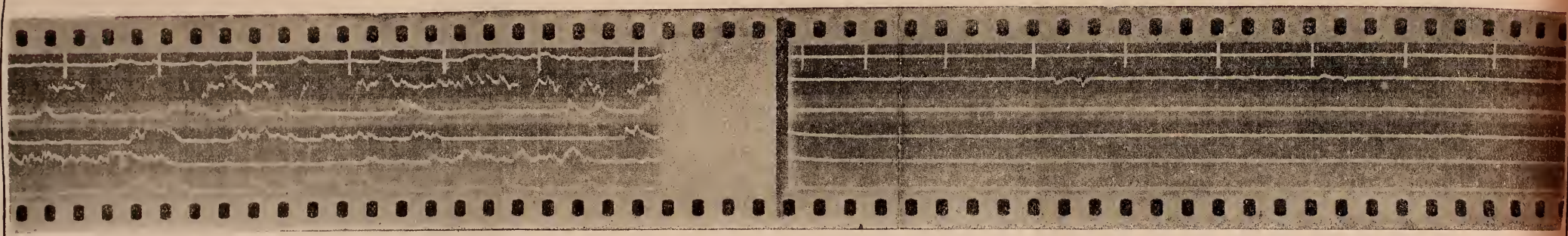
The period from March, 1918, to August 20, 1918, was one during which the ranging sections, though organized as Army troops, were operating with American divisions or corps or under French corps in sections partly held by American troops. The German offensive in March delayed the formation of the American troops into corps and armies and retarded the overseas movement of special troops and incidentally the development of the sound and flash ranging service.

The first sound ranging section, which in anticipation of the formation of our first army had been installed in the Toul sector, was dependent on general headquarters for all its technical and most of its general supplies. This management, though not contemplated in the general organization, worked so well that it was decided to

Graphical record of the End of the War

One minute before the hour. All guns firing

One minute after the hour. All guns silent



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Hour – minutes - seconds

November 11, 1918

Last record, by Sound Ranging, of Artillery activity on American front near the river Moselle

Broken character of records here indicate great artillery activity - mostly American – Lack of irregularities here indicate almost complete cessation of firing

Records of this character are used not only to indicate activity as in this case but in order to locate the positions of the enemy guns firing, thus targets and the caliber of the enemy guns - Sound Ranging Sections similar to the one which took this record are part of the Army Intelligence and are maintained in sufficient numbers to cover the entire front - They are operated by the Engineers.

increase the number of sections in the sector up to the limit of the number which could be made from the one company which had arrived in France and was trained. Capt. Lyman was put in charge of this company, which furnished three sound and one flash ranging sections. This company remained in the sector until relieved, as later explained.

The original plan of organization was to have a battalion of five companies (maximum) with each army so as to provide one company for each corps in the Army. Each of these companies was to contain four sections, two sound and two flash or three sound and one flash, dependent on the nature of the terrain or on the character of the enemy artillery in the sector.

For position warfare it was generally conceded that both the sound and flash ranging sections should remain in the sector even if the corps should move and it was for this reason that the ranging battalion was attached to the Army rather than the ranging company to the corps. It was not until August, 1918, that this proposed organization could be perfected, for during the period of the German offensive sections had to be moved wherever the Artillery could best employ them.

During this period of the German offensive the policy was adopted of placing newly trained sections in the relatively quiet Toul sector to relieve the more experienced sections which were sent to the active Chateau Thierry sector. One experienced flash section and one fairly experienced sound section were transferred in June to the active sector, and both were in operation before the 18th of July, when the Allied counteroffensive began. The flash ranging section rendered valuable service both before and after July 18. The sound ranging section also did well before the counteroffensive began, but was unable to follow the swift advance toward the Vesle and was withdrawn to the Toul sector.

In August, 1918, when the Army organization was completed, all the ranging sections were collected in the Army area and the location of the enemy artillery in the St. Mihiel salient was undertaken in preparation for the American offensive in that sector. Meanwhile Companies C and D of the 29th Engineers had arrived in France and the Second Battalion of the 29th Engineers was formed August 20.

The greater number of sections at the front had necessitated enlarging the facilities both of the school and of the technical supply depot. This latter, which had been originally located at the school, was moved to Langres which was both nearer to rail transportation and, being the headquarters of the First Battalion, 29th Engineers, permitted the institution of economies in personnel and transportation.

PERIOD FROM AUGUST TO NOVEMBER, 1918.

The period from August 20 to November 11, 1918, was one during which ranging sections were operating in an American sector as Army troops practically as contemplated in the original plans. During this period the St. Mihiel offensive was carried out and its success afforded an opportunity of judging the accuracy of the sections in locating the enemy artillery. On September 12, when the St. Mihiel offensive started, three sound ranging and two flash ranging sections were in the field. Profiting by the experience of the Chateau-Thierry offensive provisions had been made for making the sections mobile and the results were satisfactory. On account of the narrowing of the front as the line advanced one sound-ranging section was held in reserve. Thirty-six hours after the offensive started one of the sound-ranging sections came into operation for a short time. Sixty hours after the start of the offensive, the same section was operating in what proved to be a permanent position. The other sound section and both flash sections also kept up well with the advance. When the line became stabilized and new sections trained at the school went to the Army in the Toul sector, the policy was adopted of establishing sections to both the right and left of the positions already occupied. The sound-ranging sections were so disposed that three or four individual sections could be grouped so as to form a single section of very broad base. This group of sections was so laid out that it was favorably oriented for the location of the larger caliber enemy guns in the region of Metz.

When the offensive in the Argonne began one flash-ranging section was detached from the Second Army and attached to the First Army. The sector covered by the First Army was provided with French flash-ranging sections and for this reason the American section was held in reserve. It had been especially trained for mobility and had already operated with the corps to which it was attached around Chateau-Thierry. When the final advance to the Meuse near Sedan took place this section was on the left and so had the greatest distance to cover. It got into position just as the armistice was concluded.

When the Third Army was formed the Artillery of the Fourth Corps requested that this section be sent forward with them on the march to the Rhine. Another flash-ranging section also accompanied the Artillery of the other corps (the Third) of the Third Army.

At the time of the signing of the armistice there were in the field five sound-ranging sections, of which four were operating, and five flash-ranging sections. There was one company (Company F, 29th Engineers) at the school about two-thirds trained and provided with full equipment to take the field in about two weeks time. There

were on hand at the depot ample supplies for the maintenance of all the sections and new equipment was coming regularly from the United States.

After the signing of the armistice all the sections in the field except the two flash sections with the Third Army were ordered to collect their material, take in their lines, and return to battalion headquarters.

Further data on the organization, equipment, and activities of the flash and sound ranging service are given in Appendix No. 15.

REFERENCE DATA, RANGING.

	Appendix number or file reference.
Report, chief, G–2–C.	
Monthly reports and history, 29th Engineers	Appendix No. 15

Light Railways.

In the zone close to the front lines where it would have been impracticable to construct standard-gauge railways or to operate large, heavy locomotives, there was developed a system of "Light railways" with track of 60-centimeter gauge. The service of light railways began at rail heads, to which munitions and supplies were transported by standard-gauge lines and there transferred to the 60-centimeter lines. The lines increased steadily in scope and importance during the war and were a vital part of the supply system for the Armies. It is difficult to see how without them the Armies could have functioned. Great quantities of munitions, supplies, and equipment were delivered with regularity and rapidity. Troops were transported to and from the trenches by light railway and wounded were brought back in special cars adapted for carrying ammunition on the outbound trip and wounded on the inbound trip. While the actual construction and operation of light railways was nominally under Army command, the broad plans for utilizing this means of transport, for supplying trained personnel, for establishing central shops for heavy repairs, and for procuring supplies and equipment were developed and executed by the division of light railways and roads under the chief engineer, American Expeditionary Forces.

When hostilities ended there were under American Army control 2,240 kilometers of 60-centimeter lines, of which about 300 kilometers had originally been constructed by the French but rehabilitated by the American Expeditionary Forces, 200 kilometers had been constructed outright by the American Expeditionary Forces, and 1,740 kilometers had been taken from the Germans, the latter figure comprising 900 kilometers south of the battle line of November 11, 1918, and 840 kilometers just in front of it. In addition to service performed for the British Armies, the work of the light

railway regiments included construction and operation of lines in all of the principal sectors held by American troops. At the time of the armistice the system was divided into three main divisions, consisting of the Verdun district, the Toul district, and the so-called Abainville-Sorcy line, which connected the central repair shops with the system at the front. This latter line was 28.5 kilometers long and was put into operation August 22, 1918. While short it was a vital element in the system since it afforded access to the Abainville shops, the primary supply and repair center provided for engines, cars, and other equipment.

The principal troops regularly engaged on light railway construction and operation included the 12th, 14th, 21st, and 22d Engineers and the 528th, 544th, 540th, and 546th Engineers, Service Battalions, the first work done by the 12th and 14th Engineers being with the British expeditionary forces.

The nucleus for a department of light railways was selected from the 12th and 14th Engineers. The organization consisted of the following: Manager of light railways, deputy manager of light railways, chief engineer, general superintendent of transportation, general superintendent of motive power, general superintendent of construction, and supply officer. The department of light railways originally organized under the transportation department, later became the Division of Light Railways and Roads, under the chief engineer American Expeditionary Forces. The officers constituting the personnel of the original organization made investigations of light railway construction, operation, and equipment, prepared organization plans for field and shop forces and developed a centralized department for handling the light railway work in American sectors. Large orders were placed for shops, track material, equipment, including locomotives, cars, and cranes, tools, and operating supplies.

CENTRAL SHOPS.

It was essential that the organization should have its own central shops thoroughly equipped to make heavy repairs to locomotives (both steam and gas), cars of all types, and other classes of equipment, and to manufacture special equipment, special track, repair parts, etc. It was also necessary that an iron foundry and brass foundry be provided; that the main storage yards for track supplies should be adjacent to the shops; and that the shops and storage yards should be connected with light railway systems by a well-built 60 centimeter line.

About 25 shop sites were examined. By elimination, these were reduced to some half dozen, for which tentative plans were drawn, and finally Abainville (Meuse) was selected as most desirable, since

(1942–J8) TRANSPORTING WOUNDED BY LIGHT RAILWAY AT AULNOIS; TRAIN OPERATED BY 21ST ENGINEERS. JULY 1, 1918.

(1913–F9) ERECTING LIGHT RAILWAY LOCOMOTIVES AT CENTRAL SHOPS, ABAINVILLE.

it had satisfactory standard gauge railroad connections, canal connection, main highways, and was within each reach of the front. The ground covered by the shops and yards at Abainville was about 125 acres.

Orders were, therefore, placed for the structural steel on January 28, 1918, all of which arrived at the shop site about April 22. Ground was broken on April 22, 1918, the building material was brought into the yards early in May and construction commenced.

There were in all 10 buildings covering a total of about 70,000 square feet. The 10 buildings were: Erecting shop, smith shop, machine shop, foundry, gasoline engine repair shop, car shop, power plant, oil house, storehouse, and carpenter shop. The latter, however, was constructed of wood bought in France. It was later necessary to add to the storehouse, as the original building did not provide sufficient covered space. It was also necessary to erect a small engine house to take care of running repairs to locomotives on the line to the Armies.

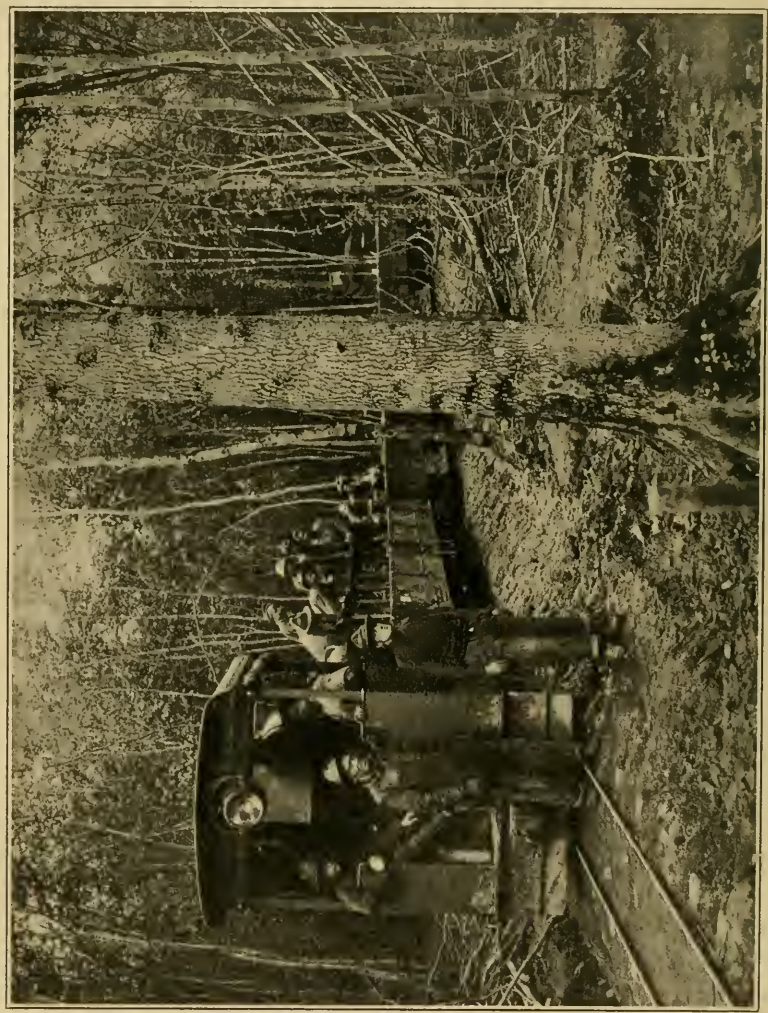
Building construction was suspended June 10, 1918, by orders from general headquarters resumed July 27, and completed August 17. While the total time from the day work was commenced until finished was 109 days, the actual net construction period, omitting the period during which work was suspended, was only 45 days.

The first machinery arrived at the shops in September and was set up as fast as received, although difficulty was encountered, due to the fact that machines arrived without motors or other essential parts. While the plant was built primarily for light railway repairs, a large amount of work was done for the various departments in the vicinity of the shops and for passing combat divisions. The erecting and repair shop, up to December 31, 1918, overhauled 47 steam locomotives, ninety 50-horsepower gas locomotives, and three 35-horsepower gas locomotives.

TRACK MATERIAL.

Track material and equipment had early been ordered on a general requisition. The rail ordered weighed 25 pounds per yard—about 25 per cent heavier than the rail ordinarily used by the British and about 40 per cent heavier than the customary French rail. Experience showed that the heavier rail much more than paid for itself in added volume and speed of traffic. The first rail ordered was in 5-meter lengths, with some shorter lengths and with a certain proportion curved to various radii, and accompanied by steel ties. Bolts and clips were ordered for use in fastening the steel ties instead of riveting the rail to ties in accordance with French practice. Experience showed that the adoption of the bolted, instead of the riveted, ties was sound. Additional orders for rail were made by the department, the greater

part of it being in 30-foot lengths, without curvature. Rail of this weight was readily bent to any desired curvature for use on wood ties. With the rail on wood ties it was also possible to use interchangeable frogs for either right-hand or left-hand turnouts. About 85,000 ties were from Portugal, and the large additional quantity of ties needed were furnished by the forestry section of the division of construction



(719-Y8) LIGHT RAILWAY TRACTOR AND TRAIN AT BEAUMONT MEURTHE-ET-MOSELLE.

and forestry. Steam and gasoline locomotives and cars of various types were secured in the United States.

Throughout the period from May, 1918, to the end of the war, the light railway organization carried on its activities in liaison not only with the chief engineer, American Expeditionary Forces, of whose organization it was a part, but with the fourth section of the general

staff, general headquarters, and with the chief engineers, Armies, and the fourth sections of the Army staffs with whose work its operations were closely connected. In addition to large amounts of construction carried out directly by the division of light railways, special detachments of light railway troops, track-laying gangs, bridge gangs, and operating units were trained at Abainville and supplied to the Armies thoroughly equipped with tools and materials. In the First and Second Army areas operations were under the chief engineers of the Armies. The manager of light railways, however, kept in close touch with the Army organizations and assisted them with trained personnel, equipment, materials, and supplies.

Immediately after the armistice, however, all light railway personnel, and construction and operations in all territories was placed under the direct control of division of light railways and roads. The manager of light railways appointed Col. L. DeB. Lovett (14th Engineers), deputy manager of light railways in the Verdun district (covering all lines west of Vigneulles), and Col. J. A. Laird (12th Engineers), deputy manager of light railways in Toul district (covering all lines east of Vigneulles and north of Sorcy). The Abainville terminals and the Abainville-Sorcy line continued to be operated as a separate division under the superintendence of Capt. Pelletier, of 14th Engineers. This organization worked very smoothly and efficiently: and during the following three months a great volume of business was handled, including German ammunition for demolition, other ammunition for storage, rations, personnel, engineer supplies, salvage, etc.

The average number of light railway troops engaged at different periods and in the different sectors was as follows:

District.	How engaged.[1]	Prior to Aug. 10.	Aug. 11–Sept. 14.	Sept. 15–Nov. 9.	Nov. 10 Jan. 18
Abainville	Construction	635	750	2,650	2,665
	Maintenance	.....	100	100	95
	Operation	.....	475	575	250
	Shop	25	175	425	750
Toul	Construction	1,305	1,545	1,280	1,155
	Maintenance	135	275	630	1,245
	Operation	220	430	840	1,100
Argonne-Meuse	Construction	.....	.....	940	2,045
	Maintenance	.....	.....	1,190	585
	Operation	.....	.....	470	370
Rattentout	Construction	.....	520	990	505
			70	70	215
			160	190	280
Baccarat	Construction	100	150	30	.....
	Maintenance	15	30	20	15
	Operation	35	35	35	35
Total	Construction	2,040	2,965	5,890	6,360
	Maintenance	150	475	2,010	2,155
	Operation	255	1,100	2,110	2,035
	Shop	25	175	425	750
Grand total	.....	2,470	4,715	10,435	11,300

[1] Under construction are included men rehabilitating captured German lines, taking up and storing track, etc.

SUMMARY OF CONSTRUCTION.

American forces not only carried out extensive reconstruction (placing new rail, ballasting, etc.) of large systems of track taken over from the French and captured from the Germans, but completed new construction of 60-centimeter lines, as follows:

	Kilometers.
Meuse-Argonne sector:	
Mount de Villus, German lines	4.3
Barricade (Mount des Allieux), Cheppy Junction	4.1
Esnes Junction-Taylor Junction (Bois de Montfaucon)	7.0
Aubreville-Cheppy Junction	9.0
Total	24.4
Sidings, spurs, etc	1.0
Total	25.4
Rattentout district:	
Near Rupt, near Muilly	5.4
Near Vigneulles	2.0
Sidings, etc	1.1
Total	8.5
Toul sector:	
Sorcy-French line, near cut-off	5.7
Near le Neuf Etang, Bois Chanot	8.0
Harnonville-Nauginsard	3.0
Nauginsard-Broussey	5.5
Bernecourt-Noviant	5.5
Sorcy-Pagny	8.3
Bois Chanot-Charriere	9.0
Flirey-Lincoln Junction (Bois de Mont Marc)	3.5
Pont de Metz-German lines	4.7
Auberge St. Pierre, near Feye en Heye	1.8
Near Toul	4.5
Total	59.5
Sidings, spurs, etc	35.7
Total	95.2
Abainville-Sorcy line:	
Main line	28.5
Sidings and spurs along main line	5.6
Abainville yards	17.8
Sorcy yards	5.2
Total	57.1
Baccarat sector:	
Main lines	11.5
Sidings, spurs, etc	2.8
Total	14.3

Summary.	Main line.	Sidings.	Total.
	Kilometers.	*Kilometers.*	*Kilometers.*
Meuse-Argonne sector	24.4	1.0	25.4
Rattentout district	7.4	1.1	8.5
Toul sector	59.5	35.7	95.2
Abainville-Sorcy	28.5	28.6	57.1
Baccarat sector	11.5	2.8	14.3
Total	131.3	69.2	200.5

OPERATIONS IN ARMY AREAS.

Upon the assignment during February, 1918, of the First and Second Battalions of the 21st Engineers (L. R.), which had arrived in France in January, 1918, to light railway work, they were ordered to the Toul sector and took over the operation, maintenance, and construction of light railways in that sector, with regimental headquarters at Sorcy. The Third and Fourth Battalions of the 21st Engineers (L. R.) arrived in France in September, 1918, and were ordered to Abainville. They were employed on the construction of the storage yard at that point and later were sent to work in the Army areas.

The First Battalion, 22d Engineers (L. R. construction), arrived in France during July, 1918; Second Battalion during August; and the Third, Fourth and Fifth Battalions during September, 1918. These battalions were used on the construction of light railways in the Army areas, and also assisted in the construction of additional storage yards at Abainville.

By Section IV, General Orders, No. 149, General Headquarters, American Expeditionary Forces, 1918, the 12th and 14th Engineers (Ry.) were designated as light railway regiments and assigned to the division of light railways and roads. These two regiments which had rendered valuable service with the Third British Army since August 18, 1917, had been released by the British expeditionary forces. The 14th Engineers (L. R.) were moved from Calais to Chateau-Thierry and took part in the Chateau-Thierry offensive during August, 1918. It was not until September, 1918, that the Second Battalion reached the Verdun sector then occupied by the first American Army. The First Battalion, 14th Engineers (L. R.), continued to operate in the Chateau-Thierry sector until October, 1918, when it was moved to Abainville and utilized at the light railway central shops, and in operation and maintenance of the Abainville-Sorcy line.

Division of light railways, transportation department, tonnage handled by American 60 cm. lines from commencement of American light railway operation to Feb. 1, 1919.

[Source of information: Weekly reports from operating units: tonnage shown is "Originating tonnage" only.]

	Week ending[1]—						
	Mar. 29.	Apr. 5.	Apr. 12.	Apr. 19.	Apr. 26.	May 3.	May 11.[2]
Kilometers operated, main line and sidings	46	46	46	46	46	46	46
Ammunition.....tons..	312	80	352	608	934	765	634
Coal (except L. R.).....do....	.....	6	.....	42	.....	20	101
Engineer material.....do....	172	.....	32	522	890	998	1,643
Forage.....do....	.....	42	.....	36	103	295	70
L. R. ballast.....do....	512	1,648	1,814	1,290	1,150	1,654	1,177
L. R. coal.....do....	6	.....	12	6	.....	.....	.....
Miscellaneous L. R. material, tons	456	216	154	306	610	504	262
Miscellaneous Army tonnage, tons	396	443	1,930	742	1,120	1,718	1,925
Personnel.....tons..	48	36	48	.....	51	16	40
Rations.....do....	6	54	684	984	1,150	1,196	768
Road material.....do....	180	.....	.....	138	189	104	701
Total.....do....	2,092	2,525	5,026	4,674	6,197	7,270	7,321

	Week ending[1]—						
	May 18.	May 25.	June 1.	June 8.	June 15.	June 22.	June 29.
Kilometers operated, main line and sidings	52	52	81	87	90	94	96
Ammunition.....tons..	384	320	616	264	776	912	326
Coal (except L. R.).....do....	16	.....	.....	.....	40	40	.....
Engineer material.....do....	1,598	946	964	1,346	1,210	1,246	683
Forage.....do....	204	240	378	330	498	336	265
L. R. ballast.....do....	1,342	616	671	576	184	240	.....
L. R. coal.....do....	.....	16	.....	16	.....	160	212
Miscellaneous L. R. material, tons	152	102	167	144	640	75	248
Miscellaneous Army tonnage, tons	632	968	1,176	1,570	1,514	1,168	754
Personnel.....do....	12	90	294	90	120	84	2,837
Rations.....do....	504	522	504	570	750	624	615
Road material.....do....	198	1,024	1,477	2,766	3,550	4,312	3,010
Water.....do....	.....	.....	.....	.....	.....	.....	60
Total.....do....	5,042	4,844	6,247	7,672	9,282	9,197	9,010

	Week ending[1]—						
	July 6.	July 13.	July 20.	July 27.	Aug. 3.	Aug. 10.	Aug. 17.
Kilometers operated, main line and sidings	106	110	131	135	139	145	205
Ammunition.....tons..	396	158	326	239	572	357	870
Coal (except L. R.).....do....	.....	106	.....	.....	26	.....	30
Engineer material.....do....	961	1,093	977	856	1,008	1,250	1,135
Forage.....do....	178	185	535	858	891	680	700
L. R. ballast.....do....	660	1,403	1,652	833	1,105	1,755	2,340
L. R. coal.....do....	62	70	.....	9	.....	56	30
Miscellaneous L. R. material, tons	570	225	1,547	1,042	458	1,987	1,304
Miscellaneous Army tonnage, tons	495	1,104	1,206	1,607	1,519	1,124	1,197
Personnel.....tons..	818	397	412	1,419	1,726	3,102	1,149
Wounded personnel.....do....	.....	13	13	.....	7	.....	.....
Rations.....do....	759	726	687	937	1,030	1,190	1,060
Road material.....do....	3,520	3,529	4,708	3,393	2,684	2,040	3,300
Water.....do....	70	70	92	76	70	63	36
Total.....do....	8,489	9,079	12,155	11,269	11,096	13,604	13,151

[1] 9-day period for Rattentout sector.

[2] 8-day period.

Division of light railways, transportation department, etc.—Continued.

	Week ending[1]—						
	Aug. 24.	Aug. 31.	Sept. 7.	Sept. 14.	Sept. 21.	Sept. 28.	Oct. 5.
Kilometers operated, main line and sidings	303	303	370	370	370	520	520
Ammunition.....tons..	190	5,870	8,210	10,580	6,880	4,130	3,169
Coal (except L. R.).....do....	10	20	350	320	166	180	500
Engineer material.....do....	608	1,237	2,419	1,730	1,613	1,281	1,488
Forage.....do....	530	635	940	505	120	445	785
L. R. ballast.....d9....	2,593	2,717	7,954	11,036	11,620	11,711	7,246
L. R. coal.....do....	285	255	638	650	730	850	960
Miscellaneous L. R. material, tons	1,406	2,111	3,058	2,442	2,596	2,031	896
Miscellaneous Army tonnage, tons	1,088	1,243	2,276	3,152	1,557	2,450	2,575
Personnel.....tons..	1,419	549	1,884	1,902	1,620	2,014	2,408
Rations.....do....	1,370	1,990	1,604	1,064	452	880	1,965
Road material.....do....	2,160	3,060	5,010	3,690	2,380	2,280	2,657
Water.....do....	81	198	599	617	674	844	784
Total.....do....	11,740	19,885	34,942	37,688	30,408	29,096	25,433

	Week ending[1]—						
	Oct. 12.	Oct. 19.	Oct. 26.	(2)	Nov. 2.	Nov. 9.	Nov. 16.
Kilometers operated, main line and sidings	520	685	703	703	721	721	743
Ammunition.....tons..	1,630	3,550	5,752	838	5,585	7,830	7,130
Coal (except L. R.).....do....	400	40	440	126	570	290	640
Engineer material.....do....	1,311	1,987	4,346	961	3,359	4,754	1,310
Forage.....do....	180	994	1,778	.....	2,415	2,710	1,490
L. R. ballast.....do....	6,584	9,515	14,368	1,558	8,208	6,056	4,339
L. R. coal.....do....	774	444	839	113	1,018	662	560
Miscellaneous L R. material, tons	934	2,256	3,842	529	5,403	3,850	1,350
Miscellaneous Army tonnage, tons	2,280	1,674	2,625	374	4,955	2,027	1,155
Personnel.....tons..	3,130	2,250	1,606	240	1,700	1,929	1,471
Wounded personnel.....do....	.....	.....	28	8	.....	.....	.....
Rations.....do....	2,385	5,212	5,212	678	6,416	8,451	6,348
Road material.....do....	3,784	3,400	7,934	1,681	3,760	5,170	680
Water.....do....	712	1,144	1,115	143	1,768	1,449	880
Total.....do....	24,104	32,466	49,885	7,249	45,157	45,178	27,353

	Week ending[1]—						
	Nov. 23	Nov. 30.	Dec. 7.	Dec. 14.	Dec. 21.	Dec. 28.	Jan. 4.
Kilometers operated, main line and sidings	870	790	779	847	832	832	832
Ammunition.....tons..	8,570	7,415	7,615	7,320	7,780	5,707	4,670
Coal (except L. R.).....do....	340	134	964	140	.....	170	152
Engineer material.....do....	1,115	1,133	2,278	3,020	3,692	4,809	5,548
Forage.....do....	740	335	40	25	50	35	80
L. R. ballast.....do....	5,800	7,640	3,480	3,068	2,610	1,649	2,356
L. R. coal.....do....	720	505	996	1,250	456	400	168
Miscellaneous L. R. material, tons	1,260	2,081	1,441	2,172	2,352	2,584	1,934
Miscellaneous Army tonnage, tons	1,845	2,430	2,101	1,901	2,763	2,093	2,424
Personnel.....tons..	1,467	1,698	1,710	1,428	1,197	1,157	968
Rations.....do....	4,154	3,410	2,900	1,397	893	900	1,634
Road material.....do....	2,500	750	760	832	604	296	790
Water.....do....	486	288	306	488	212	230	198
Total.....do....	28,997	27,829	24,591	23,041	22,609	20,030	20,922

[1] 9-day period for Rattentout sector.
[2] Additional 2-day period in Toul sector caused by change of time for closing weekly records.

Division of light railways, transportation department, etc.—Continued.

		Week ending [1]—				
		Jan. 11.	Jan. 18.	Jan. 25.	Feb 1.	Total.
Kilometers operated, main line and sidings		936	936	936	936	.....
Ammunition	tons	12,640	9,570	6,500	6,870	166,202
Coal (except L. R.)	do	.....	.....	.....	.....	6,379
Engineer material	do	7,255	3,085	3,680	3,002	86,555
Forage	do	20	24	.....	.....	21,700
L. R. ballast	do	2,780	1,160	1,490	200	160,360
L. R. coal	do	700	631	916	1,130	17,305
Miscellaneous L. R. material	do	4,149	2,685	3,644	8,271	76,456
Miscellaneous Army tonnage	do	3,033	3,363	3,823	1,631	81,146
Personnel	do	1,920	1,625	1,300	1,320	52,701
Wounded personnel	do	.....	.....	.....	.....	69
Rations	do	1,268	982	612	404	77,901
Road material	do	190	150	1,380	2,136	98,857
Water	do	290	328	372	278	15,021
Total	do	34,245	23,603	23,717	25,242	860,652

[1] 9-day period for Rattentout sector.

The 12th Engineers (L. R.) upon being relieved from duty with the British took over the construction, maintenance, and operation of light railways in the Baccarat sector in August 1918. On August 31, 1918, this regiment, with the exception of a detachment of 1 officer and 50 soldiers, who remained in the Baccarat sector, were moved to the Toul sector, where they undertook the operation of light railways under the first American Army. After the formation of the second American Army, they operated the light railway lines in the area occupied by that Army until relieved from duty in the middle of February, 1919. During the St. Mihiel and Meuse-Argonne offensive many additional troops were required for light railway work, these troops including several service battalions and pioneer Infantry regiments.

The following 60-centimeter equipment was captured from the Germans during the operations at St. Mihiel and the Meuse-Argonne: Thirty-three steam locomotives, 50 gasoline locomotives, 358 gondola and flat cars, 10 tank cars, 15 box cars, 2 speeders, and several hospital cars.

TONNAGE HAULED.

Up to February 1, 1919, American-operated light railways hauled 860,600 tons of ammunition, forage, rations, water, construction materials, and personnel, representing a ton-mileage of 8,106,700, including the empty haulage. The tonnage alone represents more than 280,000 loads for a 3-ton motor truck.

The largest number of American light railway troops engaged at one time, 13,650, was between September 15 and November 9, 1918. The net tonnage handled by light railways operated by American forces amounted to more than 8,100 tons per day in October, 1918.

To handle this tonnage there were available in the various operating districts 104 steam locomotives, 61 gas locomotives, and 1,695 cars, 20 feet long. The personnel engaged on this work numbered 55 officers and 2,585 men, operating 703 kilometers of main line and sidings. During one week in September, 10,600 tons of ammunition were handled. In one week of November, 10,700 tons of rations were transported. During various weeks it was not unusual for light railways to carry more than 3,100 tons of personnel and 1,800 tons of water.

A number of heavy troop movements were carried out by light railways. For example, during the relief of the 82d Division by the

(21–S8) TYPES OF STEAM AND GASOLINE LIGHT RAILWAY TRACTORS AT TEMPORARY YARDS BETWEEN BACCARAT AND AZORAILLES. AUGUST 15, 1918.

89th Division on the nights of August 4 to 9, inclusive, 23,155 men were shipped; in this relief 6,175 men were moved by light railway on the night of August 8 alone. Light railways were called upon for much long-haul traffic on account of delays on standard gauge lines.

For a period of two days, November 5 and 6, Company F of the 14th Engineers (L. R.), stationed at Rattentout, with some assistance from Company E, 14th Engineers, completely rationed the 33d, 35th, and 81st Divisions, or approximately 75,000 men. With 14 steam engines and 2 tractors, they handled in one day 120 cars or 600 tons of rations in addition to part of their ordinary traffic, which averaged

at that time 700 tons per day. The average haul on these ration trains was 18 kilometers, some of them going as far as Hattenchatel, others to Belrupt. Ninety per cent of this business was handled by "F" Company; about 10 per cent of the cars being handled to final destination by "E" Company at Mooseneck. The light railway thus relieved the roads of approximately 250 round trips of 36 kilometers by motor truck, or 9,000 truck-kilometers of traffic.

American light railways, contrary to the British and French practice, lengthened the usual haul of freight in certain cases far beyond anything previously considered practicable. The average haul for the entire American light railway operations was 15.3 kilometers, which was probably 30 per cent greater than either the British or the French. In the Toul sector there were regular movements from railhead to battery or company of 48 kilometers for ammunition, 55 kilometers for rations and water, and 43 kilometers for personnel.

Deliveries from the light railway central shops at Abainville during the Meuse-Argonne offensive developed the most extraordinary of all light railway movements on American lines, the longest on record being from Abainville to Grand Pre, a distance of 175 kilometers. This was executed several times. In one day during the Meuse-Argonne offensive nine trains of material were sent from Abainville to Dombasle, a distance of 140 kilometers.

On November 10, 1918, the light railway organization for the American Armies was operating 623 kilometers of main-line track with a personnel on operation of 57 officers and 3,557 men behind a front of 92 kilometers, equivalent to 5.8 men and officers per kilometer of main line track operated. After the armistice the light railways proved useful not only for supply but also for salvage.

REFERENCE DATA, LIGHT RAILWAYS.

	Appendix number or file reference.
Report, director of light railways	Appendix No. 16
Monthly reports and histories:	
12th Engineers	Appendix No. R–12
14th Engineers	Appendix No. R–14
21st Engineers	Appendix No. R–21
22d Engineers	Appendix No. R–22
Report, chief engineer, First Army	Appendix No. A–1
Report, chief engineer, Second Army	Appendix No. A–2

Road and Quarry Services, under Division Light Railways and Roads.

The original plans for road work in France contemplated a general roads and quarry service, under the director general of trans-

portation, charged with the construction, repair, and maintenance of all roads used by the American Expeditionary Forces, and with the supply of metal to roads and of railway ballast to American-operated railways. Up to the transfer of this service to the service of utilities in March, 1918, but little had been accomplished, due mainly to lack of men and material. Not only was this unification of the highway and quarry activities not carried out, but practically all the road work was executed by organizations not reporting directly to the chief of the road and quarry service, such as the division of construction and forestry and the armies.

The original project for personnel, as stated in a letter of July 10, 1917, from the chief engineer, American Expeditionary Forces, to the Chief of Engineers, Washington, D. C., was based on a combatant army of 500,000 men, plus auxiliary and line of communication troops. This plan called for 3,000 skilled road workers, 6,000 laborers, and 1,500 wagoners for the road service. For the quarry service the plan contemplated 1,500 skilled quarrymen and stone handlers and 3,000 laborers. The total requested, therefore, equaled 3 per cent of the assumed combatant forces.

Prior to November 11, 1918, there had actually arrived in France the following organizations:

ROADS.

23d Engineers, consisting of 4 battalions engineers, of 3 companies each; 10 truck companies, of 31 trucks each; 5 wagon companies, of 61 wagons each.
532d Engineers, service battalion of 4 companies.
533d Engineers, service battalion of 4 companies.
539th Engineers, service battalion of 4 companies.
541st Engineers, service battalion of 4 companies.
542d Engineers, service battalion of 4 companies.
545th Engineers, service battalion of 4 companies.

QUARRIES.

28th Engineers, consisting of 2 battalions of 3 companies each.
524th Engineers, service battalion.
535th Engineers, service battalion.
543d Engineers, service battalion.

To carry on the vast amount of road work required in the Army areas the services of many other organizations, not specially designed for road work, had to be obtained. During the early part of November, 1918, for example, when the First and Second Armies were in action in the Meuse-Argonne offensive the number of men employed

on road work, with the organizations which in whole or in part contributed, were as follows:

FIRST ARMY AREA.		SECOND ARMY AREA.	
23d Engineers	2,977	23d Engineers	1,008
28th Engineers	477	28th Engineers	456
527th Engineers	850	505th Engineers	675
537th Engineers	803	508th Engineers	201
544th Engineers	800	524th Engineers	695
545th Engineers	725	530th Engineers	401
546th Engineers	576	59th Pioneer Infantry	348
603d Engineers	240	803d Pioneer Infantry	147
54th Pioneer Infantry	2,955	804th Pioneer Infantry	2,062
805th Pioneer Infantry	2,508	806th Pioneer Infantry	1,373
807th Pioneer Infantry	480	813th Pioneer Infantry	2,384
815th Pioneer Infantry	2,955	Prisoners of war, etc	830
Total men	16,346	Total men	10,580

In the advance section, Service of Supply, there were employed at the same time 1,334 road troops. The total employed on road work on and near the front in November, therefore, amounted to 28,260 men, equal to about 4 per cent of the combatant troops then engaged along that front.

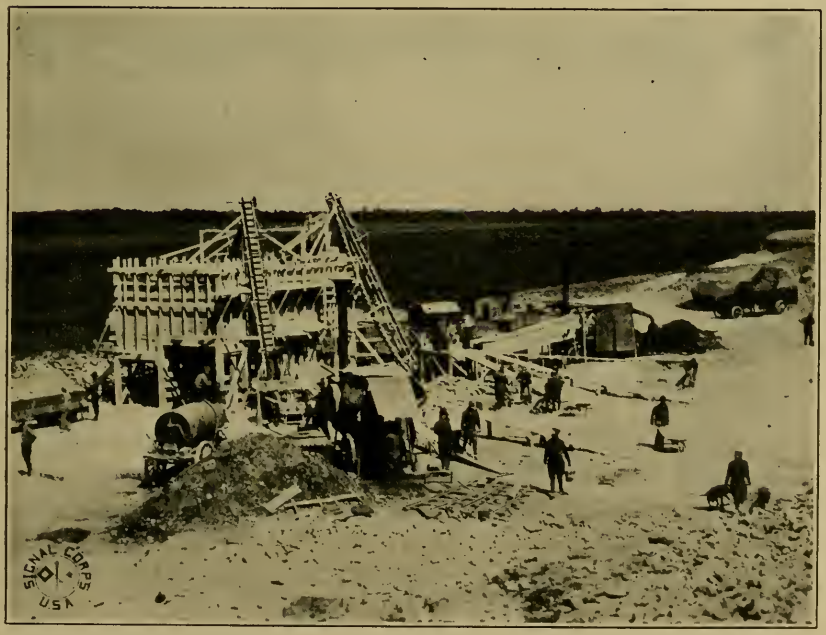
Work in Army areas.—The general type of work accomplished in Army areas may be briefly summarized as follows:

During September the First Army area came into existence and, in connection with the St. Mihiel offensive, new road construction included the Sorcy railhead road, Cumejie dumps, Sorcy warehouse-canal road, Griscourt road, Griscourt Bridge, cutoff northeast of Griscourt, Griscourt-Villers en Heye road, Belleville railhead, Andilly ammunition dumps, Ferme Boyer dump, Toul-Void road, and Gudeneau dump. Resurfacing work was carried on over various projects, as well as widening. Maintenance work was also very extensive. Road troops were largely occupied in maintaining and repairing existing roads and building temporary roads in the former no man's land and in the captured territory.

During October the area occupied by the First Army was to the west of Verdun, and new road construction included the Froides Hospital road, Varennes railhead roads, Souilly Evacuation Hospital roads, Neuilly Ammunition Park, Dombasle ammunition dump, Mobile Hospital No. 1, Fromerville road, Auzeville railhead, Glermont railhead, Aubreville railhead, and Neuvilly Artillery Park. The Neuvilly-Varennes road was widened. One hundred and seven kilometers of roads were maintained during the month in the area.

In the area occupied by the Second Army during the month new road work was carried on at Trondes ammunition dump, Ferme Boyer railhead, Marbache ammunition dump, Belleville Motor Park, Bois de la Cote ammunition dump, Etang Neuf ammunition dump, Bernecourt railhead, Nerouves-Pagney road, Villey-St. Etienne

(723–U8) ROAD REPAIR WORK AT GERARD SAS BY 23D ENGINEERS. JUNE 6, 1918.



(1958–J8) ROCK CRUSHERS, ELEVATING CONVEYORS, AND STORAGE BIN AT QUARRY NEAR ABAINVILLE. OPERATED BY 21ST ENGINEERS.

dump. Resurfacing amounted to 30,800 square meters; widening 20,500 square meters; 59 kilometers of roads were maintained during the month.

During November, in the First Army area, new construction included the Varennes railhead, Beeman dump, Souilly railhead; widening of roads amounted to 37,198 square meters, and maintenance and patching work was carried on over 438 kilometers of roads.

In the Second Army area new construction included the Etang Neuf dump road, Bernecourt railhead, Villey-St. Etienne dump, salvage dump railhead at Toul, Trondes hand-grenade road, Bois de la Cote en Heye road, Mobile Hospital No. 35 road, road to Mobile Hospital No. 39, meter gauge railhead at Toul, and Woinville railhead. Resurfacing work amounted to 16,228 square meters, widening 8,534 square meters, and estimated total maintenance 96 kilometers.

December operations, covering the period December 1 to December 15, in the former First Army area included the widening of various roads and maintenance work on 255 kilometers of roads.

In the Second Army area new road construction was continued at meter gauge railhead, Toul, and on the Woinville-Vigneulles road.

In the table following the work actually accomplished during November, 1918, by road troops in the two Army areas and in the advance section, S. O. S., is briefly summarized. It should be noted that those given for the First Army represent work which was entirely completed. In the case of the Second Army and of the advance section, S. O. S., the construction, resurfacing, and widening were in all stages of completion at the end of November.

Road work during November, 1918.

Item.	First Army.	Second Army.	Advance section.	Total.
New construction.....square meters..	4,825	35,942	1,650	42,417
Resurfacing.....do.....	.....	24,242	87,199	111,441
Widening.....do.....	37,198	48,202	4,000	89,400
Maintenance.....kilometers..	438.3	96.6	[1]15,832	.....
Stone and gravel.....cubic meters..	21,323	16,297	14,759	52,379

[1]Square meters.

Operation of quarries.—The first and largest quarry to be operated by the division of light railways and roads was located at Rupt-sur-Marne (Haute-Marne). It was opened on April 15, 1918, two crushers being installed. Shipments were commenced September 9, 1918, the capacity of the plant being 300 tons of rock per day of 10 hours. More than 10,000 cubic yards of crushed stone were delivered prior to December 17, 1918. A second but less important quarry was operated at Les Rapailles, near Neufchateau (Vosges).

The total stone quarried for road purposes from the numerous quarries opened in advance section and Army areas is as follows, by months:

Total output blocks and macadam.

	Cubic meters.
February and March, 1918	5,251
April, 1918	8,707
May, 1918	13,000
June, 1918	14,210
July, 1918	17,075
August, 1918	20,547
September, 1918	29,660
October, 1918	33,150
November, 1918	48,640
Dec. 1–13, 1918	3,524
Total	193,764

Road work other than that done by the Armies was all done under the supervision of the division of construction and forestry, and prior to the armistice was limited virtually to that necessary in connection with its numerous large construction projects, men, material, and equipment being generally lacking for more extensive work of road construction and maintenance. The necessary stone was quarried either by the labor of United States troops or was purchased from near-by privately owned quarries.

The result of this enforced limitation of road activity was the progressive deterioation of many roads used by the American Expeditionary Forces, and as a result it became necessary to enter upon a more extensive program of road maintenance and reconstruction, as described under the section of this report dealing with the operations of the division of construction and forestry.

REFERENCE DATA, ROADS AND QUARRIES.

	Appendix number or file reference.
Report, director of light railways and roads (roads section)	Appendix No. 17
History 23d Engineers	Appendix No. R–23
Chief engineer, First Army, report	Appendix No. A–1
Chief engineer, Second Army, report	Appendix No. A–2
Chief engineer, Third Army, report	Appendix No. A–3

Engineer Research.

Upon the cessation of hostilities an engineer research party was organized to study the engineering features of allied and enemy activities on the western front. The defense lines had not then been disturbed or abandoned, the personnel was available at headquarters, Second Army, at Toul, with the addition of selected officers for special studies, and it became only a question of securing transporta-

tion and supplies to preserve for future reference and study data relating to the western front at the close of operations.

Battle maps were secured covering the entire front, aerial photographs obtained to show the defenses and effects of artillery registration as plotted from the battle maps, and a force of photographers took pictures of the positions. Shelters, trenches, gun emplacements, with their relative advantages of siting and location were studied; samples of clothing, equipment, and engineer appliances were gathered and exhibits of value for engineer research were collected for shipment to the Chief of Engineers in Washington.

The research party was in charge of Col. J. G. B. Lampert, then assistant to chief engineer, Second Army, and consisted of 10 officers, selected for their knowledge and ability to report on military engineering, shelters, organization of the ground, roads, bridges, and light railways. Headquarters of the party was at Toul, where the data were compiled in the office of the chief engineer, Second Army.

The report of the engineer research party was submitted April 15, 1919, and covered the following subjects: Organzation of the ground; military bridges; dugouts and concrete shelters; German tank mines; mine warfare; standard-gauge railroads; roads. It is believed that the report forms a record of the important military engineering features of the western front and will be valuable in the study of the war.

REFERENCE DATA, ENGINEER RESEARCH.

Reports on—	Appendix number or file reference.
Engineer research	Appendix No. 18–24
Organization of ground	Appendix No. 18
Military bridges	Appendix No. 19
Dugouts and cement shelters	Appendix No. 20
German tank mines	Appendix No. 21
Mine warfare	Appendix No. 22
Standard gauge railroads	Appendix No. 23
Roads	Appendix No. 24

BOARD OF MILITARY ENGINEERING.

The board on military engineering at general headquarters was organized pursuant to Special Orders, No. 75, paragraph 61, General Headquarters, March 16, 1918. It was to consist of five members, three of whom were to be officers designated by the chief engineer, American Expeditionary Forces; one to be a member of the general staff (G–5); and one to be ex officio, the commandant, Army Engineer School.

As constituted, the board consisted of the following officers, of whom Col. Youngberg, Lieut. Col. Wilby, and Maj. Lampert were designated by the chief engineer, American Expeditionary Forces, while Col. Bond was commandant, Army Engineer School; Col.

G. A. Youngberg, Engineers, United States Army; Col. P. S. Bond, Engineers, United States Army; Lieut. Col. F. B. Wilby, Engineers, United States Army; Lieut. Col. L. H. Watkins, Engineers, General Staff; Maj. J. G. B. Lampert, Engineers, United States Army.

In the order constituting the board its duties were specified as being "to consider and report upon such matters concerning the organization, equipment, and training of engineer troops and such other matters of a technical military engineering nature as may be referred to it by general headquarters or directly by the chief engineer."

Numerous projects were brought before the board in the course of its meetings, covering questions of organization and equipment, reorganization of the engineer regiment and train, issue of automatic rifles to sapper regiments, ammunition wagons for engineer regiments, transportation for water-supply troops, transportation for service battalions, caterpillar tractors for pontoon trains, motor transportation for engineer troops, and other subjects of a military engineering nature. These projects were carefully considered by the board and recommendations were submitted in every case.

The board was further asked to pass upon and test technical appliances for field engineering, designs of all types of bridges, the relative merits of concrete and armored emplacements for automatic weapons, the value of tunneling and excavating machines. It recommended the adoption of articles of special equipment to fill conditions developing in field operations and to meet all phases of field engineering. The work of the board proved of much value.

The principal form of publication of the board on military engineering was known as "Engineer Field Notes," designed to bring up to date and keep continuously fresh the information on field practice in military engineering, the idea being to present clear and concise information leading to standardization of both design and material. This standardization would permit supplying the engineer dumps with material for prompt and uniform delivery, and also enable all officers to understand the type of field fortifications and bridges they would be called upon to construct. As methods and conditions changed new notes were issued to cover the latest and best information on each subject.

Much of the data for the "Engineer Field Notes" was gathered and compiled in the field works section by Maj. F. W. Herman and Capt. J. D. Irving, and later Maj. D. L. Weart and Capt. R. E. Tremoureux, who supervised its publication and issue to Engineer schools and organizations under the supervision of the Engineer intelligence division. This involved a study of allied and enemy structures and methods from publications, from operation notes

issued from French and British general headquarters, and from inspection and observation tours of the front.

Each of the notes was edited by Lieut. Col. F. B. Wilby, officer in charge, Engineer intelligence division, and if it pertained to some special engineer service, it was submitted to that department for criticism and correction. Advance copies, with blue prints of all drawings, were forwarded to each member of the board for study prior to a meeting of the board, at which time the paper would either be approved or returned with such recommendations as were deemed advisable. These corrections and suggestions were incorporated into the paper before it was finally approved, and it was then forwarded to the chief engineer for his action.

Notes which concerned engineer operations in mobile warfare, or engineer organizations, were submitted to the commander in chief for approval after action by the chief engineer. This was done by order of the general staff to coordinate more closely the work of the Engineer Department with operations, with new field conditions and with the policy of general headquarters.

The series of Engineer Field Notes published prior to the close of hostilities was as follows:

1. Instructions for Preparation of Engineer Drawings.
2. Trench Profiles.
3. Standard "A" Frames.
4. Pile and Trestle Bents.
5. Maintenance of Highway Bridges.
6. Road Spaces and War Strength of Units.
7. Approaches and Abutments of Military Bridges.
8. Simple Stringer Bridges.
9. Cement.
10. Piers.
11. Reinforced Wooden Beams.
12. Trench Drainage.
13. The Organization of the Ground for the Defense.
14. Military Roads in Forward Areas.
15. Standard Entrances for Cave Shelters.
16. Sectional Wooden Shelter.
17. Equipment of Engineer Train.
18. Metric Units and Equivalents.
19. Trench Traces.
20. Overhead Cover for Dugouts.
21. Engineer Equipment of a Sapper Regiment.
23. Camouflage.
24. Trench Construction.
25. Divisional Engineers in Mobile Warfare.
26. Defense of Approach Trenches.
27. Underground Water and its Relation to Field Works.
28. Revetment.
29. Locations by Map Coordinates.
30. Standard Materials for Cave Shelter Construction.

31. Principles of Shelter Construction.
32. Trench Accessories.
33. Emplacement for Automatic Weapons.
34. Gas Protection for Dugouts.
35. Wire Entanglement Drills.
37. Principles of Light Railway Construction.
38. Obstacles Against Tanks.
39. Load Tables of Front Line Engineer Material.
42. The Octagonal Trace of Trenches.
44. Duties and Relations of Engineers.
45. Portable Artillery Bridges.
46. Canvas Type Portable Foot Bridge.
47. Bills of Material for Shelter Construction.
48. Weights and Dimensions of Railroad Artillery, Tanks, Field Artillery, Escort Wagon, and Motor Trucks.
52. Bill of Material for Standard Trestle Bridges.

REFERENCE DATA, BOARD OF MILITARY ENGINEERING.

	Appendix number or file reference.
Report, assistant chief engineer, general headquarters	Appendix No. 7
Engineer field notes	Appendix No. 25

Geologic Investigations.

Geologic investigations were carried out in the course of American Expeditionary Forces' operations by several different agencies, all pertaining to the Corps of Engineers.

Early in 1917 American officers examining the work done by the British on the western front had strongly urged the value of special geologic investigations by the American Expeditionary Forces to facilitate the development of mining methods and of water supplies.

In accordance with these recommendations, a geologic section, under the chief engineer, American Expeditionary Forces, was ultimately organized. In the course of its work, which late in 1918 was carried out by six geologic officers, this section prepared geologic maps of the American front, designed for general use, for water-supply service and for special tank service. These maps were prepared from study of published French data and from original field work, and were reproduced by a plant handled by a detachment in the 29th Engineers. It is believed that their use gave results of immediate practical importance, as connected with the siting of field defenses, the areas within which underground water supplies could be reasonably expected, and the territory which would be either easy or difficult for tank operations at various seasons of the year.

But even earlier in date than the inauguration of the special geologic section, an engineer officer not connected with the section had been ordered to examine and report on the many hospital, depot, and camp sites suggested along the line of communication, with

special reference to the immediate development of underground water supplies. This work was carried out promptly and successfully, as is particularly evidenced by the group of deep wells at Bassens and Beau Desert, in the Bordeaux region. These wells averaged a flow of over 500 gallons per minute, and in each case the water-bearing horizon was encountered by the drill within a few feet of the depth at which the reporting engineer officer had placed its probable location.

Further investigations, geological in their scope, were carried out by different engineer officers, including reports on the sand and gravel deposits of various parts of France and on the available road-metal supplies of various areas.

The net result of the geologic work accomplished for the American Expeditionary Forces was satisfactory, aiding materially in the effectiveness of engineer operations and suggesting the advisability of a special development of this line of work in future campaigns. In considering such future development, it should be borne in mind that the geologic work carried out in France took two quite widely different directions. The work carried on by the geologic section, general headquarters, took largely the form of compiling and presenting information on which staff action could be planned, and as such it was closely allied to the intelligence section of the General Staff. On the other hand, the work earlier carried out in service of supply areas was devoted to actual and immediate development of underground water and other mineral resources, and therefore related to engineer and economic questions. These two different types of activity are likely to be repeated in any future campaign, and the fact that such divergence exists must be borne in mind in planning the scope and organization of future Army geologic work.

The general subject having been outlined, it will now be possible to discuss each of the activities separately.

THE GEOLOGIC SECTION, GENERAL HEADQUARTERS.

The question of taking up geologic work in the American Expeditionary Forces was first discussed in reports by Gen. S. A. Cheney and Col. Ernest Graves, who had, early in 1917, studied the various engineering operations carried out by the British on the western front. In the course of these studies it developed that geologic supervision was systematically exercised over two entirely distinct lines of activity—military mining and underground water supply. The results attained by the British under this system were so satisfactory that in their final reports both of these officers recommended that a similar system of geologic control be adopted for the American Expeditionary Forces organization.

Geologic section, American Expeditionary Forces.—As a result of these recommendations, Maj. A. H. Brooks was given the task of organizing geologic work in the American Expeditionary Forces, and selected Capt. E. C. Eckel as his assistant. These two officers reported to the chief engineer, American Expeditionary Forces, at general headquarters, early in September, 1917, but no definite plans for immediate geologic work were then existant. As a result, both officers were assigned to the division of front-line engineering. Capt. Eckel was thereafter employed on purely engineer work, and did not become a member of the geologic section when that was finally constituted.

Maj. Brooks continued on preparatory geologic work at general headquarters, and in November, 1917, Capt. (now Maj.) M. F. La Croix was assigned to his office. In April, 1918, authority was obtained for the temporary employment of an additional officer (Lieut. T. M. Smithers). This personnel was carried until August, 1918, when the force was increased to six geologic officers at general headquarters. Meanwhile, in July, 1918, a definite plan had been adopted placing technical supervision of all the geologic work carried on by the American Expeditionary Forces in charge of Maj. Brooks, as chief geologist, American Expeditionary Forces. Up to that time the most important geologic work carried on—the handling of underground water supplies in service of supply areas—had been entirely distinct from the general headquarters activities.

Work of the geologic section.—Col. Brooks has summarized the work of the geologic section under his control as follows:

The work of the section was chiefly devoted to the collection and preservation of geologic and other data relating to (1) field works, (2) water supply, (3) road metal. Of these the first two received the most attention.

The results accomplished relating to field fortification included the description of the French defenses of the Vosges and Lorraine sectors. Also the preparation of eight geologic engineering maps covering an area aggregating 7,830 square kilometers. Eleven reports were prepared dealing with field fortifications.

The water-supply work included 18 general reports and maps, showing the water supply of a total area of 14,939 square kilometers. Also 14 detailed reports describing the underground water resources of special localities. Eight maps were issued showing distribution of road metal over an area aggregating 6,473 square kilometers. A number of miscellaneous reports dealing with mineral resources, etc., were also prepared. The geologic section prepared in all some 48 reports and 31 maps.

The reports and maps issued, in printed or manuscript form, by the geologic section, general headquarters, all of which were sub-

mitted at general headquarters, are in the files of the General Staff at general headquarters, as well as in those of the chief engineer, American Expeditionary Forces.

EARLY GEOLOGIC INVESTIGATIONS, SERVICE OF SUPPLY.

In following out the history of the work of the geologic section, general headquarters, which was the chief agency for geologic investigations, it has been necessary to postpone discussion of certain important pieces of work undertaken earlier and under entirely different auspices. These will now be briefly discussed.

It has been noted that one of the officers originally intended for the geologic section never joined it, but was assigned to other departments. From September 15, 1917, to February 28, 1918, Capt. E. C. Eckel was engaged almost continuously on various phases of mining and engineering geology, but in all these cases reported, not through the geological section, but directly to other authorities. During this period he prepared a number of reports, covering a wide variety of subjects, but, with the exception of a few early ones relative to mining-school work, along two main lines. One of them, by far the more important, was the question of underground water supplies. The second, which was related in origin, was in connection with sand and gravel supplies both for filter and for concrete use.

Early in 1918 most of the water supplies planned for hospitals, depots, etc., had been provided for, and Capt. Eckel was released for service elsewhere. When the geologic section, general headquarters, was finally put in working order, the supervising authority of the chief geologist, American Expeditionary Forces, was extended over Service of Supply areas, and all later work on underground water supplies in those areas is covered by his reports. Five of these reports were filed with the acting chief engineer at general headquarters. Most of the remaining 17 are in the files of the water-supply section, Service of Supply.

Underground water development, Service of Supply.—The most important underground water-supply work in the Service of Supply was that relating to the Bordeaux region. Here there were to be at various points large camps, hospitals, and depots. The city supply was barely sufficient to cover the needs of the civil population and could not readily be increased, so that all the American requirements had to be taken care of separately.

The solution was, in general, that of deep wells. In the report of November 20, 1917, it was pointed out that (*a*) for Bassens large flowing wells should be struck at depth of 200 to 300 meters; that (*b*) for Beau Desert ample supplies should be obtained from a shallower water horizon at 35 to 50 meters, but that the deeper Bassens water horizon

could also be struck here at greater depth; and that (*c*) for Souge the same relatively shallow horizon predicted for Beau Desert should also be found water bearing.

Work along these lines commenced immediately by a well-drilling section, under command of Lieut. Whitman. The first well at Bas-

(326–S8) ONE OF THE ARTESIAN WELLS IN THE BORDEAUX DISTRICT AS RESULT OF GEOLOGIC INVESTIGATIONS.

sens was started December 13, 1917, and finished January 10, 1918. At 703 feet depth it struck an artesian flow, rising to 40 feet above the mouth of the well and flowing 550 gallons per minute. A second Bassens well, drilled later, gave 578 gallons per minute at 681 feet. The Beau Desert hospital requirements were filled next. One well

sunk to develop the deep-level horizon struck water at about 1,500 feet and yielded 500 gallons per minute. A group of four wells drilled down to the shallow-water horizon struck water at depths ranging from 85 to 130 feet and ranged in yield from 150 to 250 gallons per minute. Finally a well drilled at Souge to develop the same horizon struck it at 200 feet, yielding 100 gallons per minute.

The aggregate yield of this series of wells in the Bordeaux region is close to 4,000,000 gallons per day. All of the waters were, on test, found to be pure. The entire result checked very closely with the predicted results and furnished perhaps the best example of the immediately practical results of geologic investigations.

For the hospital at Bazoilles similar studies had been made and the water supply necessary was finally obtained from wells drilled down to the relatively shallow water horizon that had been selected. At various other points in France similar work but of less elaborate character was done.

Of course, there were a great many areas where no attempt was made to secure an underground water supply, because the preliminary studies indicated that in these areas underground water could not be counted on.

Sand and gravel supplies.—A second line of investigation related to the sand and gravel supplies of France. The necessity for this was twofold. There was, first of all, a steady demand for a relatively small quantity of carefully graded sand and gravel suitable for rapid-sand filters. Second, there was the necessity at many points for securing good sands and gravels for concrete.

Study of a number of possible sand-producing localities led to the selection of the river sand deposits in the Cher, at Vierzon Forge, as being best adapted for filter sand. The large deposits in the Moselle near Nancy were pointetd out as being good sources of concrete sand and gravel supply for front-line work. These various investigations relative to sand and gravel are covered in several of the reports noted above. In addition to field work on the deposits it was incidentally necessary to plan and prepare screens so that the proper sizes for the filters could be readily produced.

REFERENCES.

For the purposes of further detailed study the various printed and manuscript reports, maps, and other publications relating to geologic work by American Expeditionary Forces engineers are listed below. They are divided into two groups, according as the reports were made by the geologic section, general headquarters, or by other investigators.

Reports and maps issued, geologic section, general headquarters.—The following reports, maps, etc., were issued either in printed or

manuscript form by the geologic section, general headquarters. Copies of these reports are in the files of the general staff, as well as of the chief engineer, American Expeditionary Forces:

Mining Troops of the British Expeditionary Forces.
Notes on British Mining Practice.
Notes on British Mining Schools.
Notes on Engineering Reconnaissance on French Front from Belfort to St. Mihiel.
Geology and Topography as Affecting Military Engineering, Nomeny-St. Mihiel Sector.
Mine Rescue Apparatus.
Notes on Cover for Shelters.
Underground Water and Its Relations to Field Works (Engineer Field Notes No. 27).
Notes on Shelters for Infantry.
Geology and Topography as Affecting Military Engineering of German Position, St. Mihiel-Pont-a-Musson Sector.
The German Defenses of the Lorraine Front.

Geologic engineering maps.

Name of map.	Scale.	Area (square kilometers).
Montsec	1-50,000	890
Cheminot	1-50,000	890
Schirmeck[1]	1-50,000	1,010
Luneville	1-50,000	1,330
Chateau-Thierry[1]	1-50,000	660
St. Mihiel	1-50,000	880
Etain	1-50,000	970
Amelcourt	1-50,000	340

[1] Maps not issued.

GENERAL WATER-SUPPLY REPORTS.

Notes on Water Supply, Nomeny-Pont-a-Mousson-St. Mihiel Sector.
Notes on Underground Water Supply, St. Die-St. Mihiel Sector.
Note on Deep-Water Bearing Horizon in southeastern part of Commercy Quadrangle.
Hydro-Geologic Map of French front from Commercy to Thann, 1:320,000.

	Area, square kilometers.
Water Supply Map of Nancy, 1:80,000	2,633
Water Supply Map of Commercy, 1:80,000	2,633
* Water Supply of Commercy Quadrangle with map, scale 1:80,000	2,633
* Water Supply of Metz, Southwest Quadrangle with map, scale 1:50,000	640
* Water Supply of Metz, Southeast Quadrangle with map, scale 1:50,000	640
* Water Supply of Metz, Northwest Quadrangle with map, scale 1:50,000	640
* Water Supply of Metz, Northeast Quadrangle with map, scale 1:50,000	640
* Water Supply of Verdun, Northeast Quadrangle with map, scale 1:50,000	640
* Water Supply of Verdun, Northwest Quadrangle with map, scale, 1:50,000	640
* Water Supply of Mezieres, Southwest Quadrangle with map, scale 1:50,000	640

	Area, square kilometers.
Water Supply Mezieres, Southeast Quadrangle with map, scale 1:50,000	640
* Water Supply Lineville, Northeast Quadrangle with map, scale 1:50,000	640
Water Supply Sarrebourg, Southwest Quadrangle with map, scale 1:50,000	640
Water Supply Sarrebourg, Northwest Quadrangle with map, scale 1:50,000	640

* Water Supply of and Geological Notes on the Rhein Valley.

SPECIAL WATER-SUPPLY REPORTS.

Memorandum on the Joncherry Deep-water Supply.
Sources of Water Supply near Bazoilles.
Memorandum on Improvement of Water Supply at Bazoilles Hospital.
Memorandum on Water Supply conditions at Liffol-le-Grand.
Water Supply for Hospital at Beau Desert.
Water Supply for Air Service Camp near Orly.
Water Supply for Hospital Site near Beaune.
Water Supply for Hospital Site near Mesves.
Water Supply for Motor Transport Repair Shops near Circey la Tour.
Water Supply for Proposed Training Depot near St. Aignon.
Water Supply for Hospital Site near Mars.
Water Supply for the Anglo-American Tank Factory at Neuvy-Pailloux.
Water Supply of Proposed A. E. F. Tank Training Camp between Neuvy-Pailloux and Chateauroux.
Report on Underground Water Supply along Mountain Division of P. & O. Railroad.

LIST OF MAPS SHOWING DISTRIBUTION OF ROAD METAL.

	Area, square kilometers.
Road Metal Map, Commercy Quadrangle, 1:80,000	2,633
Road Metal Map, Verdon Northeast Quadrangle, 1:50,000	640
Road Metal Map, Verdun Southeast Quadrangle, 1:50,000	640
Road Metal Map, Metz Northwest Quadrangle, 1:50,000	640
Road Metal Map, Cheminot Quadrangle, 1:50,000	640
Road Metal Map, Montsec Quadrangle, 1:50,000	640
Road Metal Map, Briey-Longwy Iron District, 1:50,000	640

Map of France showing distribution of rocks adapted to Road Metal; Scale, 1:2,500,000.
Memorandum on Road Metal in Luxemburg and in the Coblenz Zone of Occupation of the Rhine Province.

MISCELLANEOUS REPORTS.

Notes on Mining Industry of Northern France, Western Germany and Belgium.
Notes on Potash Deposits in Alsace.
Note on Sand and Gravel Deposits of Liverdun.
Note on Sand and Gravel Deposits in the Toul-Nancy Region.

* Indicates reports printed.

Report on the Geologic Work of British Army with notes on the use of Geology by the French and German Armies.
Plans for Applying Geology to Military Purposes.
Results accomplished and plans for Geologic Section.

Reports and maps issued, geologic section, Service of Supply.—The following reports, maps, etc., were submitted by Capt. Eckel in manuscript form during the period before the Service of Supply work came under the jurisdiction of the geologic section, general headquarters. The originals are on file, for the greater part, in the files of the water-supply section, Service of Supply. Five of the earlier reports were filed with the acting chief engineer at general headquarters:

September 20, 1917: Water supplies for hospital at Bazoilles.
September 21, 1917: Scope and requirements of the mining school.
September 27, 1917: Water supply and other engineering conditions at possible Army school sites.
September 27, 1917: Report on conference on the First Corps Mining School.
October 13, 1917: Program for pioneer course, first week, First Corps School.
October 25, 1917: Low temperature records at Chaumont.
October 28, 1917: Souge water-supply conditions.
November 25, 1917: Sources of water supply near Bazoilles.
November 12, 1917: Plan for examination of terrain at fronts.
November 12, 1917: Possible Bordeaux water supply.
November 13, 1917: Water conditions at Bourges.
November 20, 1917: Water conditions of the Bordeaux region.
November 26, 1917: The use of puzzolan cement.
December 5, 1917: Rainfall records at St. Nazaire, Savenay, and Nantes.
December 10, 1917: Probable water conditions at camp and hospital sites.
December 16, 1917: Water conditions at Gievres.
December 28, 1917: Water conditions at Savenay and St. Nazaire.
January 10, 1918: Rainfall distribution in northeast France.
January 15, 1918: Slag supply (as road metal) in the Nancy region.
January 20, 1918: Filter sand supplies, Moselle River region.
January 30, 1918: Calibration of sand screens.
January 31, 1918: Investigations of French sand and gravel supplies.

Engineer Schools.

The war in France had developed many technical specialties such as flash and sound ranging, map making from aerial photographs, camouflage, the use of searchlights in antiaircraft operations, new forms of field fortifications, wire entanglements, etc., with which the officers and men of the American forces were, for the most part, wholly unfamiliar. It was only through the medium of schools that the necessary instruction in the duties of these special services, as well as in sound tactical principles, could be given. Accordingly a comprehensive school project for the American Expeditionary Forces was developed. While all schools were, by general orders, established and directly controlled by the training section of the general staff, the chief engineer American Expeditionary Forces was

vitally concerned in the development of the engineer schools, inasmuch as his was the responsibility of supplying the instructor personnel, selecting candidates for attendance and utilizing to the best advantage the knowledge gained in the courses of instruction given.

INSTRUCTION WITH BRITISH AND FRENCH.

At the very outset, lack of experience on the part of American officers and men was keenly appreciated, and to supply the training then needed the policy was adopted of sending a certain number of newly arrived officers to the front on trips of inspection and study under the guidance of the French and British. In addition, facilities were provided whereby American officers were temporarily assigned to duty with British divisional and corps engineer troops as well as at general headquarters. Then, too, provision was made for the attendance of small numbers of American Engineer officers at British and French schools of instruction. As early as August, 1917, arrangements were under way for sending details of American officers to the Royal Engineers (British), mining courses at Chatham, England, and to the French sapper and pioneer schools at Chalons-sur-Marne. The experience thus gained could be used to great advantage at the American Army Engineer school at Langres, for which plans were then being made.

The original idea had been to create an Army school center to which instructors and students should be assigned. It was expected by the end of the first course at the Army school it would be possible to select from among the students those most likely to be useful as instructors in their turn at the various corps schools. The corps schools would in their turn develop instructors for divisional and lesser units. This far-reaching plan was set aside in consequence of the slow arrival during the summer and fall of 1917 of American troops. By the end of August the First Division was concentrated in an area around Gondrecourt, and it was known that it would be the nucleus of the First Army Corps. In place of organizing the Army schools first, it was therefore decided to organize the First Corps Schools. With one or two exceptions, the instructors at the First Corps Engineer School were therefore necessarily detailed from among the commissioned personnel of the First Regiment of Engineers. The further result was that the First Corps schools furnished the bulk of the instructors for the Army schools.

CORPS AND ARMY SCHOOLS AUTHORIZED.

In the fall of 1917 the Engineer school situation for the American Expeditionary Forces was crystallized in General Orders, No. 45, General Headquarters, October 8, 1917, authorizing the establishment on October 15, 1917, at Gondrecourt, of the First Corps center

of instruction, including an Engineer school under the directorship of Maj. H. C. Fiske, 1st Engineers. The order provided that the First Corps center of instruction would be conducted under the supervision of general headquarters. The commanding general of the first division, however, was charged with the duty of furnishing troops, as required by the several schools, for demonstration, fatigue, construction, and general service. Two days later there were authorized by the provisions of General Orders, No. 46, General Headquarters, October 10, 1917, the Army Engineer School and the Army Gas School, Lieut. Col. Gustave H. Lukesh, Corps of Engineers, being named as commandant.

A number of possible locations for the Army schools had been suggested by the French, Chatillon-sur-Seine being the one specially offered for consideration. Late in September a board consisting of Brig. Gen. J. W. McAndrews, Col. Paul Malone, Infantry, and Capt. E. C. Eckel, Engineers, examined a number of possible sites, including Chatillon, Auxerre, Langres, Bourbonne, and Vittel. The conclusion, based largely upon engineering conditions as to timber, water, and soil, was that Langres offered the best available location, and this site was chosen.

STATUS OF SCHOOLS AT ARMISTICE.

The two General Orders, Nos. 45 and 46, 1917, marked the beginning of the engineer section of the school project for the American Expeditionary Forces. Subsequently there were established a Second Corps and a Third Corps Engineer school, the former located at Chatillon-sur-Seine and the latter at Clamecy. From the fall of 1917, when the first definite action was taken to provide engineer instruction, until the signing of the armistice on November 11, 1918, the various engineer schools, and in particular the Army Engineer School, underwent great development. Just prior to the cessation of hostilities the status of the several engineer school projects was as indicated in the following tabulation which Maj. Gen. W. C. Langfitt, chief engineer American Expeditionary Forces, on October 14, 1918, sent to the assistant chief of staff, G–1, general headquarters.

Status of engineer schools October 10, 1918.

Army Engineer School:

Location	Langres (Haute Marne).
Function	School for candidates for commission in Engineers.
Length of courses	Three months.
Number of instructors	51 officers, 60 enlisted men.
Number of student personnel	1,100.
Commandant	Col. P. S. Bond, Engineers.
Director	Lieut. Col. F. K. Newcomer, Engineers.
Senior instructor	Maj. Raymond G. Moses.

Engineer section, First Corps School:

Location	Gondecourt.
Function	Instruction of officers and noncommissioned officers for duty in the line.
Length of courses	About five weeks.
Number of instructors	4 officers, 7 noncommissioned officers.
Number of student personnel	15 officers, 23 noncommissioned officers.
Director	Maj. Thomas D. Finley, Engineers.

Engineer section, Second Corps School:

Location	Chatillon-sur-Seine.
Function	Instruction of officers and noncommissioned officers for duty in the line.
Length of courses	About five weeks.
Number of instructors	6 officers, 6 noncommissioned officers.
Number of student personnel	58, maximum 192.
Director	Maj. T. B. Larkin, Engineers.

Engineer section, Third Corps School:

Location	Clamecy (Nievre).
Function	Instruction of officers and noncommissioned officers for duty in the line.
Length of courses	About five weeks.
Number of instructors	4 officers, 6 noncommissioned officers are under orders from general headquarters to report for duty as instructors and should arrive in a short time.
Number of student personnel	At present 90, but normal capacity is 150. This school also received about 150 students daily from other schools during first part of course.
Director	Maj. E. C. Kelton, Engineers.

FUNCTIONS OF CORPS SCHOOLS.

While the corps schools drew their instructors and personnel from the Engineer establishment, the control of this instruction was directly under general headquarters. A definite statement as to policy was contained in General Orders, No. 130, General Headquarters, August 6, 1918, which specified that corps schools will be established by orders from and will remain under the direct control of these headquarters.

The primary function of the corps schools was to fit officers of incoming divisions as promptly as possible for the training of their men in the use of weapons and formations developed during the war. The intention was later to make the chief missions of the schools the production of a high degree of technical skill among selected officers and noncommissioned officers, and the instruction of officers in the tactics of their proper commands and in the command of the next higher grade.

As early as September, 1917, Gen. McAndrew had insisted, in all his personal and official dealings with the officers likely to be involved in school work, that the existing trench warfare was essentially a transitory phase of the war; that economic and political necessities would sooner or later force an attempt to secure a decision in the open; and that when this time came the American troops should prove to be better fitted by tradition and training for open warfare than would most other armies. In the discouraging autumn of 1917 this definite feeling that in the spring warfare would be in the open, and that in the open the American forces could certainly surpass the enemy, was a very essential factor in the preservation of American Expeditionary Forces morale. Its reflection on Engineer training was obvious. From the earliest days of the First Corps School more attention was given to strictly pioneer and combat work, and less to heavy construction, than had been the practice at British schools.

For the Engineer schools a four weeks' period of instruction was prescribed. As to the scope of these courses the following quotation from General Orders, No. 77, General Headquarters, May 22, 1918 (amending G. O. No. 5), indicates the requirements:

> Sufficient knowledge of divisional operations in open and trench warfare to insure a correct understanding of the pioneer and engineer work required, proper organization for work, and cooperation with other arms of the service; instruction, theoretical and practical, in all classes of pioneer and engineer work which may be required and for which the divisional engineers are equipped (except instruction in bridging); instruction in the handling of engineer detachments, sections, and companies, and in the supervision of pioneer work of other troops. The instruction for noncommissioned officers will be devoted chiefly to practical work and to the handling of detachments and sections in such work.
>
> Upon completion of the course at corps schools, commandants of corps schools will order the students of the Corps Engineer schools to the Army schools for a six-day course in bridging.
>
> Instruction in Infantry training and tactics will be given the students in the Corps Engineer schools by the Corps Infantry School.

As for the Army Engineer School, its principal functions were to train officers in order to make them available as instructors, either in the corps schools or in their own organizations, and to give the enlisted man, through the medium of an "Army candidates school," an opportunity for intensive training and for promotion to commissioned grade. The Army Engineer School also conducted its courses with a view either to supplying qualified officer personnel for service with combat troops or for return to the United States for the instruction of newly organized units.

EARLY DIFFICULTIES.

In the early days of both the corps and Army schools great difficulties had to be overcome. First of all, it was necessary to prepare courses of instruction in subjects in which comparatively few American engineer officers at that time were well versed. This meant study of French and British military engineering practice and an adaptation of their methods to the needs of the American Expeditionary Forces. In itself this was a difficult task, but it was hardly greater than the one presented by the physical difficulties which had to be surmounted before the schools became going concerns. In the case of the Army Engineer School at Langres a certain portion of the instructor and student personnel could be housed in existing French barracks, although much additional construction had to be performed. At Gondrecourt the situation at the First Corps School was worse, inasmuch as the schools had, as a start, practically nothing but a broad expanse of field, ankle deep with mud and swept by cold, driving rains. As one officer expressed it, "Gondrecourt was a good idea, but a bad location." Shortages in construction material of all sorts, together with inadequate transportation facilities, were additional complicating factors in the establishment of the First Corps School. Nevertheless, wooden barracks were set up and a start made on mapping out courses of instruction and securing officers to conduct them.

At the Army Engineer School at Langres much preliminary work had to be done to provide for the reception of students in as large numbers as contemplated. A reconnaissance of the site was made in the fall of 1917 in order to ascertain what new construction and equipment were needed. Lighting and water supply had to be investigated and plans made to supplement existing inadequate facilities. In his outline of the construction project at Langres, dated October 27, 1917, the chief engineer, American Expeditionary Forces, had planned housing, water supply, lighting for an initial personnel to arrive before December 1, 1917, and an ultimate personnel of 4,500 by June 1, 1918.

At the Second and Third Corps schools, which were established later, much preliminary work had also to be done. Students arrived in much larger numbers than had been anticipated, new barracks had to be built, electric light and water systems installed and beds provided for students' use.

Yet, in spite of obstacles, the Army Engineer School and the corps schools were organized, provided with staffs of instructors, and equipped to handle the thousands of officers and men who continuously passed through them.

THE INSTRUCTOR PROBLEM.

Coupled with the physical difficulties of providing shelter at the school and mapping out courses of instruction was the big problem of securing competent instructors. It should be realized that in the early days comparatively few officers had sufficient experience to fit them for the work of training others. Those officers who had the necessary experience were urgently needed with their own regiments. At this time the securing of officer personnel throughout the Engineer establishment in France had become extremely acute, a situation which did not facilitate the organization of the teaching staffs at the Engineer School. This state of affairs extended through the period of each school's existence.

As late as August, 1918, the commandant of the Army Engineer School at Langres emphasized the great hardship under which the school was forced to work, due to the constant change of the instructor personnel at the very time when the school was undergoing a very considerable expansion, stating that the lack of permanence in his staff of instructors had been responsible for a 40 per cent reduction in the efficiency of the school's work. As the number of students at the school was constantly increasing, it became a problem not only of attempting to hold the instructors then on duty, but of securing many others.

In an estimate made August 12, 1918, the commandant of the Army Engineer School stated its minimum needs, in the way of regular officers, as one colonel or lieutenant colonel, as commandant, one major as commandant of the candidates' school, and one major in charge of the bridge section; the remainder of the instructing staff was to consist of reserve officers. It was also essential, if the flow of officers through the school was to be maintained, that new ones should be assigned to duty as instructors as the old officers left.

As the result of experience in connection with the work at the Army Engineer School the following principles applying to instructor personnel were evolved: No officers should be kept as instructors longer than six to eight months. Instructors ordered to the school should have had some experience at the front. One regular officer of Engineers would be sufficient for each of the Corps Engineer schools, while three regular officers of Engineers should be prescribed for the Army Engineer School. Later it was further specified as desirable that instructors, on completion of their courses, be sent for duty with combat divisions.

ARMY CANDIDATES SCHOOL ESTABLISHED.

In spite of the fact that Engineer officers were arriving in France in increasing numbers during the early part of 1918, there still existed a

shortage in commissioned personnel, and it was also clear at this time that some provisions would have to be made for replacing officer casualties. As a result the Army Candidates School was established with the main object of supplying replacements of second lieutenants in the combatant troops of the American Expeditionary Forces. In fulfilling this object the policy adopted was to assign for a three-months' course of instruction at the Army Candidates School, a certain number of selected soldiers from the various Engineer regiments in France. These men, on the completion of their period of instruction, if found qualified, were commissioned as second lieutenants in the Engineers. Men who, after several weeks' work at the school, demonstrated their incapacity for commissioned grade, were relieved and returned to a replacement depot for reassignment. In addition to the Engineer section, the Army Candidates School included sections devoted to the other branches of the service, Infantry, Cavalry, Signal Corps, Artillery, etc. At first age limits between 21 and 40 years were prescribed for the Army Candidate School, but these limits were later abolished.

Dates of assembling classes were announced from time to time from general headquarters and regimental commanders and officers commanding smaller seperate units were ordered to send qualified soldiers to the school. By the terms of General Orders, No. 32, General Headquarters, February 18, 1918, each divisional, corps, or Army Engineer regiment was authorized to send nine candidates to the Engineer section of the Army Candidates School. In addition a provision was made for sending to the school enlisted men in the Engineer Department not included in the preceding clause covering only combatant troops, so that men engaged upon construction work in the Service of Supply were given the same opportunity for qualifying for commissions as were men in combatant organizations.

With reference to the matter of securing sufficient commissioned personnel for Army, corps, or divisional troops, General Orders, No. 32, 1918, made the following important announcement as to policy:

> Hereafter, except in very unusual cases, no one will be recommended for commission as second lieutenant of the Officers' Reserve Corps, National Army or National Guard who is not a successful graduate of the Army Candidates School.

The main idea in the establishment of the candidates school was to secure for its student personnel noncommissioned officers and men who, by their work in their own organizations, had demonstrated their fitness as officer material. The clear intent of the general order announcing the establishment of the Army Candidates School was to limit the student personnel to men selected on account of previous efficient work. While this was the basis upon which many regi-

mental commanders chose men for assignment for duty at the school, the spirit of the order in many cases was not carried out.

Among the first calls on commanding officers for recommendation for Army school candidates was the one sent out by the chief engineer on April 24, 1918, and again on July 11, 1918. Even as late as September, 1918, relief in the officer shortage had not been found, particularly in view of the fact that the policy was in force whereby every sapper regiment was required to relinquish each week one officer for return to the United States for purposes of instructing new Engineer units. As the case actually worked out this obligation caused the loss of more officers every three months than each regiment was allowed to send to the schools, inasmuch as the portion of the total enlisted strength of the Engineer Department authorized for assignment to the school by General Orders, No. 32, 1918, was limited to two-tenths of 1 per cent.

No attempt will here be made to set forth in detail the scope of the work of various engineer schools, and the methods of conducting the courses. Complete information on this subject will be found in the reports of the school commandants attached hereto as Appendices. Suffice it to say that the training section of the general staff had outlined a thorough school program and, by authority contained in general orders, was charged with the responsibility of exercising general control and supervision over the work. The chief engineer, American Expeditionary Forces, did not directly control the work of the Engineer schools.

THE ARMY ENGINEER SCHOOL.

The Army Engineer School at Langres was opened on October 31, 1917, with Col. G. R. Lukesh as commandant. The months of November and December were spent in preparation and organization, and early in January courses were open for students in the following sections: Bridging, camouflage, flash and sound ranging, mining, pioneering, topography, and searchlight. After a reorganization of the Army Candidates' School the Engineer section was created as part of the Army Engineer School January 22, 1918.

On March 1, 1918, the school moved from Langres to Fort St. Menge, 10 kilometers north of that city. At that time the searchlight section was severed from the school and taken over by the antiaircraft and trench mortar school. The topographical section remained in Langres, operating at the Turenne Barracks. On March 1, 1918, Col. P. S. Bond, Corps of Engineers, relieved Col. G. R. Lukesh as commandant.

The importance of the work at the Army Engineer School was thus summed up by Lieut. Col. Fiske, assistant chief of staff, G–5, in memo-

randum to the chief of staff, in which he requested orders detailing Col. Bond as commandant. "The Engineer School," Col. Fiske said, "affects not only the instruction of Engineer troops and services, but, by the instruction they give in fortification and in the organization of the ground, also the instruction given to all branches of the service. It is essential that the commandant of the Army Engineer School, which trains instructors of all Engineer schools, be an officer not only with engineer training and experience but also with tactical and staff training."

Col. Bond, on assuming his duties as commandant at Langres on March 1, 1918, immediately began the organization and expansion of the school work. Lieut. Col. W. H. Holcombe, Corps of Engineers, was appointed assistant commandant June 11, 1918, and was relieved by Lieut. Col. F. K. Newcomer, Corps of Engineers, August 20, 1918.

On June 25, 1918, a school was opened for Engineer officers and was called the student officer training camp, ending August 7, 1918.

In the latter part of July the topographical section was taken over by the Army intelligence school, and in its place was created the Artillery orientation section, operating at Langres.

On October 1, 1918, there were about 50 officers and 70 enlisted men assigned as instructors in the seven sections of the school. To perform and assist in the practical and demonstrational work in connection with the school, various Engineer companies and detachments were assigned to the school from time to time. There were about 700 men on this work on October 1, but this number was subject to constant change. The towns of Bannes, Campigny, Jorquenay, Humes, Rolampont, and Charmes were assigned to the Army Engineer School.

The school gave the full courses of five weeks for the Fourth, Fifth, Sixth, and Seventh Corps, and a one week's course in bridging for students of the First, Second, and Third Corps schools. In addition, students were sent to Langres for special courses from all branches of the services. Brief demonstrations were given from time to time to students of other Army schools.

On October 1, 1918, out of an original class of 400, 324 successful students at the candidates' section were given temporary commissions as second lieutenants, per Special Orders, No. 272, C. S., General Headquarters, American Expeditionary Forces. The class commencing October 6 had about 800 students. Commencing November 1 and on the first of each month thereafter provision was made to have 400 new students enroll, thereby making the constant strength of that section 1,200.

On January 1, 1919, at the Army Engineer School, all sections had closed except the following: Mining, bridge, pioneer, and camouflage.

The last course at the Engineer Candidates' School was completed January 31, 1919, marking the closing of this school. Approximately

(3236–V8) TIMBER TRESTLE BRIDGE BUILT AT THE ARMY ENGINEER SCHOOL, LANGRES.

400 candidates entered the class in November; 250 remained until the end of the course and 222 graduated.

The object of the Student Officers' Camp at the Army Engineer School, above referred to, was to train officers for duty with any com-

(3271–V8) DUGOUT CONSTRUCTION AT ARMY ENGINEER SCHOOL, LANGRES.

batant regiment. To attain this end instruction was arranged so as to provide students with first-hand knowledge of the life of an en-

listed man, to teach them how to train new recruits and to impress them thoroughly with the fundamental points of discipline. A secondary object was to determine whether students were fitted to perform the duties of a higher rank, what students were unfit for service with troops, or for further service in the Army.

The system of instruction followed was intended to facilitate the observation and grading of each officer. Details of the work at the student officers' camp are given in the report of the Army Engineers' School.

FIRST CORPS SCHOOL.

The First Corps School was established at Gondrecourt (Meuse) and commenced to function on October 15, 1917, under direction of the training section, general staff, general headquarters.

The original schedule contemplated a five weeks' course which was reduced, at the end of the fifth course, to four weeks after General Orders, No. 77, General Headquarters, 1918, had been issued prescribing that instruction in bridging should thereafter be given at the Army Engineer School. The Engineer section of the First Corps School was in continuous operation from its inauguration, and until the last course was completed on December 21, 1918. Maj. (later colonel) H. C. Fiske, Engineers, was the first director and was succeeded, respectively, by Col. Francis B. Wilby, Majs. E. F. Miller, W. E. R. Covell, D. L. Weart, and Thomas D. Finley, all officers of the Corps of Engineers.

The course of instruction was divided into three main parts: Instruction of captains and lieutenants from Engineer regiments; instruction of noncommissioned officers from Engineer regiments and from pioneer platoons of Infantry regiments; and instruction of officers of the Infantry and machine-gun schools in certain features of military engineering.

As a supplement to the courses of instruction given at the school, visits to the front were provided for. Each graduate was graded by the school commandant as to his qualifications as a corps school instructor, the four grades being "Excellent, very good, good, and not proficient."

Before the school was established plans were considered for conducting extensive courses in mining, and Capt. E. C. Eckel, Engineers, was detailed for duty at the school in mapping out this program. It was decided on examination of the terrain, however, that the ground in the regions at the front which would eventually be taken over by the American forces was largely underlaid by hard rock, which would not have permitted mining operations on any considerable scale. The early plans contemplating large scale mining operations were, therefore, abandoned, although the course subse-

quently developed provided for such underground construction as dugouts and other forms of shelter.

SECOND CORPS SCHOOL.

The Second Corps Engineer School, similar in general scope and policy to the First Corps School, was established and started instruction February 4, 1918, at Chaillon-sur-Seine. The first director was Maj. (later Lieut. Col.) J. W. Stewart, who reported for duty on January 28, and continued in this capacity until August 15, when he was relieved by Maj. T. B. Larkin. The Second Corps School was discontinued in April, 1919.

THIRD CORPS SCHOOL.

In like manner the Third Corps Engineer School was organized on August 19, 1918, in accordance with instructions from G–5, general headquarters. The school was located at Clamecy (Nievre) with Maj. Edwin C. Kelton, Corps of Engineers, as director. The first course began September 2, 1918. The final course was completed March 15, 1919.

In accordance with the principles of training adopted by the training section of the general staff, the course included instruction in musketry and bayonet, automatic rifles, grenades, and machine guns. For the officers, a special course in tactics of six and one-half days was given by the tactical school. The last two days of the regular four weeks' course were devoted to combined maneuvers, the Engineer school students taking part as Infantry.

The engineer instruction consisted of work in wiring, organization of ground, trench tracing and profiling, camouflage, interpretation of aerial photographs, demolitions, dugouts, cut and cover shelters, roads and light railways. Bridges were not included in the course as this subject was taken up at the Army Engineer school at Langres, after completion of the corps school course.

The later courses, as a whole, were reported as entirely satisfactory. The compulsory two-hour study period in the evening was eliminated. On account of the closing of the Army Engineer School, a bridge department was formed at the Third Corps School, the time spent on bridges being taken from the time formerly devoted to Infantry work. A new elective system was introduced by which students were enabled to submit a list of first, second, and third choices for the following courses—surveying, map reproduction, water supply, bridges, concrete, railroad construction, and strength of materials. For the noncommissioned officers, the electives included demolitions, map reproduction, arithmetic, algebra, use of slide rule, use of level, and use of transit. Early in February it was planned

to convert the Third Corps School into a vocational school, each course being one month, so as to allow students to specialize in work of their own choice. These plans, however, were not carried out, due to the closing of the school in March, 1919.

SUMMARY OF CORPS SCHOOL WORK.

The following statement shows the number of students enrolled at the First, Second, and Third Corps Schools, together with the dates of beginning and completing the courses of instruction:

Number of students enrolled for each course, First Corps Engineer School.

Course No.—	Officers.	Noncommissioned officers.
1	22	16
2	60	65
3	32	37
4	54	12
5	60	65
6	13	63
7	41	73
8	28	30
9	52	78
10	13	24
11	49	59

First course began Oct. 15, 1917.
Final course completed Dec. 21, 1918.

Number of students enrolled for each course, Second Corps Engineer School.

Course No.—	Officers.	Noncommissioned officers.
1	74	.....
2	65	6
3	22	10
4	39	29
5	47	52
6	35	35
7	27	33
8	27	21
9	66	113
10	25	116

First course began Feb. 4, 1918.
Final course completed Mar. 8, 1919.

Number of students enrolled for each course, Third Corps Engineer School.

Course No.—	Officers.	Noncommissioned officers.
1	52	79
2	41	58
3	34	59
4	67	124
5	39	74

First course began Sept. 2, 1918.
Final course completed Mar. 15, 1919.

REFERENCE DATA, ENGINEER SCHOOLS.

Document.	Appendix number or file reference.
Report Army Engineer School	Appendix No. 27
Monthly reports First Corps School	Appendix No. 28
Monthly reports Second Corps School	Appendix No. 29
Monthly reports Third Corps School	Appendix No. 30
Report 116th Engineers, replacement	Appendix No. R–116

The Engineer Replacement and Training Depot at Angers.

The problem of furnishing trained Engineer soldiers as replacements for the Engineer regiments of the American Expeditionary Forces was solved by the 116th Engineers. This regiment, the sapper unit of the 41st Division, was designated on December 10, 1917, two days after its arrival at St. Nazaire, as a training and replacement regiment, and took its station at Angers on February 5, 1918.

The city of Angers was in many ways unusually suitable for the location of a replacement depot. Large French barracks with stables and a spacious drill ground were taken over for the use of the troops. A tract of land not far from the barracks was secured for Engineer drill, and the broad Marne River afforded excellent opportunity for ponton drill. Furthermore, there were sufficient railroad facilities, and the city was well located with respect to the base ports and the lines leading to the front.

The main task involved was that of an organization such as would permit the operation of a training course without interference with receiving and forwarding replacements. This was achieved by dividing the work among three sections; a property section responsible for the equipment of the men and for the provision of engineer and other supplies needed for the post; a training section concerned solely with instruction and discipline; and a classification section charged with the maintenance of the records of the personnel at the training depot.

The policy followed by the 116th Engineers was, in effect, one of forwarding trained replacements. The men received from America were, in most cases, recruits who had received little training, and it was essential that instruction should begin with the rudiments. The replacements were to be sent into regiments which had been prepared not only by months in the training camps, but by actual experience in the field, and it was essential that the training should be thorough. The organization of the depot was therefore built around that of the training section.

Three stages of instruction comprised the training course at Angers. Upon arriving at the station, the men were attached to the "Provisional company" for duty, discipline, and quarters. They

were then assigned to a "Permanent company" for instruction and rations. This instruction was elementary and included the following subjects: Interior discipline in barracks, care and nomenclature of the rifle, personal hygiene, calisthenics, general orders for sentinels, school of the soldier and of the squad, and customs of the service. Before being passed to the second stage, the men were required to qualify in digging with pick and shovel, use of the axe and crosscut saw, handling of an oar, and the tying of simple knots.

After completion of the recruit instruction, the men were enrolled as members of lettered companies, the organization of which conformed to that of a standard sapper regiment, and began the second course, which consisted of instruction in the general duties of Engineer soldiers and included practically everything which a private might be expected to know. The course, as prepared, required four weeks, but the time was shortened or extended in individual cases as deemed advisable. The value of this training was greatly enhanced by facilities for simulating the conditions of actual warfare. Trenches, dugouts, pits, and emplacements of every type were constructed, and all the implements likely to be used by Engineer troops were provided. The use of explosives and automatic weapons was taught by actual practice supplementary to class work. In order that both instruction and organization might proceed with the greatest efficiency, a permanent corps of noncommissioned officers was maintained, many of them being selected from among the most able of the replacements. There were 12 subjects at first, namely:

1. Calisthenics.
2. Bayonet and hand-to-hand combat.
3. Small-arms practice.
4. Hygiene and sanitation.
5. Infantry, close order, to include school of the battalion.
6. Tent pitching, cooking, and field services.
7. March and extended order.
8. Miscellaneous special work as directed.
9. Floating bridges and cordage.
10. Trenches and revetments.
11. Obstacles.
12. Guard and signaling.

Later these were increased by the addition of—

Grenades.
Musketry.
Gas defense.
Road march, full pack.
Company commanders' course.
Automatic weapons.

The third course consisted of instruction in engineer specialties by classes; men taking this course were placed on a special-duty

status. The work of each class was anticipated by the instruction of specially selected noncommissioned officers to act as assistant instructors, while the commissioned instructors were chosen for special knowledge and experience. Instruction included the following subjects:

Class A. Dugouts.
B. Bridging.
C. Explosives.
D. Topography and photography.
E. Trade schools and shops.
Drafting and reproduction.
Carpentry and wood shop.
Blacksmithing and horseshoeing.
Concrete and masonry.
Rigging and weights.
Packing.
Saddlery and cobblery.
Searchlights and electrical installation.
Railway construction and operation.
Gas engines.

The need for special training of noncommissioned officers became particularly apparent in a regiment where private soldiers were trained so thoroughly, and a course was inaugurated which aimed to inform them of their duties and responsibilities. This course consisted of 12 lectures and extended over a period of six weeks. The subjects were as follows:

1. Responsibility of the noncommissioned officers—relation to company commanders and lieutenants.
2. Organization within the company and on the work.
3. Example and deportment in barracks, quarters, at mess, off duty, etc.; proper mode of address; discipline.
4. Handling of military prisoners and responsibility of guard.
5. Care of men in the trenches; trench customs, cleanliness, etc.
6. Field orders of enlisted men; field expedients.
7. General Orders, Headquarters, American Expeditionary Forces.
8. Organization and duties of divisional, corps, and Army engineers.
9. Maps of the American Expeditionary Forces.
10. Snipers and observation posts and camouflage.
11. Adrian barracks, Swiss huts, etc.
12. Review, particularly on discipline, command, and organization in barracks and on work.

In addition to these subjects, a one week's course was given in map making and map reading.

While the training and forwarding of the new recruits was the primary function of the depot, it was also intrusted with the work of handling casuals who had been released from hospitals. A man upon being sent to a base hospital was dropped from the rolls of his unit and it was the duty of the Angers depot to return him to it,

or in certain cases to send him elsewhere. These men were given a course of instruction like that of the replacements with a view to bringing them back to good physical condition, although they seldom remained very long at Angers. In October alone, 1,842 hospital casuals were forwarded.

The depot did not concern itself solely with enlisted men. The organization by which casual officers were taken care of was similar to that for the enlisted personnel. The officers were assigned upon arrival to a "Cadet company" under the command of a "Cadet captain" and "Cadet lieutenants" and the company was managed on the same basis as a permanent company of the regiment. While officers were held personally responsible for the care of their equipment and quarters, police details were furnished from among the enlisted men. Noncommissioned officers were assigned to the company in addition to the commissioned personnel, and were given authority corresponding to their position in the company. There were four stages of instruction, each stage requiring one week, as follows:

STAGE 1.

General service training.
Company administration.
Organization, American Expeditionary Forces.
Maps of the American Expeditionary Forces.
Roads.
Trenches.
Light railways.
Engineer dumps, tools and equipment.

STAGE 2.

General service training.
Musketry.
Bayonet.
Entanglements.
Strong points.
Engineer consolidation of captured positions.

STAGE 3.

General service training.
Grenades.
Stokes mortar.
35 mil. gun.
Smoke bombs.
Gas defense.
Infantry organization and tactical disposition.
Camouflage and screens.
Sniping, snipers' posts and observation posts.
Machine-gun emplacements.
Dugouts, cut and cover shelters and mining.

STAGE 4.

General service training.
Review and special subjects.
Duties of engineers in open warfare.
Bridges.
Demolitions.

In addition to this course, a candidates' school was conducted at which enlisted men showing special fitness were trained for duty as officers and after completion of the course duly commissioned.

The work of the classification section was extensive in a depot where several thousand men were arriving and departing each month, particularly as the standard company organization was so closely adhered to and company rolls and records were maintained in the usual manner in spite of the great number of changes involved. Replacements, both officers and men, were carefully classified as to qualifications, both upon arrival and departure, and care was taken to send men of special fitness where they would be of greatest service. This work became of even greater importance when, late in the summer, Service of Supply hospital casuals began to pass through Angers instead of Blois, for from every part of the Service of Supply there was a constant demand for specially trained men. All records in connection with the progress of the training were also kept by this section and its efficiency was an important factor in the successful operation of the depot.

With the rapid increase of troop arrivals in France during the spring and summer months of 1918, the number of replacements passing through Angers became correspondingly greater. The first big influx occurred in March when 1,195 men and 83 officers were received at Angers, but the heaviest work was done in the last five months of hostilities, when the average number of men received per month was over 5,000, or more than the equivalent of three sapper regiments. The high mark for arrivals was reached in July when 6,402 men were received. The number of troops forwarded increased more slowly, as it was the policy of the depot to maintain a large reserve to draw upon in order that the men could be more carefully selected. Nevertheless, with greater demands for replacements during the last months the figures mounted until in October 5,659 men and 246 officers were sent out from Angers. From its inception until January 1, 1919, the depot forwarded more than 1,350 officers and 29,000 men or the equivalent of 17 complete sapper regiments. All of these men were trained in the duties of the Engineer soldier in the field.

A great many men contributed their share to the accomplishment of the 116th Engineers and during its career in France the organization had several commanding officers. Col. (now Brig. Gen.)

M. L. Walker was in command when the regiment arrived in France, and it was he who was chiefly responsible for its organization and development in America. He was succeeded, January 28, 1918, by

INSTRUCTION TRENCH AT ANGERS, SHOWING TYPES OF REVETMENT.

Lieut. Col. (later Col.) Roger D. Black, who laid the foundation of the replacement depot. On May 11, 1918, Col. Black was relieved by Maj. Dewitt P. Olson, who was in command during the strenuous months of summer and autumn. Maj. Olson became Lieut. Col.

shortly after taking command, continued in charge until he was relieved by Lieut. Col. F. S. Strong about November 1. These officers were assisted by a carefully chosen force, many of them being selected from among the casual officers who came to the depot, and by a similarly selected cadre of noncommissioned officers. The valuable assistance of Lieut. Rene Foulguies, of the French Army, who conducted special classes in trench warfare, and two veteran British sergeants major who superintended combat drill, was of great value in the work of the training section.

Training of Divisional Engineers.

The period between the arrival in France of a sapper regiment and its actual participation in operations at the front was, in so far as conditions permitted, one of training. The length of the training period and the character of work performed varied widely, since such factors as the relative urgency of the needs of the armies and the service of supply, the plans of the training section of the general staff and of the commanding generals of divisions, the use of British training areas and British or French instruction, personnel and methods, determined, in the case of each unit, the detailed character and scope of its course of instruction. Infantry work, musketry, and trench warfare methods, however, invariably constituted an important part of engineer training, while instruction in technical specialties was made as thorough as the amount of time and the material available permitted.

For training purposes there were selected in the region to the north and east of Chaumont, certain "Divisional areas." By the time hostilities ended, 23 of these American divisional areas had been established and in them billeting accommodations had been supplemented by barracks. Here the divisions were housed and trained prior to their entry into the line. Some exceptions to this general plan occurred in the case of Engineer regiments which trained with the British or were employed on general construction in the advance section or at other points in the Service of Supply. The first training center was at Gondrecourt for the First Division.

REGIMENTS ARRIVING IN 1917.

Five divisional Engineer regiments, the 1st, 2d, 6th, 101st, and 117th, reached France prior to December 31, 1917. As was to have been expected in the case of the early arrivals, the large amount of miscellaneous work to be done prevented any rigid adherence to a prescribed training schedule. The early operations of these units, therefore, can not be cited as typical; there follows, however, a brief recital of their training activities.

The 1st Engineers, after arriving at St. Nazaire August 20, 1917, engaged in infantry drill, barracks construction, road building, and other miscellaneous duties until arrival in the Gondrecourt and Bourmont training areas during September and October, 1917. There the construction of cantonments formed the major portion of the regiment's work. A number of practice marches were made between Gondrecourt, Abainville, and other towns during October. On October 15 Company D was detached and sent to the Arbois sector for training with the French, and after a month there was replaced successively by other companies of the regiment. In the meantime the regiment, less the companies on duty with the French, remained in the training area to carry out a program of barracks construction, practice marches, infantry, and engineer drill. On January 15 the Second Battalion was sent to the sector north of Toul for front-line work, and was followed about February 1, 1918, by the First Battalion.

The 2d Engineers arrived in France October 8, 1917, and was engaged on general construction, mostly of barracks, until January 1, 1918, when training was begun in the region of Neufchateau. During January the regiment, in the divisional area, followed a training schedule which had been issued from general headquarters, prescribing five weeks' work in infantry and engineer drill, the latter including bridging, wiring, trench layout, and, to a small extent, trench construction. Lack of materials prevented extensive engineer drill. During December the regiment received 400 replacements, which were divided into three companies and trained. On February 20 the First Battalion was sent to the front east of Toul, while on March 15 the Second Battalion left for duty with the French in the quiet sector south of Verdun.

After arrival in France, December 20, 1917, the 6th Engineers proceeded to the divisional training area at Prauthoy, where the early work consisted principally of unloading cars of building material for the 10th Divisional area. During January one company was sent to the First Corps School at Gondrecourt and three companies were assigned to general construction in the advance section. On February 10 the regimental headquarters and two companies were sent to the Fifth British Army for bridge work, and were later followed by the remainder of the regiment.

Barracks construction and infantry drill constituted the early work of the 101st Engineers after its arrival in France, October 11, 1917. During November half of one company was training with the 26th Division at Neufchateau under French engineer officers, while the remainder of the regiment was engaged on general construction. On February 24 the regiment moved to Liffol-le-Grand, where intensive

training consisted of gas drill, musketry, infantry drill, close and extended order, and engineer instruction. Part of the training consisted of constructing a road and laying out and excavating first-line trenches and communicating trenches. The French system of working in shifts of 6 hours and resting 12 hours was followed, and operations continued night and day to simulate war conditions.

The 117th Engineers proceeded to the fifth divisional area (Vaucouleurs) after arrival in France November 1, 1917, and engaged in general construction during the greater part of the time until February, when a course of lectures was given nightly to officers and noncommissioned officers. A part of the regiment followed a limited drill schedule consisting of rifle practice, marches, and close-order drill. The regiment left for the front February 19, 1918.

TRAINING WITH THE BRITISH.

During May and June, 1918, the period of increased troop arrivals in France, many Engineer regiments were sent for training with the British. Among these were the 4th, 102d, 103d, 105th, 108th, 110th, 302d, 303d, 305th, and 307th Engineers.

After arrival at Calais May 19, the 4th Engineers fitted out the training area for the 4th American Division under British supervision. The work included reconnaissance and sketching, general cantonment construction, the building of rifle ranges, and Infantry and Engineer drill.

After disembarking at St. Nazaire May 31, 1918, the 102d Engineers proceeded to British training areas and were equipped with gas masks and Lee-Enfield rifles. Instruction was begun in gas defense, rifle practice, bombing, bayoneting, infantry drill, field cooking with rolling kitchens, etc. A number of practice marches were made and during June trench digging and wiring were carried out under the direction of the Fourth British Corps. During July the program followed was that outlined in the "Program of Training, First Phase, for American Divisions Training with the British, No. 1008," issued by general headquarters, American Expeditionary Forces. Officers and noncommissioned officers were sent as observers into the British lines, and in July a platoon of each company was detailed for six days' training in the line with the Forty-first British Division.

While differing in certain details, similar courses of training in British areas were followed by the other regiments above named. In addition to the usual Infantry drill, rifle practice, and gas drill, the work comprised bayonet exercises and the construction of trenches, dugouts, observation posts, bridges, and practice in demolitions. The work was occasionally varied by divisional maneuvers. This

was a feature of the work of the 302d Engineers during May. In addition a number of regimental night problems were undertaken. A considerable amount of time was devoted to target practice with the British Lee-Enfield rifle.

TRAINING IN AMERICAN DIVISIONAL AREAS.

The remainder of the divisional Engineer regiments were trained in American divisional areas, detachments being sent from time to time for front-line instruction with French units. The 5th Engineers, between the time of their arrival in France, August 13, 1918, and the 1st of October, was engaged on engineer and infantry drill until it went into the line with the Seventh Division in the Toul section. The 7th Engineers, arriving March 24, 1918, engaged in construction, the Second Battalion at the general intermediate storage depot at Gievres, and the First Battalion in the advance section engaged principally in barracks and hospital construction in divisional areas. In June the regiment was relieved from Service of Supply duty and joined the Fifth Division at the front.

The 104th Engineers, arriving June 26, 1918, engaged in drill and also performed a certain amount of stevedore work at the docks at Brest before reaching the divisional area at Prauthoy in June, where intensive training was carried on. General construction in base areas occupied the 107th Engineers from the date of arrival in France in February until they reached the divisional areas early in March, and was continued during April and May in the 7th, 8th, 9th, 10th, and 13th divisional areas. The following month the regiment was on duty with the 32d Division engaged on construction of trenches, dugouts, repair of front-line positions, camouflage, and road work.

The training of the 111th Engineers, arrived July 31, 1918, was begun at Bar-sur-Aube, the work consisting of the usual Infantry and Engineer drill, trench layouts, wire entanglements, road building, strong points, topography and mapping, demolition and camouflage practice at night. Practice marches and combat exercises were also a part of the program.

Training programs similar to the foregoing followed by other divisional Engineer regiments, except those that arrived only a month or so before the armistice. In the case of the latter units, the work in France consisted generally of construction in the Service of Supply. The 106th Engineers, for example, arrived at Le Havre, October 1, and were assigned to general construction in base section No. 5. Work at the large hospital center at Mesves occupied the 109th Engineers from arrival in France October 6. The 113th Engineers, arriving September 28, were assigned to Air Service construction in the advance section.

The early work in France of the divisional Engineer regiments, therefore, may be divided into four general groups: The first included those units reaching France during the latter part of 1917, before any comprehensive plan of training had been developed. The second group included those regiments which were trained in American divisional areas. The third group consisted of units whose training periods were spent with the British. The fourth group comprised those regiments which arrived in France too late for front line service and whose duties consisted mainly of general construction in the Service of Supply.

REFERENCE DATA, TRAINING OF DIVISIONAL ENGINEERS.

Monthly regimental reports and histories, page 437.

Program of training (first phase) for Sixth Division; No. 1307, G–5, General Headquarters, July 22, 1918.

Memorandum for corps and division commanders, subject: "Training," August 5, 1918.

Program for training for divisions in the United States, Appendices Nos. 31, 32, 33.

ARMY OPERATIONS OF UNITED STATES ENGINEER UNITS.

The order in which the first units of the American Expeditionary Forces were organized and transported to France was influenced by representations of the British and French, who stated that the most urgent need was personnel for the construction and operation of railways. Consequently, nine Engineer railway regiments were recruited to a strength of 1,066 men each, and six of them had debarked in France before the arrival of the first American combat division. All nine regiments landed in France within the period July 26, 1917, to August 30, 1917. Shortly after reaching France the railway regiments were increased in strength to 1,587 men.

The regiments were the 1st, 2d, 3d, 4th, 5th, 6th, 7th, 8th, and 9th Railway Regiments, United States Reserve, later designated the 11th, 12th, 13th, 14th, 15th, 16th, 17th, 18th, and 19th Engineers (Railway) United States Army. The five last-named regiments were immediately assigned to the American line of communications and, excepting the 15th and 16th Engineers, never served as Army troops. Upon their arrival in France, the 11th, 12th, and 14th Engineers were attached to the British Expeditionary Forces, while the 13th Engineers was attached to the French forces. The 16th Engineers was eventually relieved from duty in the American Service of Supply and joined the three other United States railway regiments with the British Expeditionary Forces.

ENGINEER ARMY TROOPS WITH BRITISH EXPEDITIONARY FORCES.

Brig. Gen. John Biddle was placed in command of the three regiments of American railway troops upon their arrival in the British Army areas. Brig. Gen. W. C. Langfitt, who was at the same time manager of light railways in the American Expeditionary Forces line of communications, relieved Gen. Biddle in October, 1917. Beginning in November, all other American units attached to the British Expeditionary Forces, including aero squardons, hospital units, and detachments of Army Engineer regiments, formed an American command, principally for administration purposes, under Gen. Langfitt. Having been promoted, December 18, 1917, Maj. Gen. Langfitt continued in the above-described command until relieved by Brig. Gen. W. W. Harts to become chief of utilities of the American Expeditionary Forces Service of Supply.

11th Engineers.—From the 10th of August, 1917, until the end of January, 1918, the construction and maintenance of the standard-gauge and light railway lines of the British military railway system was in the general vicinity of Peronne. The regiment operated under direction of the Third Army's assistant director of light railways. In its normal duties of railway construction and maintenance the regiment participated in the preparation for and execution of the British Cambrai offensive beginning November 20, 1917. Company B and one-half of Company D at Plateau assisted in unloading a fleet of the tanks used in the offensive. Great secrecy was maintained in the operation, tanks being parked in a valley to be made ready for action and then reloaded for transport to points close to the lines. The work was all done at night or on very foggy days. The territory captured in the attack contained the badly demolished French standard-gauge line running from Epehy through Gouzeaucourt to Marcoing. Companies B, F, and half of Company E immediately engaged in the reconstruction of that line in order to effect a connection with the captured German lines at Marcoing. Working with the Fourth Canadian Railway Battalion, the two and one-half companies had accomplished their task when on November 30 the enemy counter-offensive was launched. It came so quickly that the men of the regiment working in the vicinity of Gouzeaucourt were taken completely by surprise and had difficulty in retiring. In the action there were 2 men killed, 13 wounded, and 15 missing. The other members of the detachment retired to their camp at Sorel. As the camp was under intense enemy artillery fire, it was quickly abandoned and the detachment engaged in the construction of a reserve position some distance farther back. The men were armed and under orders to hold their works. if necessary.

Until the end of January the regiment continued its work in the reconstruction of light railway lines and in effecting additions to the existing system.

Early in February the regiment was released to the American Expeditionary Forces, and until April 4, 1918, engaged in railway construction in the American Services of Supply. However, as a result of a British request following the enemy offensive of March 21, 1918, the regiment was returned to the British Expeditionary Forces. Attached to the First Army, British Expeditionary Forces, from April 6 to May 10, 1918, it served as corps troops of the Seventeenth British Corps, engaging in the construction of reserve field defenses through out the strong enemy pressure of that period. A detail of the unit engaged in trench and entanglement construction on the 12th of April suffered 18 casualties from enemy artillery fire—2 killed and 16 wounded. Changing station on May 10, 1918, from Wanquetin (Pas de Calais) to La Bussiere (Pas de Calais), the regiment became corps troops of the First British Corps, continuing its field fortification work in the reserve position of that command until June 13, 1918, when it returned to the American Expeditionary Forces.

12th Engineers.—From August 21, 1917, to February 28, 1918, the Twelfth Engineers engaged in the operation and maintenance of light railways of the British military railway system attached to and in the area of the Third Army (South), British Expeditionary Forces. From the latter date, although engaged in the same work, the regiment was attached to the Fifth Army, British Expeditionary Forces, until March 21, 1918. The entire regiment participated in the preparations for the Cambrai drive, operating trains and repairing track more or less under artillery fire and partially under machine-gun fire. Ammunition was delivered under machine-gun fire to a battery within 500 yards of the enemy outpost works. Several train crews were operating in the immediate battle area when, on November 30, 1917, the enemy began his counterattack. His advance swept past one of the train crews; the men, however, concealed themselves and reported back to regimental headquarters after the Germans had been stopped and driven back. The entire regiment except train operators, who also carried rifles, stood by under arms all day November 30.

Upon the retirement of the British Fifth Army during the great enemy offensive of March 21 to 25, the regiment barely saved its personnel and part of its property. However, it lost its light railway lines, and from March 28 to April 12, 1918, it engaged in the construction of a system of defenses near Terresnil, just north of Amiens. The works were called the Pas-Conde defense line and were designed for the defense of Abbeville. On April 13, 1918, the regiment, less Company C, moved to la Val de Maison and engaged there in the construction of defense works until the 22d. From the latter date

until July 25 the five companies engaged in double-tracking the existing Longpre-Gamaches standard-gauge railway under the direction of the D. G. T., British Expeditionary Forces, in the Fourth Army area. Company C in the meantime was engaged in road construction in the vicinity of Planques. The 12th Engineers was released from duty with the British Expeditionary Forces on the 25th of July, 1918.

14th Engineers.—From the middle of August, 1917, until May 18, 1918, the 14th Engineers engaged in light railway operation and maintenance under direction of the assistant director of light railways, British Third Army. That part of the British military rail-

(25–S8) LIGHT RAILWAY TRACK WORK AT AZERAILLES BY 12TH ENGINEERS. AUGUST 15, 1918.

way system operated and maintained by the regiment covered a considerable area north and south of the Albert-Baupaume-Cambrai highway and extended after the Cambrai drive, in which the entire regiment participated, to a line approximately 18 kilometers west of Cambrai, serving a front of approximately 17 kilometers. The entire regiment, as transport, participated in the defense of the Third Army front and the slight retirement therefrom during the enemy offensive of March 21–26, 1918. Seven men of the regiment were wounded in that action. The First Battalion was relieved from its 60-centimeter railway construction on the 17th of May, and until June 12 engaged in the construction of the Auxi-le-Chateau-St.

Riquier section of the standard gauge line upon which the Second Battalion was already engaged. The First Battalion, however, operated under the direction of the D. G. T., Fourth Army, British Expeditionary Forces. In the foregoing operations the regiment was exposed to enemy artillery and air bombs a great part of the time. However, it lost only one man killed and one man wounded. The regiment was relieved from service with the British Expeditionary Forces on the 12th of June, 1918.

6th Engineers.—Regimental headquarters and First Battalion having debarked at Brest December 22, 1917, and Second Battalion at St. Nazaire on the 26th, the 6th Engineers, not then attached to a division, was assigned to construction duties in the divisional training areas of the American Expeditionary Forces. In the latter part of January, 1918, arrangements were made by general headquarters, American Expeditionary Forces and British Expeditionary Forces, for the instruction and training of the 6th Engineers as an Army bridge unit by attaching it to the British Expeditionary Forces for bridge construction in British Army areas.

Accordingly regimental headquarters and Companies B and D arrived at Doingt, near Peronne, February 11, 1918. From that date until March 22, 1918, the regiment, less Companies A, C, E, and F, engaged in heavy bridge construction under direction of the chief engineer, Fifth Army, British Expeditionary Forces. The experience and practice gained was remarkably valuable, for the regiment was worked at top speed in the erection or alteration of all of the numerous types of British standard timber and steel bridges. The structures ranged from timber and pressed iron culverts to multiple span-river crossings employing cantilever suspension and pile-bent supports, and included thousands of yards of pile trestle for light railways. The Fifth Army's area, mostly very low country, was profusely traversed by streams and canals, including the Somme, and the Army transport lines radiating from Amiens required a very large number of heavy bridges.

The enemy offensive of March 21, 1918, brought the 6th Engineers camp at Doingt under his very severe artillery fire. On the following day, therefore, the regiment was ordered to retire to Chaulnes, where was located a large Engineer dump. The command arrived in Chaulnes early in the morning of March 23, and in the afternoon received orders to prepare the dump for destruction and to await further orders for the abandonment and destruction of the dump. Such orders were received that night, and the command, less a demolition detail, left Chaulnes and arrived in Moreuil, as ordered, in the early morning of the 24th. The demolition detail, having accomplished its task, rejoined the command at Moreuil on the same

day. Of equipment, only a few truck loads and such as the men could pack was saved.

The command rested at Moreuil during March 24 and 25, except that on the second day details were employed in laying out certain defense works then planned. Ordered to Demuin on the 26th, the command was assigned the construction and defense of a position there, and at noon of the following day were again moved, by truck, to a position on the line which repulsed the enemy advance. The position, located near Warfusse-Abancourt and extending to the north side of the Bois de Taillaux, was entered by the 6th Engineers, Lieut. Col. J. N. Hodges commanding, on the 27th of March. Existing trenches were consolidated and the position was organized as well as conditions permitted. With Col. Hodges in command of the subsector, the position was held by the 6th Engineers and various odd organizations of the Fifth Army until relieved, April 3, 1918, against more or less continuous assault. The heterogeneous forces comprising Col. Hodge's "last stand" garrison were a part of the handful of brave men, called "Carey's Forces" and "Carey's Chickens," who, by their sudden desperate stand under Gen. Carey, robbed the Germans of complete victory.

Upon their relief by British combat units the 6th Engineers marched to Abbeville for rest, reaching that place April 5, 1918. On the 7th, however, the command marched to Camon and there reengaged in heavy bridge construction under the chief engineer, Fourth Army, until April 26, when it marched to Gorenflos and engaged in resting, refitting, and training until May 9, 1918.

In the meantime Companies A, C, E, and F had been relieved from construction duties in the American Service of Supply, and rejoining the regiment attached to the Fourth Army, were on May 2, 1918, assigned to field fortification and demolition duties under the chief engineer, Australian corps, until June 6, 1918. Companies B and D concluded their rest period May 9 and reengaged in Fourth Army bridge work until June 6.

On the latter date the regiment was concentrated at Renaucourt near Amiens, where, on June 8th, the regiment was relieved by Gen. Sir Henry Rawlinson, commanding the Fourth Army, British Expeditionary Forces, who conferred decorations upon several of the officers and men for distinguished service. The regiment was relieved from service with the British Expeditionary Forces and entrained for the American sector June 10, 1918, to become the divisional Engineer regiment of the Third American Division.

56th Engineers.—The American Engineer unit organized, trained, and equipped for Army searchlight work, cooperating with Artillery, machine guns, and pursuit planes in the antiaircraft service, was the 56th Engineers. Company F of the regiment was attached

to general headquarters, British Expeditionary Forces, from August 8, 1918, until October 15, 1918. The company was split into many detachments by that headquarters and distributed to the various British armies, each detachment being attached to a British Army searchlight unit. Assigned to antiaircraft duties along the entire British front just as the British Expeditionary Forces were inaugurating their final offensive, the company rendered conspicuous service in the successive operations up to October 15.

Electrical-mechanical detachment.—In response to a British general headquarters request, made about November 1, 1918, for expert electrical and mechanical personnel a detachment of one officer and 75 men chosen from six United States Engineer units reported to that headquarters for duty November 20, 1918. Although hostilities had ceased on the 11th, the need of the detachment was still very urgent. It was therefore divided into three equal parties and engaged in effecting electrical installations of more permanent character. One party was attached to the First Army, British Expeditionary Forces, one to the Second Army, British Expeditionary Forces, and the other to the line of communications, British Expeditionary Forces.

The efficient service of all the United States Engineer units with the British Expeditionary Forces is shown by numerous commendations of their technical ability, their resourcefulness under trying conditions, their bravery under fire, and their gallantry in action from British general officers. The authors of these expressions of appreciation ranged in rank from the field marshal, Sir Douglas Haig, down to the chiefs of various technical army services.

ENGINEER ARMY TROOPS WITH FRENCH ARMIES.

Only the 13th Engineers (Railway) and two companies of the 56th Engineers (Searchlight) were attached to French armies for duty.

13th Engineers.—Beginning August 18, 1917, the regiment was attached to the Second French Army for the purpose of operating and maintaining standard-gauge railway in the communication system of that army's area, which was the Verdun salient.

Until September 11 the regiment remained at Chalons while detachments were kept out on the military lines studying French methods of operation and becoming acquainted with the use of French power and equipment. On the 11th of September, 1917, the regiment established its headquarters at Fleury-sur-Aire (Meuse), 57 kilometers east of Chalons and 27 kilometers southwest of Verdun, and took over the operation and maintenance of railway lines supplying the sectors west and southeast of Verdun.

The enemy, learning of the presence of American railway troops in the area, harassed their operations continuously for the first 10 days—aeroplanes chasing trains with machine guns and bombs at night and artillery during the day breaching the lines. Train crews of the regiment on various parts of the railway operated under fire during the entire period ending with the armistice.

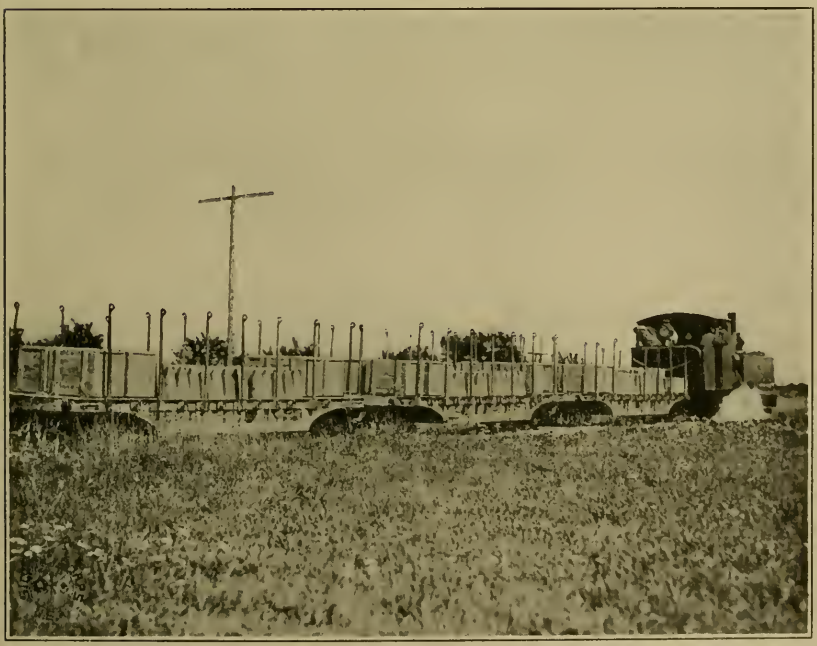
The mileage operated by the 13th Engineers was gradually increased. Various lines having been taken over from French units, who were thus released for other work. The work of the regiment was not only one of the very important elements concerned in the defense of the Verdun sector but it contributed to the Allied success in all actions originating in the Meuse, including the First American Army's St. Mihiel and Meuse-Argonne offensives.

56th Engineers.—Two platoons of the 56th Engineers, equipped with six 90-centimeter searchlights, were attached to the First French Army, and began operations near Amiens on the 15th of May, 1918. The detachment was increased in June to five platoons and organized as Company C, 56th Engineers. The company engaged in the antiaircraft defense of Amiens, cooperating with the British defenses until June 8. On the latter date, the air bombing of Beauvais having become very intensive, the company was moved to that vicinity and worked its lights in cooperation with pursuit planes, the first instance in which such tactics had been employed. After a few days the enemy's air activities ceased and the company was moved back to its former duties at Amiens. Upon the inauguration of the First French Army's offensive, July 1, 1918, Company C was moved up close behind the front lines and introduced into the French Army the "line of searchlights" method of defense. As the army advanced the company followed closely, maintaining its peculiar system of defense all the way. In spite of considerable hardship and some losses, it kept up its work during the advance until October 15, when it was relieved from duty with the French and withdrawn for service with the First American Army.

Company B of the 56th Engineers was attached to the Third French Army on July 4, 1918, and assigned to the antiaircraft defense of the important railhead of Creil. Creil was an important objective of enemy night bombers, and during the time the company operated in that vicinity it rendered effective service. On the 1st of September, 1918, the company was relieved from duty with the Third French Army and assigned to duty with the First American Army.

The work of the 13th Engineers and the 56th Engineers in the service of the French was very highly praised and commended in citations and letters of French commanders, many officers receiving awards.

(1944–J8) TROOP TRANSPORTATION BY LIGHT RAILWAY.



(7–S8) LIGHT RAILWAY AMMUNITION TRAIN ON LINE BETWEEN BACCARAT AND AZERAILLES. AUGUST, 1918.

UNITED STATES DIVISIONAL ENGINEERS WITH BRITISH EXPEDITIONARY FORCES.

Due to the crisis caused by the enemy's powerful offensives in the early spring of 1918, it was agreed at an interallied conference, May 2, that British shipping would immediately transport 10 divisions from the United States. Those divisions were to go into the British command for final equipment and training, serving as reserve divisions during the training period.

The first of the 10 United States divisions arrived in the British area April 16 and the last June 18. The British defense lines having become well stabilized and Paris being gravely threatened by the German Aisne-Marne offenses of May 27 to July 18, five of the American divisions were withdrawn from the British area during the second week of June before the last of the 10 had arrived. Two of the five, the 4th and 28th, with the 4th and 103d Engineers, respectively, attached, were rushed to reserve positions with the Paris group, between Chateau-Thierry and Paris. Of the other three, the 77th, 35th, and 82d Divisions, with the 302d, 110th, and 307th Engineers, respectively, attached, the first was moved to the relief of the 42d United States Division in the Baccarrat sector of the French front; the second relieved a French division in the Luneville sector; and the third relieved the 26th United States Division in the sector north of Toul.

The 4th Engineer Regiment, in common with its division, had received five weeks of valuable training with British corps before leaving the British area for the Paris group of divisions. Defense construction and road and light railway work, mostly under artillery fire, comprised its instruction. The 103d Engineers, however, had no sooner entered the British areas than it was moved out with its division and into the Paris group. It had, therefore, received no front-line training—in fact, none in France—before elements of its division entered the line on the Marne near Chateau-Thierry.

On the other hand, the Engineer regiments of the five divisions not withdrawn from the British area in June received from nine weeks to three months of training in British corps before going into line with their divisions. In the latter part of August, 1917, three of those divisions were withdrawn from the British command and moved to the newly-organized American front, while two of them remained with the British. The operations of the five Engineer regiments in the British areas are set forth below.

108th Engineers, 33d Division.—The regiment, having debarked at Brest May 25, 1918, arrived at Oisemont in the British area May 27. Until June 12, it remained in the training area in the vicinity of Oisemont, making up its equipment and engaging in gas, mus-

ketry, and engineer drill, and then proceeded to the vicinity of Amiens in the area of the British Fourth Army. There the First Battalion of the regiment was attached to the British Third Corps and the Second Battalion and Engineer train was attached to the Australian Corps. During the remainder of June and part of July, the regiment worked principally in the construction of the Fourth Army's line of principal resistance. Throughout July a detachment was attached to a British field survey company for instruction in printing, map reproduction and computing and in the reading of ærial photographs and preparation of artillery maps. Other detachments were attached to British royal engineer, tunnel, railway, and pioneer companies.

The regiment built several miles of trenches and wire entanglement; constructed revetments; designed and built machine-gun emplacements, turrets, and observation posts; and a considerable amount of standard-gauge and light railway; repaired and built all types of roads and various types of bridges, constructed strong points and installed water points.

Every night for a period of five weeks, details of from 10 to 20 men with one officer and several noncommissioned officers threw a pontoon bridge across the Somme River near Corbie. That bridge was under the direct observation of the enemy and almost continuously under heavy shell fire. However, it was the only means of crossing for ration and ammunition wagons and its nightly use was of vital necessity. It was thrown across at 9 o'clock each night and taken down about 4 o'clock the next morning. It was often damaged by shell fire, necessitating quick repair. Practically all platoons of the Second Battalion were assigned in rotation to the operation of that "Silent Bridge," as it was called. These details received high praise from Australian commanders for their efficiency.

Details from all companies of the regiment were constantly pressed into service with raiding parties along the entire front. Their work consisted of wire-cutting, patrolling "No man's land," and repairing damaged outposts and front-line defenses. The regiment also gained considerable experience in demolition and searchlight work.

The Second Battalion was relieved from the Australian Corps on August 6, when the entire regiment was assigned to the Third British Corps.

Company D, on August 7, was ordered forward to complete a Cavalry road for the combined attack on Villers-Bretonneaux on the morning of August 8. The company carried out what proved to be a very difficult operation in a manner so creditable as to win high praise from the Cavalry division commander.

From the 8th of August, when the British Somme offensive began, until August 20, the regiment participated in the advance, accomplishing well all its tasks, which included everything expected of a sapper unit in such an action. There were several casualties and two awards of the military medal in the regiment. Concentrating at Querrieu, August 21–22, the regiment entrained at Amiens on the 24th and left for St. Mihiel, where it was attached to the Fifth Corps, First American Army.

305th Engineers, 80th Division.—The regiment arrived in the British Samar training area near Boulogne June 17, 1918. While there it reequipped and engaged in Infantry and Engineer training according to schedule. On July 4 the regiment entrained and proceeded to Beauval, where the 80th Division went into front-line training, brigaded with British divisions of the 4th, 5th, and 6th British Corps until August 18. All companies of the 305th Engineers engaged in Engineer duties pertaining to a division in the line. Two companies were assigned to each of the three British corps. Their work included trench, entanglement, dugout, pill-box, and road construction, both in front line and in second position. Considerable survey, reconnaissance, and demolition work was also done.

The regiment was relieved on August 18, and on the 22d entrained for the American training area in the vicinity of Chatillon-sur-Seine.

303d Engineers, 78th Division.—Arriving in the British Alincthun training area near Boulogne on June 18, 1918, the regiment reequipped and engaged in Infantry and Engineer training under supervision of British engineer officers until July 3. On the latter date the regiment marched to the Oudezeele area, where its Engineer training was considerably broadened by better facilities. The regiment entrained July 27 for St. Pol, where it rejoined its division. In the British area about St. Pol the regiment continued its training according to schedule, carrying on also some dugout and hut construction and surveys. It entrained August 20 and moved to the 11th American training area in the vicinity of Jussey.

102d Engineers, 27th Division.—The 102d Engineers arrived in the British training area in the vicinity of Noyelles on June 4, 1918, and was fitted with gas masks, equipped with British rifles, bayonets, and helmets and instructed in their use. Other instruction in British practice was given under direction of British Royal Engineer officers until the 18th of June, when the regiment began moving to the area of the British Third Army. It arrived at Beauval, between Doullens and Amiens, on the 20th, and there continued schedule training until July 2, when it entrained for the area of the British Second Army, to the north. The regiment was there detailed to the construction of the East Poperinghe line of emergency works, which had already

been laid out and partly constructed. On July 25 a platoon from each of the companies was detailed for six days with the 41st British Division in the line for training purposes. Between the 1st and 18th of August three platoons of all companies of the regiment were detailed for six-day periods to the 41st Division, British Expeditionary Forces, in the line, in the capacity of divisional engineers. From August 21 to 31 the regiment engaged in the forward area defense construction over the British Nineteenth Corps front. On the 31st and through the three following days it participated with the 27th Division in a slight advance of the corps front in the Dickebusch area, just south of Ypres. The regiment, with its division, was relieved from the line on the 3d of September and moved south to the vicinity of Doullens, where, with the 30th Division, the 27th became the British Third Army's general headquarters reserve. A few days later both divisions were transferred to the British Fourth Army, and as the Second American Corps continued under the British Fourth Army commander until cessation of hostilities, taking part in the operations described subsequently herein.

105th Engineers, 30th Division.—The regiment arrived in the Licques British training area, near Calais, on June 18, 1918. Until the 28th of June it engaged in reequipping, receiving instruction in British practice and in Engineer training. During the 28th, 29th, and 30th of June the regiment marched to the Winnezeele area of the Second British Army. There until the 10th it continued its schedule training and engaged in the construction of the Winnezeele reserve line.

In the period July 10 to August 17 the regiment, with the entire 30th Division, engaged in training in various parts of the British Second Army's area. The regiment's work embraced all manner of field fortifications, as well as road and light railway construction and operation. Generally the system of platoon tours on various kinds of work was followed as has been described for the 102d Engineers, the platoons working with the division engineers of the 33d and 49th British divisions and with the pioneer battalions and foreways (light railway) companies.

By the middle of August the 30th Division had completed its training to an extent deemed sufficient to qualify it to take over a sector of the front, and on the 17th of August it relieved the British 33d Division in what was known as the Canal sector, just south of and adjacent to Ypres. On the night of August 26–27 the 105th Engineers, under British supervision, successfully launched a cloud gas attack from light railway trains. The 30th Division made an Infantry attack on its front simultaneously with the 27th American Division on its right on the 31st of August. The attack of the two

American divisions was entirely successful in its object of reducing a slight enemy salient. Companies E and F of the 105th Engineers were attached to the two attacking Infantry regiments of the 30th Division. Both companies were highly commended by the Infantry commanders.

The Division was relieved on the night of September 3–4, and moved south to the army reserve of the First British Army near St. Pol, arriving on the 7th of September. The regiment there continued its training until the 17th, when the division was transferred to the reserve of the Third British Army. The regiment then moved to Talmas, and on the 22d the division was again transferred to the Fourth British Army, with which command it remained until the signing of the armistice.

SECOND AMERICAN ARMY CORPS.

The Second American Army Corps was organized on June 19, 1918, for the administration of the American divisions training with the British. As has been related, the 10 divisions originally in the British area had been reduced to two, the 27th and 30th. In September the 27th and 30th Divisions became components of the British Fourth Army. On September 29 they were placed in line for the Fourth Army's attack on the Hindenburg line. The two American divisions took over a front between Le Catelet and Bellicourt, with British corps on either flank. The 102d and 105th Engineers laid the tapes for the Infantry jump-off, and one battalion of each regiment followed through on the reconstruction of roads over "No man's land" and the provision of water supply. Detachments of the regiments also were engaged in the destruction of enemy traps in captured works.

Attaining their objective, the two American divisions were relieved and the line was carried forward by the Australian Corps, which passes through them. The two Engineer regiments, however, were retained on road and light railway construction immediately behind the advancing front.

On October 6 the Second American Corps assumed tactical command of the two American divisions, and on that date relieved the Australian Corps. In the continuation of the Fourth Army's advance, the Second American Corps was in the center, the Ninth British Corps on its right, and the Thirteenth British Corps on its left. The 30th Division held the Second Corps' line and the 27th Division was in reserve. The sector taken over by the Second Corps on October 6 had for its northern boundary the line Haut Allaines (inclusive) Templeux-la-Fosse (exclusive), Templeux-la-Guerrard (inclusive), Mount St. Martin-Beaurevoir (exclusive), Premont (exclusive), Busigny (inclusive). Its southern boundary was the line Brie

Le Mesmel, Cartigny (inclusive), Hervilly (inclusive), Etricout Montbrehain (inclusive), Bohain (inclusive).

The Engineer troops of the Second Corps, outside of the divisional engineers, were furnished by the British when the sector was taken over. They consisted of two Army troops companies, two Australian tunnelling companies, three labor companies, and a detachment of electrical and mechanical troops. They were in command of a British officer, serving as chief royal engineers of the Second Corps, under the corps engineer. On the date of taking over, the 102d Engineers (27th Division) had been temporarily detached for work on roads across "No man's land," under the Thirteenth British Corps, but rejoined the Second Corps on October 8. They then served as corps troops until the 27th Division went into the line.

The items of Engineer work of pressing importance in the corps area on October 6 were the improvement of the water supply and the maintenance of the road across the "No man's land." The only available water supply for the forward lines at this stage of the operations was the St. Quentin Canal, which there runs in a deep cut and tunnel. A pumping plant to deliver water to the top of the cut had been installed, water sterilizing lorries established, and horse troughs put in. As that water point had to supply the horses of all the Artillery in the corps, as well as the forward division, there was much congestion at the point. As rapidly as possible the horse troughs were extended and the water point improved. Forty lorries were engaged in hauling stone to keep up the main supply road of the corps in the section between Hargicourt and Bellicourt, where it crossed the shell-torn area.

October 8 to 11 the 30th Division attacked and advanced the line to the west side of the Selle River. East of the line Premont-Brancourt, enemy demolitions were numerous, including some nine road craters, obstruction of streets in villages by blowing buildings into the road and the destruction of overhead railroad bridges. The 105th Engineers executed the advance Engineer work, and with the assistance of the Australian tunnelling companies, filled or by-passed the craters. The 102d Engineers as corps troops, at first maintained the Haricourt-Bellicourt road, and subsequently, assisted the 6th Canadian railroad battalion in the construction of a light railway line for the supply of the corps. The advance uncovered a considerable number of wells, and the water situation was thus relieved.

The interval between October 11 and 17 was spent in completing the repairs to the road craters, and in preparing for a further advance. The 102d Engineers then rejoined its division. The 105th Engineers continued the work on light railways. One Australian tunnelling company was relieved and replaced by an Army troops company.

On October 17, the 27th and 30th Divisions attacked side by side, crossed the Selle River, and carried the line to the heights overlooking the Sambre-Oise Canal. Each divisional Engineer regiment within its sector and the corps troops took over all work in rear, successfully executed all bridging operations in connection with the crossing of the Selle River. The Australian tunnelling company substituted heavy bridges where necessary, and completed the clearing of an enormous pile of débris across the road east of St. Souplet, caused by the destruction of the high brick viaduct that had carried the railway over the road.

On October 19–20 the divisions of the Second Corps, exhausted and depleted by the month's fighting, were withdrawn east of Amiens, except one battalion of each divisional Engineer regiment, retained for light railway work. Before needed replacements were received, the armistice had been signed.

UNITED STATES DIVISION ENGINEERS WITH FRENCH FORCES.

SECTOR OCCUPATION AND DEFENSE, INCLUDING THE "SECOND BATTLE OF THE MARNE."

Prior to the opening of the German offensive in March, 1918, the guiding principle of the general staff, American Expeditionary Forces, for the employment of arriving American divisions was that each division as it reached France would be sent to a specially chosen training area for a period of from one to two months. During that period the division would be equipped and receive its special training. Upon the completion of that preliminary period the division would be brigaded with French divisions in quiet sectors of the front for a month or six weeks duty in the trenches. Following that term of actual combat service the division would be reassembled in a training area and given a month of additional instruction, in which attention would be especially devoted to maneuvering as a division. Upon completion of the last month of training the division would take its own sector in the line.

The German advance toward Amiens on March 21, 1918, caused practically the entire abandonment of these plans. On that date only one United States division, the 1st, had completed the entire schedule. However, the 2d, 26th, and 42d Divisions had progressed to the point of sharing subsectors of the line by brigades with French brigades. Following the advance of the enemy on the Somme during the last week of March, Gen. Pershing turned over to Marshal Foch all available American combat divisions, and from that time until the beginning of the reduction of the Chateau Thierry salient all American divisions not with the British operated as elements of French army corps in the occupation

or defense of various sectors of the line. After Chateau Thierry, American army corps assumed tactical command of certain divisions. The operations of the Engineer regiment of each division under French army corps command will, therefore, be related only in connection with the operations of its division up to the time its division passed into American army corps command. From the inauguration of tactical command by American army corps the operations of Engineer units therein will be considered with relation to those of the corps operations.

1st Engineers, 1st Division.—The 2d Battalion, 1st Engineers, having participated with the French in the construction of front-line defenses in the Ansauville subsector north of Toul from January 21, 1918, and the 1st Battalion from February 1, the regiment was well qualified to discharge the duties of divisional engineers when it was withdrawn from its training in the latter part of March. Following the transfer of American divisions to the French high command, the 1st Division having been relieved by the 26th American Division, was moved from its sector to position in reserve at Chaumont-on-Vexin, in the rear of Montdidier sector. On March 28 the regiment had moved into the line, and until the 13th of July engaged in the construction of trenches, entanglements, dugouts, and the maintenance and construction of roads in the vicinity of Montdidier. On May 24 Company D moved to Froissy, to join the 28th Infantry in its practice for an offensive against Cantigny. The attack was made on the night of May 27 and morning of the 28th. The company advanced with the Infantry when the latter took the town, and there constructed strong points, working under intense enemy artillery fire for five hours. Having completed its work, the company was reassembled in rear for use as reserves. It was returned to the line as Infantry on the 28th, and continued such duties until the night of May 30. A citation in 1st Division orders, June 22, reads:

> Company D, 1st Engineers, Capt. H. L. Smith, jr., commanding, although handicapped at the beginning of the action by the loss of two officers killed and one wounded, nevertheless carried out its mission in a highly efficient and satisfactory manner; in addition to its duties as an Engineer company it acted as an Infantry reinforcement, and during the three days suffered severely in killed and wounded.

The regiment was concentrated at Roissy, July 13, and with the division moved to a place in line on the west face of the Chateau Thierry salient. The division front was Ambleny southeast to Dommiers. On its right was the 1st Morrocan (French) Division, and on the latter's right was the 2d (American) Division. Their objective was the heights just south of Soissons.

With the others, the 1st Division attacked on the morning of July 18. During the first two days of the advance the 1st Engineers, besides serving as Infantry reserves, engaged in road construction and in assisting the advance of the tanks. After the second day, however, the regiment did no engineer work, but was employed entirely as Infantry. That the division and brigade commanders rated the regiment highly as combatants is made evident by the fact that its elements were assigned most important objectives for attack and most difficult points for defense against counterattack, and also by the fact that the casualties in the regiment totaled 157. Coming out of action on the 22d of July, the regiment moved to Beaumarchais, and there rested until the 29th. Leaving Beaumarchais on the 30th of July, the regiment was moved with the division to a position in the line in the Saizerais sector, northeast of Toul. The sector being very quiet up to the inauguration of preparations for the St. Mihiel offensive, the regiment engaged principally in rest, engineering training, reequipment, and maneuvers with the division. Its participation in that offensive will be described under a subsequent heading.

2d Engineers, 2d Division.—The 1st Battalion was detached from the regiment, then engaged in training with its division in its training area on February 26, 1918, and on the following day, to supplement the 1st Engineers, joined the 1st Division in the Ansauville subsector, north of Toul, occupied jointly with the French. The battalion there received front-line training similar to that given to the 1st Engineers until May 9, when it rejoined its regiment with the 2d Division.

In the meantime, on March 15, the regimental headquarters and the 2d Battalion had left with the 2d Division for a tour of front-line training with the French in the Robert Espagne and Sommedieue sectors, south of Verdun. It was there the 1st Battalion joined the regiment.

The German drives of March and April caused Marshal Foch to retire his reserve divisions from positions in training to points where long movements might be facilitated. Accordingly the 2d Division, which had been turned over to him, was assembled near Bar-le-Duc, May 10–12, and after a week of cleaning up, reequipping, and drilling, the Engineer regiment was moved with the division on the 20th to the vicinity of Chaumont-en-Vexin, from which latter point the 1st Division had already gone into line at Cantigny. It was intended that the 2d Division should relieve the 1st Division and the 2d Engineers had received orders to proceed into line near Montidier when, on the afternoon of May 30, the orders were rescinded, and the entire 2d Division was prepared for its march to the Château-Thierry

front, where it was thrown in to stop the advance of the enemy west of Château-Thierry. On June 3 the division took over a line thinly held by the French, and running through Hill No. 142, south and east, through Lucy-le-Bogage, Tiangle, Le-Thiolet to La-Mouette Farm. The division front was held on the left by the 4th (Marine) Brigade, 5th and 6th Marines, and on the right by the 3d (Infantry) Brigade, 9th and 23d Infantry.

The Germans attacked principally at Lucy-le-Bogage, on the following day, and were decisively repulsed. On the 6th the division began its attack which continued day after day in spite of vigorous enemy counter attacks. By July 10, when the division was relieved, it had won Belleau Wood, Bouresches, Dois de la Maritte, and Vaux. It had forced back the German line approximately a mile and a half, so that the division front was established on the line running southeasterly from Hill No. 126, and including Belleau Wood, Bouresches, and Vaux.

The 2d Engineers was engaged as Infantry throughout almost the entire period of defense and offense, the 1st Battalion attached to the 32d Brigade and the 2d Battalion attached to the 4th Brigade. Elements of the regiment, nevertheless, did procure sufficient relief from action as combatants, by working at night, to construct a very strong second line of defense approximately upon the division's original jump-off position. The excellence of the 2d Engineers as a combatant unit is attested by numerous citations concerning its work in the 2d Division's advance. It is significant that all or part of the 2d Engineers participated with the Marine and 3d Infantry Brigade on an equal footing as combatants in every action in that defensive and offensive operation which so covered those brigades with glory. The extent of the regiment's casualties is indicated by the fact that at the end of the series of actions one company mustered 30 men. The regiment's technical ability, however, was afforded no opportunity for test in the operation. The 2d Division, after stabilizing its line, was relieved by the 26th Division, the 101st Engineers taking over from the 2d Engineers. The latter regiment then withdrew to the vicinity of Montreuil-aux-Lions, where, until July 16, it rested, refitted, drilled, and accomplished some work on the corps defense line. On the 16th it moved in camions with the division to its sector in the line southwest of Soissons. The 2d Division took over to the right and south of the 1st Morrocan Division, on whose left was the 1st (American) Division. The southern point of the 2d Division's line of attack was Chavigny Farm. The objective of the three divisions, has already been described. The 2d Division attacked on the morning of the 18th, advanced 8 kilometers in the first 26 hours, and took its obectives.

During the advance both battalions of the 2d Engineers were attached to attacking Infantry elements. As new positions were taken they were consolidated and partially manned by the Engineers. From darkness until 2 a. m. on the night of July 19–20 both battalions worked on the organization of the division's new front, part of the men working their rifles where they were needed and the others working their intrenching tools on the defense works. Withdrawn from the front line at 2 a. m. on the 20th, the regiment and the division were relieved from the sector on that day, retiring to the vicinity of Meaux. On the 30th, after a slight rest and some reequipping, the regiment moved with its division by train to Champigneulles, near Nancy, in preparation for the St. Mihiel offensive.

101st Engineers, 26th Division.—The 101st Engineers remained in training with its division in the Neufchateau training area until February 7, 1918. Leaving Liffol-le-Grand on the 8th, the regiment, less Companies B and C, moved to the Soissons front, where it engaged in field fortification work, the companies being attached to French engineer units and operating under the direction of French engineer officers. The sector was quite lively at the time, and the work, consisting of entanglement, trench, and dugout construction, repairing of roads, erection of camouflage, and building of machine-gun emplacements, was accomplished under shell fire a great part of the time. Regimental headquarters and four companies continued their training with the French until March 21. The casualties were 2 killed, 8 seriously wounded, and several others slightly wounded or gassed. One officer and 14 men received the Croix de Guerre. Companies B and C in the meantime had remained in charge of the movement of divisional property from the Neufchateau training area to Orquevaux training area. The regiment, less Companies B and C, ordered to rejoin its division, reached the French sector March 22. The division having completed its tour of training with the French, had preceded the regiment to that area.

The 26th Division relieved the 1st Division in the Ansauville sector, north of Toul during the latter part of March, and by the 31st all companies of the 101st Engineers were on duty with the division. In addition to the sector taken over from the 1st Division, the 26th Division relieved an adjacent French division. The 101st Engineers therefore was charged with the engineer duties of a two-division front, which in April became exceedingly active. A vast amount of engineer work was required in the sector upon the arrival of the regiment, and a great deal more was made necessary by two fairly heavy attacks of the enemy, including the battle of Seicheprey on April 20. The two engagements caused serious destruction of existing defenses. All field works had to be rebuilt and their former strength increased.

The second and third positions of the sector were also considerably strengthened, all work being done by the regiment or by Infantry under the direction of Engineer personnel.

The regiment continued in the construction and supervision of field fortification and in the operation of dumps and a sawmill, until relieved by the 307th Engineers, 82d Division, and two companies of the 154th French Division, on June 28.

Entraining in four sections on the 29th and 30th of June, and the 1st of July, the regiment moved with the 26th Division to the relief of the 2d Division, which during its advance, June 6–July 10, had established a new front line running north and west from Chateau Thierry and including Belleau Woods, Bouresches, and Vaux. The 26th Division relieved the 2d Division July 10, the 101st Engineers taking over from the 2d Engineers. The operations of the 101st Engineers with the 26th Division in its advance from that line were under the First American Corps commander, and will be described further on.

117th Engineers, 42d Division.—The 117th Engineers left the Langres divisional training area February 19, 1918, for the vicinity of Luneville. There the division was brigaded with the French in the Luneville and Baccarat sectors. The Engineer regiment was distributed over a wide area and engaged in field fortification work under supervision of French engineer officers. The division took over the Baccarat sector from the French on March 29 and until June 18, 1918, the Engineer regiment discharged all the divisional engineer duties of the sector. On the latter date the division was relieved by the 77th Division and proceeded by rail to the Champagne front. It was there assigned a part of the second defensive position in the Suippes sector. The 117th Engineer regimental headquarters was at Vadenay with the divisional headquarters. The regiment made every effort to deepen and improve the second position, and by July 14, had it in such shape that it could be occupied and defended.

The German offensive in that sector began on the night of July 14–15. On the 15th, the 117th Engineers relieved the 165th Infantry in support. The German attack having been decisively repulsed, the 42d Division was taken out July 19 and moved to the Chateau Thierry front.

4th Engineers, 4th Division.—Having left the British Army areas and arrived in the vicinity of Meaux on June 13, 1918, while the German Aisne-Marne offensive toward Paris was yet strong, the regiment was moved with the 4th Division into the areas of the Second and Seventh French Corps in line northwest of Chateau Thierry. The 4th Division less the 7th Brigade operated with the Seventh French Corps, under the commanding general of the 164th

French Division. The 7th Brigade operated in the sector to the north, with the Second French Corps. Companies A, B, C, and D of the 4th Engineers were attached to the division while Companies E and F were attached to the 7th Brigade in the Second French Corps area. The division participated in the advance of the two French Corps, operating under the Seventh French Army until July 23, when they had crossed the Soissons-Chateau Thierry road. On the latter date the 4th Division was withdrawn from the French Corps, reassembled, and assigned to the army reserve of the Sixth French Army on the right. It became available then as First American Corps reserve. The work of the Engineers in the 4th Division's advance northwest of Chateau Thierry was principally consolidation of positions taken by the advancing Infantry, although considerable road work was accomplished. The casualties of the 4th Engineers during the six days of action were quite heavy.

FIRST AMERICAN ARMY CORPS.

The First American Army Corps was authorized January 9, 1918, and organized January 20. On June 21, 1918, the First Corps established headquarters at La Ferte-sous-Jouare and was placed in administrative command of the 1st, 2d, 3d, 4th, 26th, and 28th Divisions, constituting at that time the Paris group. For 10 days the First Corps operated in conjunction with the Third French Corps. The corps engineer handled the work of the corps' sector in collaboration with the chief engineer of the French Corps. On July 4 the First American Army Corps formally took over from the Third French Corps the sector immediately northwest of Chateau-Thierry, the front line running in a northwesterly direction from the vicinity of Vaux to the vicinity of Bussiares. At that time the sector, which was under the Sixth French Army, was held on the left by the 167th Division, Infantry (French), and on the right by the 2d Division (American).

It has been related that the 26th Division relieved the 2d Division in the First American Corps sector on the 10th of July. The First American Corps at the beginning of the offensive had the 26th Division in line on the right, the 167th French Division on the left, and the 42d American Division in reserve. It later had the 4th American Division.

101st Engineers, 26th Division.—On the morning of the 18th the two divisions in line attacked and continued their advance to a northwest and southeast line halfway between Beuvardes and Fresnes, which they reached on July 25. The 42d Division then relieved the 26th Division and the French Division.

During the advance of the 26th Division several details from the 101st Engineers were attached to the Infantry and, acting as com-

batants, took part in the attack in addition to their work as engineers. The main work of the regiment during the advance, however, consisted of repair and maintenance of roads. Road work was of special importance, owing to the great distance of the advancing front lines from the railhead, and also because of the great volume of troops and transport concentrated upon the few roads available. After the relief of the 26th Division, on July 25, the 101st Engineers continued on road work under the direction of the corps engineer, following closely behind the 42d Division to the line established on the Vesle, until August 3. On the latter date the regiment was relieved from duty under the corps engineer and returned to its division near Chateau-Thierry, where it remained until August 13. On the latter date the regiment departed with its division for the Chatillon-sur-Seine training area. It remained there until August 31, thence departing for a position in readiness for the St. Mihiel attack.

117th Engineers, 42d Division.—The 42d Division relieved the 26th Division in the Bois de la Fere on July 25. In its attack the 42d Division advanced very rapidly to the Ourcq River, and there fought for several days. Two companies of the 117th Engineers had been assigned to keep up the bridges over the Ourcq River. There they had many casualties, but kept the bridges rebuilt as fast as they were shot away. All of the other companies worked on the roads from Trugny up to the Ourcq. On July 28 these four companies were placed in divisional reserve, and on the night of August 1 they were ordered into line for an attack to take place on the following morning. The attack was made, and the 117th Engineers advanced to Chery Chartreuve, where it was relieved of its Infantry duties. At the time it was relieved the regiment, less the two companies, was the farthest advanced element of the division, or of any element of any division on the right or left of its division. Upon the relief of the 42d Division by the 4th Division, on August 2, the 117th Engineers was placed under the direction of the corps engineer and assigned to the construction of defensive positions to the front and rear of Chery Chartreuve.

The 117th Engineers was relieved from duty with the corps engineer and returned to the division on August 11, when it moved back to entraining points at La Ferte and Chateau Thierry. The regiment then proceeded with its division to the Bourmont training area, where it arrived on August 20. It remained there until the 28th, when it departed for the St. Mihiel offensive.

4th Engineers, 4th Division.—The 4th Division relieved the 42d Division north of the Ourcq, between Mareuil and Dravegny, August 2. On the following day the 4th Engineers moved into the division sector. During the next five days of the division's advance and check

at the Vesle, the regiment was engaged principally in repairing shelled roads, camouflaging roads, placing wire entanglements, building foot bridges across the Vesle, clearing passages for the Infantry, and burying horses. The regiment was under Artillery fire during the entire period, its casualties reaching a total of 210. From August 9 to 12, the regiment engaged in road repair and then withdrew. The 4th Division having been relieved by the 77th Division, the 302d Engineers taking over from the 4th Engineers. Until the end of the month, the regiment engaged in rest and training. It then departed for an American training area to refit and train until the 9th of September. On the 9th the regiment left with its division for a position in the St. Mihiel salient.

Corps Engineer operations.—The principal duties of Engineers coming under the direction of the corps engineer, First Corps, were the construction and maintenance of corps roads, the organization of second positions, and the supply of Engineer materials and shelter for troops. The corps engineer received a few Army road troops from the Sixth French Army, and on the 20th of July, Companies B and D of the 30th Engineers were assigned to him for road work. It has been related that the 101st Engineers and the 117th Engineers were used as corps troops upon the relief of their divisions. On July 24, the 308th Engineers arrived in the sector as a corps engineer regiment, and from July 26 until the relief of the corps on the 4th of August it was engaged in road repair and maintenance. On the latter date two French engineer companies and two battalions of French labor troops and the 1st Battalion of the 1st Pioneer Infantry as corps troops also began road work under the corps engineer. The First Corps turned over its sector to the Third American Corps on the 4th of August and assumed a position in readiness for the St. Mihiel offensive. All corps Engineer troops were turned over at the same time.

6th Engineers, 3d Division.—Having functioned as Army troops with the British Expeditionary Forces as related, the 6th Engineers next joined to the Third American Division on the 11th of June, and until July 14 engaged in the construction of defense works on the division's front, extending from just east of the Surmeline River to Chateau Thierry. A strong German attack, preceded by a heavy bombardment, was launched on the morning of July 15. Four companies of the regiment were at the time acting as Infantry regimental reserves, and the other two acted as part of the divisional reserve.

On the night of the 21st of July, Companies B and F, in preparation for the division's advance, constructed footbridges across the Marne at Fossy and Mezy. On the following night they threw across the Marne at Mezy a pontoon bridge consisting entirely of captured German material. The division began its attack on the 21st, using the

footbridges built by the Engineers. It took the north bank of the Marne and then swung northeastward, continuing its advance toward the Aire River until July 28, when the left half of its front was taken over by the 28th Division which in turn was, three days later, relieved by the 32d Division. In the meantime two companies of the 6th Engineers had completed, by noon of July 27, a heavy trestle-bridge across the Marne at Mezy, materially aiding the division's communications by relieving the ponton structure of the heavier traffic. The ponton bridge at Mezy was then removed and thrown across down the Marne at Jaulgonne. It was opened to traffic at that point on the morning of the 28th. The part of the regiment not engaged in the foregoing bridge operations was engaged as Infantry support and in the construction and repair of roads in the area of the division's advance.

The 6th Brigade of the 3d Division continued on to the Vesle, which was reached August 4, Companies B and C of the 6th Engineers accompanying the 6th Brigade. Company B built a timber bridge on the Gaussoncourt-Coulonges road on the 2d of August, and on the 4th replaced it with a heavier structure capable of carrying all loads. Between the 4th and 10th of August the two companies built many bridges in the area of the brigade advance, besides accomplishing a great deal of road repair. The other four companies of the 6th Engineers had remained in the vicinity of the Marne, engaged in the construction of permanent heavy bridges and of emergency defenses. On August 10 the 6th Brigade and two Engineer companies in the line were relieved by the 28th Division, and the entire division was relieved from the sector on August 14. The regiment then moved with the division to the Gondrecourt area, where it engaged in refitting and training.

103d Engineers, 28th Division.—Having arrived in the Paris group after leaving the British areas in June, 1918, the 28th Division became a part of the French Sixth Army reserve. Elements of the 28th Division served with French and American divisions during the attack north of Chateau-Thierry during the latter part of July, and on August 9 the division relieved the 32d Division, which at that time was part of the Third American Corps. Until the division went into line as a whole on that date, the 103d Engineers functioned as a corps regiment, first under a French corps and then under the Third American Corps. Its principal operations were the construction of lines of resistance, repairing roads and bridges, the erection of camouflage, and salvaging material. When its division went into line on the Vesle the regiment engaged in the construction of defenses on the division front and in bridge work on the Vesle.

107th Engineers, 32d Division.—The 107th Engineers joined its division, which had taken over a French sector in Alsace, on June

26, 1918. Until July 20 the regiment engaged in divisional Engineer work in this sector. The 2d Battalion, less one company, was assigned to work on the front-line trenches and the 1st Battalion operated directly under the orders of the French corps engineer on the second line of defense. In addition, detachments of the regiment operated the Engineer dumps and sawmills and did considerable surveying and mapping.

With the division, the regiment left the Alsatian sector July 23 and moved to the Chateau-Thierry front. There the division went in on the right of the 42d Division's advance toward the Vesle, relieving the 28th Division, which for three days had taken over the front of an advancing French division and half the front of the 4th Division, on the right of the latter. The 32d Division then continued the advance to the Vesle.

Because of the fact that all troops and transport of the 32d Division, the assisting elements of the 28th Division, and French corps artillery had only one road available during the advance, the Engineers' problem became entirely one of road maintenance. All roads were found pitted with shell holes, and in three places mines had completely destroyed the road. Also three indispensable bridges of about 25-foot span had been totally wrecked. As showing the manner in which the Engineer regiment performed its duties, it may be stated that all movement orders were issued at division headquarters on the supposition that the roads were in good condition throughout their entire length, and that, though obstacles due to demolitions were known to exist when the orders were written, repairs would be completed before the troops had reached their locality. These plans of the division staff were actually carried out without interruption as far as transport facilities were concerned. Although it had been raining heavily during the greater part of the advance, there was no instance of vehicles being mired on the division's roads. In regard to bridging, the case of the bridge at Coulonges may be cited. It had been a 25-foot steel-girder bridge and was completely demolished by the retiring enemy. The Infantry advance reached the crossing late one afternoon. By 1 o'clock the following afternoon the bridge had been replaced by a structure built of material from ruined houses in the immediate vicinity. That hastily assembled bridge not only carried all traffic of the division, but in addition carried with perfect safety a train of heavy artillery, each piece of which brought a 20-ton load on the bridge.

Up to August 9, when the division was relieved, the regiment had built 6 bridges and repaired 5; had built 5 culverts and filled 3 large mine craters; had demined 3 bridges and culverts; had constructed 1 kilometer of new road and repaired 32 kilometers of old;

had cleared 3 towns of débris, and constructed two dugouts, all in addition to maintaining a detail of 10 officers and 30 men daily on engineer reconnaissance, from which were made 7 maps in 535 copies.

On two nights all preparations were made for bridging the Vesle River with either foot, pontoon, or trestle bridges, as the situation might demand. In each case it was found impossible to subdue the enemy's fire on the sites sufficiently to permit the work to progress, and no bridge was actually built. Fords, however, were located and subsequently used. Much of the work was done in areas subject to gas, shell, and machine-gun fire. Some of the reconnaissance was accomplished not only in advance of the division's Infantry but on one occason well within the enemy's lines.

Upon the relief of the 32d Division the 2d Battalion of the 107th Engineers was attached to the 28th Division and the 1st Battalion to the 6th Brigade of the 4th Division, to assist in the construction of the bridges over the Vesle. On two consecutive nights all preparations were made, including the bringing up of material for all types of bridges, but as before the operation was prevented by hostile fire. The regiment, relieved from that duty on August 11 and withdrawn to the rear, continued road and bridge repair work under direction of the chief engineer, Third Corps, of which its division became the reserve until August 31. Leaving September 1 for the French sector just north of Soissons, the regiment was engaged in active operations with its own division there until the 6th.

When it was relieved, and until the 26th, the regiment engaged in training and reequipping in the American divisional areas in preparation for the Meuse-Argonne attack.

302d Engineers, 77th Division.—As has been related, the 77th Division relieved the 42d Division in the Baccarat sector June 17, 1918. The 302d Engineers, of the 77th Division, then continued the field fortification, road, and engineer supply operations of the 117th Engineers until the end of July. The 77th Division was then relieved by the 37th Division, the 112th Engineers relieving the 302d, which entrained for the Marne, where on August 4 the 77th Division relieved the 4th Division on the Vesle. The 302d Engineers then relieved the 4th Engineers and the 117th Engineers, also operating within the division sector.

THIRD AMERICAN ARMY CORPS.

The Third American Army Corps was organized late in June, 1918, and given administrative command of several American divisions. It assumed tactical command of the 28th, 4th, and 32d Divisions about June 28, and with those divisions on the right of the First American Corps, carried the line from the Ourcq River to

the Vesle. The Third Corps then took over also the First Corps front, holding it with the newly acquired 77th Division. The 302d Engineers of that division there completed the construction of a strong defense system on the south bank of the Vesle.

The enemy began his withdrawal from the north bank of the Vesle on the 3d of September, and the Third Corps immediately crossed the Vesle in pursuit. The 302d and the 103d Engineers followed the Infantry, maintaining roads and constructing bridges over the river.

Corps Engineer troops.—The 1st Battalion, 14th Engineers (L. R.), formerly attached to the British Expeditionary Forces, reported August 2 to the corps engineer, Third Corps, for duty as corps troops. On August 7 the 2d Battalion reported for similar duty. The regiment was engaged principally in road and quarry work, but two of the companies made surveys for and began the construction of a light railway line from the broadguage north of Trugny to Fere-en-Tardenois. Upon its withdrawal the 308th Engineers and the 1st Pioneer Infantry were turned over to the Third Corps by the First Corps. They engaged in road and bridge work, cleaning up ground for aviation field, and in salvaging and the operation of engineer dumps. Other units assigned to the Third Corps by the First American Army, which had been organized August 10, were: Company A, 23d Engineers (road company); 10th Truck Company, 23d Engineers; Company D, 26th Engineers (water supply); Company C, 27th Engineers (mining); detachment 30th Engineers (gas and flame); detachment 40th Engineers (camouflage); and detachment 464th Engineers (ponton company).

Army Engineer troops.—The chief engineer of the First American Army had established headquarters at La Ferte-sous-Jouarre on August 10, and when his headquarters moved to Neufchateau, August 13, in preparation for the St. Mihiel offensive, having certain Army Engineer units available, turned them over to the corps engineer, Third Corps. These units, employed by the corps engineer, Third Corps, as indicated, were: Regimental headquarters and Company E, 37th Engineers (electrical and mechanical); Company A, 23d Engineers (road): half of regimental headquarters, and Companies B and C, 27th Engineers (mining); one-half Company D, 26th Engineers (water supply); Company E, 11th Engineers (railway); and regimental headquarters and 2d Battalion, 14th Engineers (railway).

During the period September 10 to 15 the Third American Corps was relieved from its front between the Vesle and the Aisne. The American divisions in the corps were moved to the rear and prepared to take positions in the Meuse.

OTHER DIVISIONS IN FRENCH SECTORS.

7th Engineers, 5th Division.—Beginning July 8, 1918, the 5th Division moved out of its training area and took over a French sector at St. Die, in the Vosges. Until August 19 the regiment engaged in the construction of dugouts, trenches, machine-gun emplacements, wire entanglements, and trench mortar bases in the front and second lines, and the construction of shelters, roads, and camouflage in the rear. Details also accomplished considerable reconnaissance work, participating in patrols and raids with the Infantry. Other details were engaged in felling timber and the operation of several sawmills. The regiment retired with the division, August 20, for a period of intensive training in preparation for participation in the St. Mihiel offensive.

317th Engineers, 92d Division.—On the 20th of August the 92d Division took over the St. Die sector from the 5th Division, the 317th Engineers carrying on the work of the 7th Engineers. The defenses in the town of Frapelle, captured by the 5th Division just prior to its leaving the sector, were organized by Company E, 317th Engineers. The operation entailed the carrying of a considerable quantity of engineer material under intense artillery fire, during the period August 23–28. Company D of the regiment working in the vicinity of Angleterre, was called into support of the Infantry September 10, and did such work as to gain commendation from the brigade commander. The regiment withdrew with the division on September 21, and moved to a position in the rear of the First Army's Meuse-Argonne offensive.

110th Engineers, 35th Division.—The 110th Engineers with its division moved into the Remiremont sector in the Vosges on July 1, 1918, relieving a French unit. In addition to discharging the various duties of divisional engineers in war of position, the regiment accomplished a great deal of tunneling, for communications between numerous bomb-proof dugouts in hillsides. Another exceptional feature in the work of the regiment was the construction of an aerial tram.

The 35th Division was relieved on September 1 by the 6th Division, the 318th Engineers relieving the 110th Engineers. The regiment left the area with its division on September 4 for participation in the St. Mihiel offensive.

318th Engineers, 6th Division.—Having taken over the 35th Division's sector in the Vosges on September 1, 1918, the 6th Division retained its occupation until October 10. During that period the division's Engineer regiment, the 318th, carried on the engineer work of the area.

The division was relieved by two French divisions on October 10, and left the area on the 13th. In the vicinity of Bussang (Vosges), the regiment drilled and reequipped until October 26. On the 27th the regiment entrained and departed with its division for the Meuse-Argonne offensive.

112th Engineers, 37th Division.—The 37th Division relieved the 77th Division in the Baccarat sector on August 3, 1918, and the 112th Engineers took over the work of the 302d Engineers. Until October 4 the 112th Engineers engaged in construction of wire entanglements, dugouts, machine-gun emplacements, observation posts on the line, and of various forms of shelter in the rear. Details also engaged in gas-proofing dugouts, reconnaissance, map making, and reproduction, and the operation of a sawmill and shop at Baccarat. On September 14, the division began moving out of the Baccarat sector. The 112th Engineers was in position with its division for the Meuse-Argonne offensive, on September 22.

104th Engineers, 29th Division.—The 29th Division, with the 104th Engineers attached, arrived in the French Corps area including Belfort, on July 7, 1918. The division, however, did not take over a sector in the line until August 9. The Engineer regiment until that time engaged in Infantry and Engineer drill. From that date and until September 21, while the division was in the line, the regiment engaged in construction of dugouts, trenches, and entanglements. It also maintained two division dumps and furnished details for work in the French Corps dump.

Company C participated in two raids, its function being to breach the enemy wire by the use of bangalore torpedoes, which proved unnecessary, as the explosives were not used in either instance, it being found that the supporting barrage had entirely laid the wire.

September 21 to 28, the regiment with its division was en route to a position in the area of the First Army's Meuse-Argonne advance.

DIVISIONAL ENGINEERS WITH THE FRENCH IN BELGIUM.

Owing to the depletion of the French forces advancing in Belgium during September, two American divisions participating in the First Army's Meuse-Argonne offensive, were withdrawn from the latter operation on October 6, sent to the rear for a short period of training and reequipment, and then moved north to the vicinity of Vlamertinghe (Belgium). The two divisions, the 37th and 91st, with the 112th Engineers and 316th Engineers, respectively, attached, detrained in that area on the 19th, 20th, and 21st of October. The two divisions there became components of the Seventh French Army Corps, and participated in that command's Lys-Scheldt offensive, from October 29 to the cessation of hostilities on November 11.

112th Engineers, 37th Division.—The advance of the 37th Division began on October 28. One company of the 112th Engineers took charge of the pontoon and pasarelle bridges over the Lys, which had already been placed by French engineers. Another company was attached to the two Infantry brigades, and engaged principally in neutralizing traps and mines left by the retiring enemy. From October 31 the other four companies followed the Infantry advance and maintained the axial road. The division having arrived at the Escaut (Scheldt) on the 8th and 9th of October, the 112th Engineers threw footbridges across the river for the Infantry's advance. On the following day a reinforced timber bridge, for all loads, was thrown across the Escaut. In addition, other footbridges were laid on the night of November 10–11. The regiment continued road and bridge construction and maintenance until November 21, when it moved back to Ardoye, Belgium.

316th Engineers, 91st Division.—Although operating in the area of its own division, the 316th Engineers worked under orders of the chief engineer, Seventh French Army Corps, during the advance to the Escaut. Its principal activities were road and bridge construction, the maintenance of the axial roads, and the removal of mines and explosives from bridge abutments, road crossings and traps. Among the bridges built by the regiment was a temporary timber structure in Wareghem, a similar one in the town of Audenard, and a pontoon bridge just north of the latter town. Bridge material was assembled at several places during the operation but changes in corps or division orders rendered the preparations futile.

It is interesting that during the regiment's billeting period in Audenard—November 11–18, it removed approximately 300 mines in that town. They were planted chiefly in the main arteries of travel leading out of the city, and at intersections within the city. In some cases the location of the mines was revealed by the Belgian inhabitants. More than 400 mines were removed from the road between Audenard and Wacken.

OPERATIONS WITH THE AMERICAN FIRST ARMY.

Reduction of St. Mihiel Salient.

The American First Army headquarters was organized in July, 1918. It had been proposed that the First Army should begin its operation in the reduction of the Marne salient, and it was intended that it should use two American corps on that front, the First and Third, whose headquarters had already been organized. It will be remembered, however, that these corps, as components of French Army commands, had already reduced the salient from Chateau Thierry to the Vesle and there established their sectors of the new

front. A new front was therefore selected for the first operations of the American First Army; and this St. Mihiel salient where the enemy occupied the general line in front of Rouves, Cheminot, Regnieville-en-Haye, St. Baussant, Apremont, Fort du Camp des Romains, Chauvoncourt (including the city of St. Mihiel), Spada, Seuzey, Combres, Tresauvaux, and Ville-en-Woevre. The line was strongly fortified and the enemy's forces were distributed in great depth in order to meet a strong attack. The composition and disposition of the First Army was as follows:

First Corps on the extreme right, extending from Port-sur-Seille west to Limey, with the 82d, 90th, 5th, and 2d Divisions in line and the 78th Division in reserve.

Fourth Corps on the left of the First Corps, its front extending from Limey to Richecourt, with the 89th, 42d, and 1st Divisions in line and the 3d Division in reserve.

Second French Colonial Corps, capping the point of the salient, with a front extending from Richecourt around Chateau-Thierry north to Mouilly. It had the French 29th and 36th Infantry Divisions and 2d Dismounted Cavalry Division in line and no reserve.

Fifth Corps to the west of the salient and on the extreme left of the line, its front extending from Mouilly north to Watronville, with the 26th Division, 15th French Colonial Division, and elements of the 4th Division in line and the remainder of the 4th Division in reserve.

The general plan of the offensive included—

(*a*) An attack from the south through the wooded country southeast of Vigneulles.

(*b*) A follow-up attack on the left flank of the southern attack.

(*c*) An attack from the west over the eastern heights of the Meuse between Les Eparges and Seuzey toward Hannonville and Hattonville.

(*d*) An exploitation and follow-up attack on the right flank of the western attack.

(*e*) Eventual exploitation of all successes attained.

The southern attack was to be made by the First and Fourth Corps from left to right. The follow-up attack on its left flank was to be made by the Second French Colonial Corps two hours after the southern attack had started. The French corps also was to make the attack given in (*d*) above, advancing two hours after the attack given in (*c*) above. The Fifth Corps was designated for the western attack.

After four hours of Artillery preparation the Infantry advanced at 5 o'clock on the morning of September 12. To relate the operations of each Engineer unit engaged in connection with the operations of its command is not possible within the limits of this report.

The general Engineer operations of the three American corps will be presented, therefore, and followed by a summary of the salient features in the operations of the Army Engineers.

First Army Corps.—The Infantry of the First Corps, preceded by divisional Engineers, who destroyed the successive bands of wire entanglements, had taken its final objective before dark on the day of the attack. The Infantry was accompanied by tanks and platoons of Engineers were employed in assisting the tanks over difficult terrain. The 2d Division took Thaiucourt and there remained then only the task of consolidating the new position and the effecting of a junction with the Fourth Corps on the left. The latter was effected on the following day. Divisional engineers were employed in the construction of the defenses on the new line. By the 14th the Infantry had again advanced and established a new line east of Jaulny, and on the 15th the final front was established just south of Rembercourt.

On the final line the divisional Engineers, assisted by the Infantry, dug an extensive system of defenses. The greatest task of divisional and corps engineers during the advance was the construction and maintenance of roads for heavy transport. The Infantry and the light artillery had swept forward regardless of their transport, and the preparation of two-way roads for the movement of supplies and heavy artillery was a difficult task. It had been anticipated that the roads of "No man's land" would be in bad shape on account of the long period of stabilized warfare, but they were bad beyond anticipation. To a large extent they had been obliterated by three years of shelling. They were in addition cut by trench crossings, obstructed with wire and at intervals with tank traps. They were narrow and without foundation, making almost complete reconstruction necessary through a width of more than a kilometer. It was impossible because of the enormous traffic to transport road rock from the rear, and walls in ruined villages were demolished and the stone used for rebuilding and repairing roads.

The Engineer regiments of the divisions in the line, the 2d, 7th, 315th, and 307th Engineers were employed principally in wire cutting in advance of the Infantry, assisting tanks, locating and destroying enemy traps, building and repairing roads and bridges, repairing and operating light railways, locating and opening up water supply, and operating captured Engineer dumps.

The 315th Engineer Train operated two wrecking trucks during the period of heavy traffic in the attack. They proved to be of great value, for the roads were extremely slippery. One of the wreckers pulled out 19 ditched trucks in one day.

The following experience of the 307th Engineers is typical: On September 12, Company D opened the road, then in "No man's land."

from Pont-a-Mousson into Norroy, demolishing buildings and building a sheltered road into the town. Capt. Baird and Lieut. Andrews with 13 of their men picked up an Infantry patrol and captured Maison Gauthier, a machine-gun nest in the German lines. Company E moved from Dieulouard to the Cantonnerie on September 14, and on the 15th advanced with the Infantry from Norroy to Vandieres, organizing with the Infantry the new line from the hill northwest of Vandieres back to Norroy. Companies B and C on the night of the 15th organized the hills west of the Moselle from Pont-a-Mousson to Norroy, where there was an exposed flank. The above work by all four companies was rendered difficult by the extreme darkness, the fact that none of the officers had seen the terrain, and the lack of guides. The machine-gun positions were located largely by memory of the ground as shown on maps. The entanglements and trenches were laid out under gas and high-explosive shell fire. Despite such difficulties few changes were necessary when the work was inspected the next day.

The 111th Engineers, First Corps troops, and the 303d Engineers of the 78th Division in reserve, as well as the 53d Pioneer Infantry, rebuilt and maintained the roads of the corps area in the rear.

The First Corps was relieved on the night of September 17 from its sector of the line by the Fourth Corps which continued to hold its sector on the left.

Fourth Army Corps.—The 1st, 42d, and 89th Divisions took Mont Sec, Monsard, and Lamarche on the first day of the attack. On the following day they had taken St. Benoit and had formed a junction with elements of the Fifth Corps. Their advance was continued until September 18, when the front was established west and south of Etang de Lachaussee. The work of the divisional Engineers, the 1st, 117th, and 314th Engineers, in the demolition of enemy defenses, the organization of positions, assistance of tanks, and construction and maintenance of roads was similar to that of the divisional Engineers of the First Corps. However, the advance of the Fourth Corps, having included an area threaded by the Rupt de Mad and its numerous branches, the divisional Engineers were required to build many more footbridges and to replace them later by timber structures for heavy traffic.

Company A, 1st Engineers, built five footbridges over the Rupt de Mad from Laheville to St. Eaussant. The timber for the bridges was carried 7 kilometers and the bridges were erected in from 5 to 15 minutes. Company B built eight bridges across the same waterway between Laheville and Richecourt. The first wave of the 1st Division's Infantry used those bridges almost entirely in crossing the waterway. A 20-man detachment constructed a timber bridge for artillery and tanks in three hours; another detachment prepared

a ford for artillery; another detachment, after damming the creek the night before, crossed with the first wave and prepared an artillery ford at Richecourt; another party of 28 men built a four-span artillery bridge at Richecourt in nine hours. The bridge carried light tanks and 155s.

The Engineer troops working under the immediate direction of the corps engineer were the 301st Engineers, engaged principally in road work and operation of corps Engineer dumps; the 1st Battalion, 51st Pioneer Infantry, on road work; and the 6th Engineers of the reserve division, employed on road and permanent bridge construction. A French wagon train of 150 carts and wagons was also assigned to the corps engineer for carrying road and other Engineer material.

The Fourth Corps was relieved in its sector the latter part of September by the newly organized Sixth American Army Corps.

Fifth Army Corps.—The greater part of the Fifth Army Corps' advance was made by the 26th Division. The French division on the left had a much shorter distance to cover, and the elements of the 4th Division on the left of the French division merely held the line, acting as pivot. The work of the 101st Engineers with the 26th Division was practically the same as that of the divisional Engineers in the First and Fourth Corps.

The Engineer units operating under the direction of the corps engineer were the 4th Engineers, detached from its division; the 1st Battalion of the 53d Pioneer Infantry; and the 310th and 602d Provisional Corps Engineer Regiment.

The topography of the St. Mihiel sector was exceedingly irregular, and the corps sector was a series of high, heavily wooded hills, with winding roads and railroads. As detours were impossible, the slightest obstruction in the roads made them practically impassable to the artillery and supply trains.

Portable bridges were constructed previous to the action for the use of the Artillery in crossing trenches and other obstructions of similar nature. The building of other bridges proved to be troublesome only in the immediate rear of the enemy's former front lines where existing bridges had been destroyed either by the enemy or by our fire. They were replaced, however, in the usual manner, except that the scarcity of bridge timber necessitated the use of round timber cut on the spot.

Narrow-gauge railroads were carried as close as possible to the lines prior to the operation by the 12th Engineers (railway), and preparations made to extend them as soon as circumstances would permit. The enemy had left a very elaborate light railway system almost intact and did very little to interrupt its operation by United States railway troops. The roadbed across the two trench systems

alone was lacking in the connection of the First Army's light railway with that of the German. Having the materials at hand and concentrating upon that work the two lines were rapidly connected, affording a very efficient system for the transportation of supplies and material.

Roads were of primary importance, and to that phase of the work the greatest amount of time and effort was directed. Through the lack of transportation prior to the engagement, it was impossible to establish dumps of road materials in the forward areas where it would be easily accessible and available for use in the immediate vicinity. The lines in the sector had been practically stationary since the war began, and in consequence the roads over "No man's land," through the two trench systems, and in the district in the immediate rear were all overgrown, washed out by the heavy rains, and generally deteriorated. Heavy rains just prior to the attack had made the roads in the rear almost impassable, and they were badly torn by new shell craters. All available forces were concentrated, therefore, in working on roads through the old enemy line of resistance.

One bridge of 16-foot span was built across the River Vaux in the town of Vaux; four tank traps on the Vaux-St. Remy road were filled with rock from Vaux and from trench waste. Those traps were holes about 10 feet deep and 25 feet in diameter, directly in the center of the road.

The corps engineer moved his headquarters to Ville-sur-Cousance (Meuse), September 19, in preparation for the Meuse-Argonne offensive.

OPERATIONS UNDER DIRECTION OF CHIEF ENGINEER, FIRST ARMY.

The chief engineer, First Army, devised the general plan of operations of Army, corps, and divisional Engineers in the St. Mihiel offensive and maintained supervision of the Engineer operations under the direction of the corps and division Engineers. In addition his headquarters directed the actual operations of the Army Engineer troops not attached to corps or divisional headquarters.

Outside of planning and supervising the general Engineer phase of the offensive he was charged with the execution of certain principal duties in which were to be employed the technical Engineer troops and labor troops assigned to his command. Those duties were: The advance of standard-gauge railheads as far as enemy artillery and aircraft permitted; the advance of light railway lines to the limit of direct artillery and machine-gun fire; the maintenance of roads and bridges from railheads forward to points where they could easily be cared for by corps and divisional troops; the provision and installation of water-supply and electrical and mechanical facilities; the

operation of searchlights in antiaircraft defense; the application of camouflage; the fabrication, repair, and issue, or delivery, of Engineer materials.

The Engineer units assigned as Army troops under the chief engineer, First Army, in the St. Mihiel offensive were as follows:

11th Engineers (standard-gauge railway)—entire regiment.

15th Engineers (standard-gauge railway)—2 companies.

12th Engineers (light railway)—entire regiment.

21st Engineers (light railway)—entire regiment.

23d Engineers (roads)—1st and 3d Battalion and wagon train headquarters, 6 technical companies, 4 wagon companies, and 5 truck companies.

(1255–D8) 26TH ENGINEERS ERECTING WATER TANK AT CHEPPY (MEUSE). OCTOBER, 1918.

24th Engineers (shop and supply)—1st and 2d Battalion headquarters, 4 companies.

26th Engineers (water supply)—4 companies.

27th Engineers (mining)—regimental headquarters, 2 companies.

28th Engineers (quarry)—1st and 2d Battalion headquarters, 3 companies.

35th Engineers (railway shop)—detachment of 53 men.

37th Engineers (electrical and mechanical)—entire regiment, less 1 company.

40th Engineers (camouflage)—2 companies.

56th Engineers (searchlight)—regimental headquarters and 2 companies.

1st Provisional Water Train.

464th Pontoon Train.

505th, 534th, 527th, 528th, and 537th Service Battalions, complete.

508th Service Battalion—1 company.

522d Service Battalion—1 company.

530th Service Battalion—battalion headquarters and 2 companies.

STANDARD-GAUGE RAILWAY OPERATIONS.

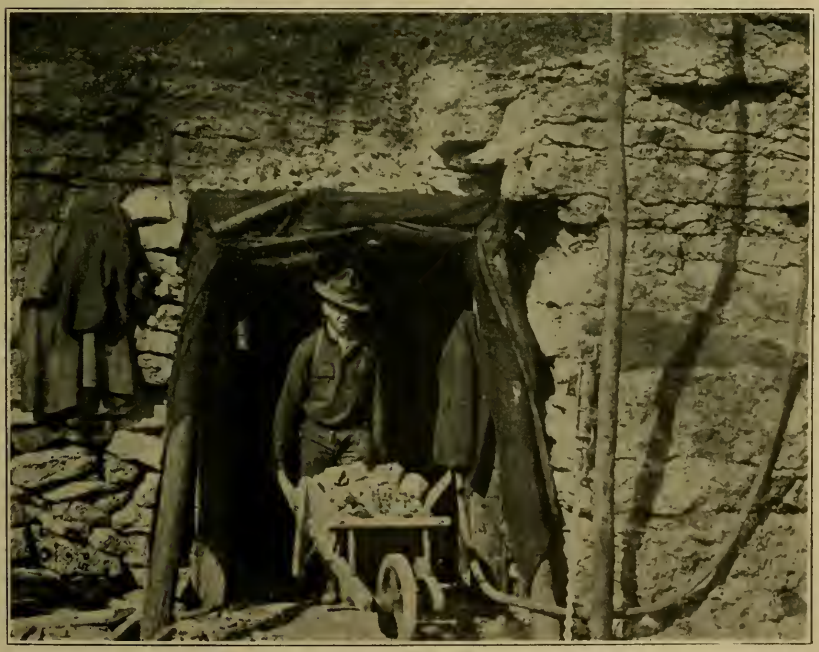
Prior to the opening of the St. Mihiel offensive standard-gauge railheads were in operation at Sorcy, Toul, and Belleville, and Menil la Tour had been extensively used as a railhead, but had to be abandoned because of shell fire. In preparation for the offensive additional railheads at La Ferne Boyer and Manonville were utilized. In the Rattentout sector railheads were established for ammunition at Courouvre and for general supplies at Rattentout. Engineer supplies were shipped to Domgermain, Leonval, and Rattantout. The only other standard-gauge construction work done by the First Army prior to the St. Mihiel offensive was the construction by one company of the 15th Engineers, assisted by United States and French labor troops, along the standard-gauge line north of Nancy, Toul, and Commercy of certain sidings and spurs for artillery.

Immediately following the offensive the reconstruction and repair of the line from Commercy through St. Mihiel to Verdun was started by two companies of French engineers and two companies of the 15th Engineers, and the work of transforming the meter-gauge line from Commercy to Woinville to standard gauge was started by the 11th Engineers. The line was completed and ready for traffic to Apremont September 25. Between Apremont and Woinville it was found that the Germans had removed all the rails and ties, and it was necessary to reconstruct entirely the old meter-gauge roadbed to Woinville.

After the completion of the Commercy-Woinville line to Apremont one battalion of the 11th Engineers was moved to Aubreville. The construction of the line from Apremont to Woinville was then continued by two companies of the 11th Engineers, assisted by two labor companies. The line was completed by the Second Army after the First Army had been transferred to the Meuse-Argonne front.

One company of the 11th Engineers, assisted by two labor companies, on September 28 started an extension of the standard-gauge line from Ansauville to Bernecourt. Work on the railhead at the

(474–M8) UNDERGROUND P. C. CONSTRUCTION BY 2D ENGINEERS NEAR MENIL-LA-TOUR. MARCH, 1918.



(476–M8) REMOVING ROCK FROM UNDERGROUND P. C. CONSTRUCTED BY 2D ENGINEERS NEAR MENIL-LA-TOUR. MARCH, 1918.

latter point was started at the same time. That extension was also completed by the Second Army.

LIGHT RAILWAY OPERATIONS.

Toul sector.—Before the inauguration of preparations for the St. Mihiel offensive the light railway situation in the Toul sector was, in general, as set forth below. The 21st Engineers, with headquarters at Sorcy, was in charge of the light railway construction, operation, and maintenance, in the Toul sector, from Sorcy to Broussey, and east to Menil-la-Tour and Bernecourt. The area included about 150 kilometers of 60-centimeter track. The main standard-gauge railhead was at Sorcy, where facilities had been provided for transfers from standard gauge to light railway, to storage, and to motor transport. The light railway terminal facilities were also located at Sorcy, including an engine house, machine and blacksmith's shops, coaling stations, sand driers, boiler-wash, and yard tracks. A light railway connection between Abainville and Sorcy was completed in the latter part of August, which made possible the quick transfer of material and supplies from the light railway depot at Abainville to the front.

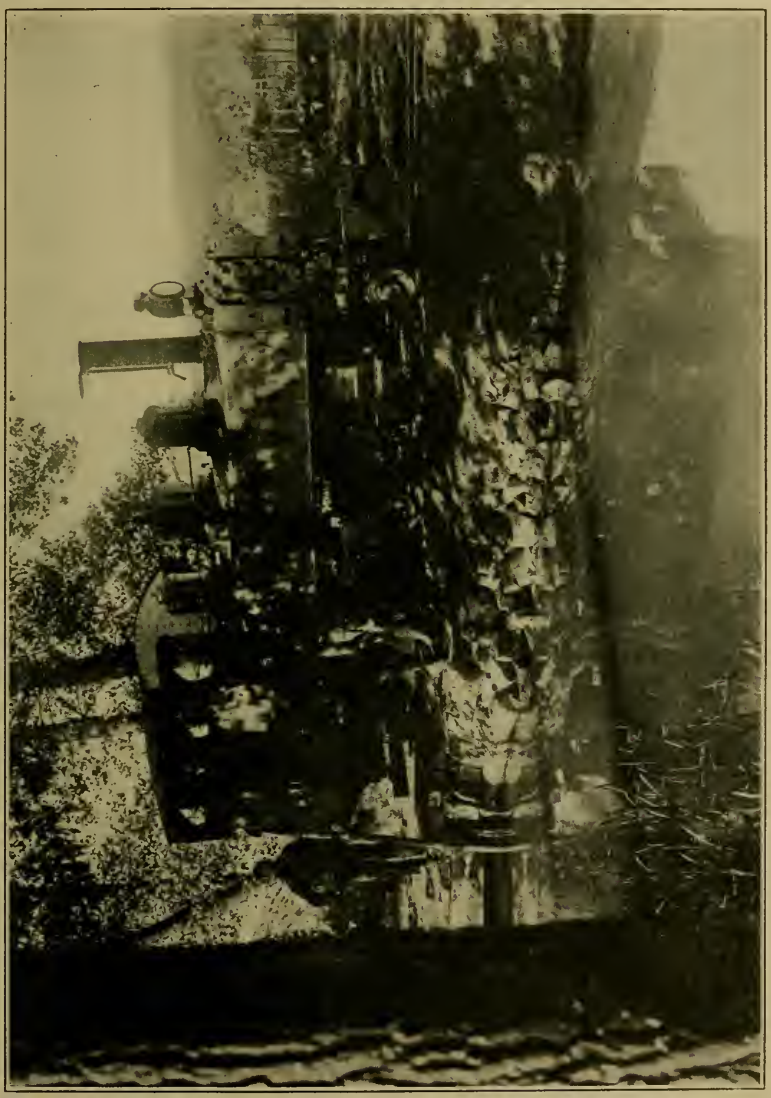
In preparation for the offensive there were also constructed lines from Pagny to Sorcy, Dongermain to Ecrouves, and a 1.7-kilometer detour at Jouy, and to permit the prompt connection of the advance lines with the German system from the three light railheads—Pont de Metz, Flirey and Bois Chanot—the advance dumps at these points were stocked with large quantities of rock, steel, ballast, and tools. This work was all done under the division of light railways and roads.

On September 1 American light-railway troops took over from the French all 60-centimeter lines east of Menil-la-Tour and Bernecourt as far as Belleville, so that at the start of the offensive the First Army was operating all lines in the Toul sector between Sorcy, Broussey, Belleville, and Toul, approximately 250 kilometers of track.

Immediately following the offensive, the three connections with the German system from the railheads mentioned above were begun and completed on September 15. The lines were: Pont de Metz to St. Jean Canyon, 3.2 kilometers; Flirey to Bois de Mort, 4.5 kilometers; Bois de Chanot to Xivray, 9.3 kilometers. The three connections brought under American operation a very extensive system of German 60-centimeter line in the St. Mihiel salient between Woinville, Vigneulles, Essy, and Thiaucourt. It was found that many of the German lines were of short curvature and heavy grades, and in many places so badly damaged by American shell fire that it was neces-

sary to rehabilitate about 20 kilometers before successful operation could be undertaken.

Including the extensions built and the German lines taken over, the total amount of 60-centimeter line under operation in the Toul sector on September 23 was approximately 400 kilometers, and heavy



(18-T8) U. S. ARMY LIGHT RAILWAY LOCOMOTIVE AT RUPT-EN-WOEVRE. SEPTEMBER, 1918.

tonnage of all classes of material was handled during and following the offensive, not only in the old American area, but also in the new territory evacuated by the enemy.

Rattentout sector.—The lines in the Rattentout area were operated by the French until September 1, when those portions between

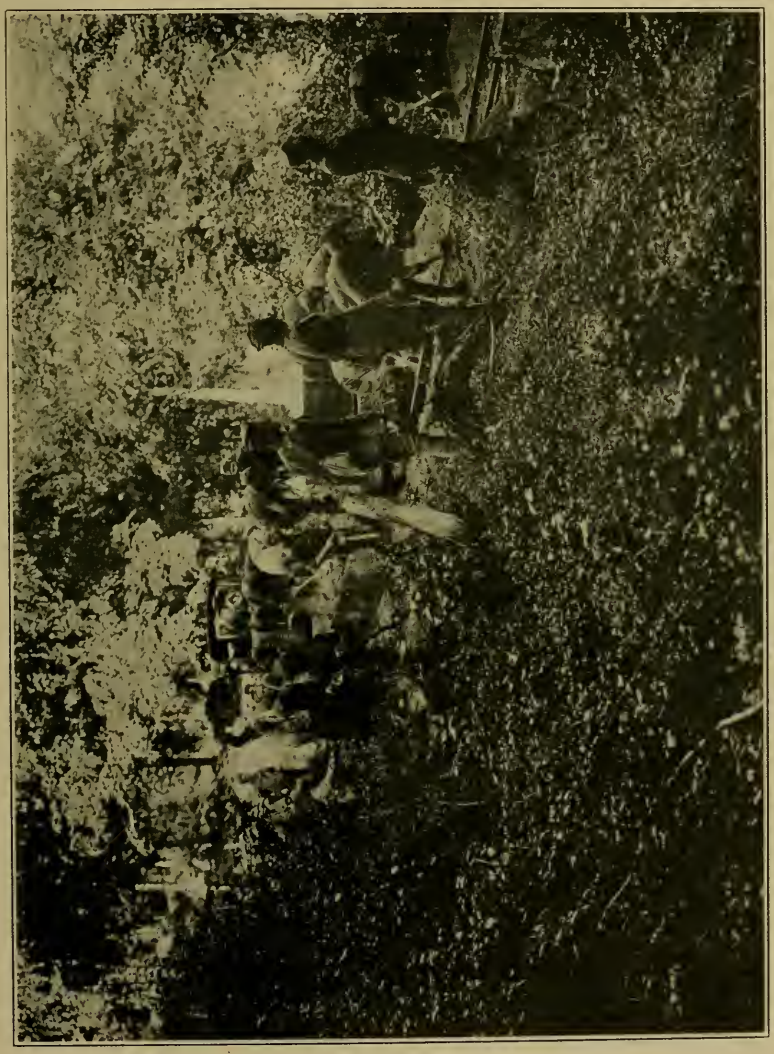
Rattentout, Rupt, Amblonville, and Mouilly were taken over by the 1st Battalion of the 12th Engineers, with six French railway companies to assist. Following the advance on September 12, the 60-centimeter line was extended from Londremont through Mouilly, a distance of 6.5 kilometers, to connect with the lines of the German system. It was found necessary to rebuild about 3 kilometers of the German lines, and when it was accomplished the system of the Toul and Rattentout sectors became continuous from the light-railway supply source at Abainville to all parts of the former St. Mihiel salient and of the Meuse-Argonne front.

Roads.—The base of the road system in the St. Mihiel offensive comprised north and south routes between Souilly, Bar-le-Duc, and Ligny, and between Dieulouard and Toul, by way of Pompey, in addition to an east and west route—Toul-Ligny. The advanced base road, uncovered in the operation, was that following the Meuse from Verdun to St. Mihiel and thence to Pont-a-Mousson. The Army road troops, including the French in their corps area, were in general responsible for the road work in the area between the main highway and a variable line between 3 and 4 miles in rear of the extreme front.

Toul sector.—The Army Engineer troops available for road work in the Toul sector were 3 technical companies, 2 wagon companies, and 3 truck companies of the 23d Engineers; 2 companies of the 28th Engineers (quarry), and 3 service battalions, the 505th, 524th, and 537th—a total of 4,800 men. One technical company, 1 wagon company, 1 truck company, and 1 service battalion were placed in the First Corps area, and the same assignment made to the Fourth Corps area. The 2 quarry companies and 2 service companies were employed in the operation of quarries at Sorcy, Dieulouard, Royaumeix, Vertusey, Trondes, and at various points in the First Corps area. One technical company, 1 truck company, and 2 service companies were held between Toul and Menil-la-Tour to care for the roads in that district and at the same time be in a position to move forward to any point of emergency. The personnel of the technical companies was used to instruct noncommissioned officers in charge of working details in special work calling for skilled handling of equipment and materials.

Moving material up at night only, because of the necessity of secrecy, by September 12, the corps dumps and the Army dumps were plentifully supplied with stone, road planks, sandbags, fascines, poles, road equipment, and small tools. Also prior to that date all roads in the Army area were brought to a high state of perfection. These roads were then maintained by Army troops throughout the operation. Following the advance, Army road troops were called upon to relieve, or assist, the corps troops in the reconstruction of the

roads across "No man's land," notably, Flirey to Essey (6 kilometers), Beaumont to Seicheprey (2 kilometers), Apremont to St. Mihiel (8 kilometers), and Broussey to Richecourt (8 kilometers). Army road troops were placed on the Flirey-Essey road to assist the corps troops on September 15, but the road was not taken over as an Army



(15-T8) BALLASTING LIGHT RAILWAY TRACK IN VICINITY OF MOUILLY (MEUSE). SEPTEMBER 25, 1918.

road until the 25th. On the Beaumont-Seicheprey road and the Broussey-Richecourt road the Army did not assume entire responsibility until September 30, although Army road troops were turned over for work thereon as early as September 16. The Apremont-St. Mihiel road was the main connecting link between the First and Fourth Corps areas and the Argonne sector. It was completely re-

constructed for two-way traffic in four days, beginning September 19, when it was first taken over by Army troops. During the four days 1,200 men were employed on that road.

In addition to the road work in the Toul sector proper there were also Army road troops (1 technical company, 1 truck company, and 1 wagon company, 23d Engineers), engaged in maintenance operations in the 6th Groupment Routier of the Eighth French Army extending from Menil-la-Tour as far south as Colombey-les-Belles. Their principal work was the repair of the Toul-Void-Ligny Road, highly important, because it formed part of an alternate route between St. Mihiel and the Argonne front.

Rattentout sector.—The Army troops available for road work in the Rattentout sector were 1 technical company, 1 truck company, and 1 wagon company of the 23d Engineers, and the 527th Service Battalion, a total of 1,700 men. One of the service companies was loaned to the 12th Engineers for light railway work, and one was stationed at the general Army dump at Rattentout to assist in unloading supplies and material from railway cars. No road work had been done for American troops in the Rattentout sector prior to the beginning of preparations for the offensive. After putting the roads in the rear in good condition and stocking them for maintenance, the Army road troops in the Fifth Corps area were employed until September 17 in the maintenance of roads for divisional movements and assisting corps troops in reconstructing roads across the former "No man's land." On the 17th the Army road troops were moved to the Meuse-Argonne front.

Bridges.—In the offensive very little bridge work was anticipated for Army troops, and no great preparation was made for it. However, approximately 150 trestle bents, with the necessary stringers and flooring, were assembled in Leonval for possible use. Prior to the attack several small bridge gangs of Army troops strengthened 14 bridges over which heavy artillery and tanks were to pass, and assembled material in forward positions for use in the repair of bridges following the advance. Not much of the latter work was done by Army troops, however, as most bridges were found in fairly good condition and were easily repaired by the divisional or corps Engineers. A timber structure for return traffic was therefore constructed at that point. The 464th Pontoon Train, stationed at Toul, was placed at the disposition of the First Corps for possible use in crossing the Moselle, but was not used.

All bridges over the rivers and canals had previously been mined by the French for demolition in case of a reverse. Upon the stabilization of the new line the charges were removed.

Water supply.—The Army Engineer troops engaged in water supply in the St. Mihiel operation were 4 companies of the 26th Engi-

neers, 2 companies of the 27th Engineers, 1 company of the 37th Engineers, and 255 men divided between 2 provisional water-tank trains. They were concerned only in that part of the operation pertaining to the First and Fourth American Corps, arrangements having been made for French water supply troops to care for the areas of the Second French Colonial and Fifth American Corps.

The geological conditions in the St. Mihiel region were unfavorable for springs and wells, and September being in the driest season, the streams and springs were at their lowest ebb. Prior to the opening of the offensive forward areas were thoroughly reconnoitered, and water facilities for a concentration of 400,000 men and 90,000 animals were created, involving the installation in the First and Fourth Corps areas of pumping plants and tanks or reservoirs at seven different points, new filling and animal watering points in the Foret de la Reine, and the improvement of six similar points previously installed by the French.

On the day of the attack all water points were placed under control of guards with orders to maintain order, regulate traffic, and keep the facilities in repair. Following the advance, Army water supply troops moved forward to make immediately available the captured water installations and to set up canvas reservoirs for water hauled forward by motor-tank trains. Among the captured plants converted to the use of the United States troops were those at Thiaucourt, Maiserais, and Euvezin. Temporary installations included 12 canvas reservoirs, 7 hand pumps, 3 animal trough points, 2 sterilab locations with tanks, and 5 sites for mobile purification trucks.

In areas where there were no other resources water was delivered to tank cart or other containers at filling points by units of the two water-tank trains or by tank cars on the light railway. All water for troop consumption was tested and sterilized by chlorination before delivery.

Electrical and mechanical operations.—The troops available for Army electrical and mechanical work were Companies A, B, and E of the 37th Engineers; Company D operated in the Rattentout sector as the water-supply company for the Fifth Corps area; one company was assigned to each of the three American corps areas where they took over all pumping plants, lighting sets, and air compressors formerly operated by the French. All machinery was overhauled to place it in the best possible operating condition. Power was installed in the concrete factory at Liverdun and in the sawmills at Marbache and Menil-la-Tour. The main dumps for electrical and mechanical materials were established at Toul and Souilly, and a small stock of additional supplies was maintained with the electrical and mechanical company in each corps.

During and following the advance, details were moved forward to make the necessary mechanical installations for the water-supply stations. Among the captured pumping plants rehabilitated and placed in operation was that at Thiaucourt, where the damaged motor was replaced by a gas-engine driven pump. As corps and division post commands were moved forward their portable lighting plants were also moved up, reinstalled, and operated.

Considerable quantities of electrical material, consisting of transformers, motors, generators, gas, steam, and water-driven plants were captured and some were repaired and operated. The area covered by the advance contained an extensive network of transmission lines fed from a central station at Metz. A captured map showed the location of all lines of the system, but its operation was not possible, as the source of power remained in German hands. It was intended to connect the system with a power terminal in Pont-a-Mousson, but the plan was abandoned on account of the withdrawal of troops necessary for the Meuse-Argonne offensive.

Searchlight operations.—The Army searchlight troops available for use in conjunction with antiaircraft batteries were Companies A and B of the 56th Engineers. They were equipped with 26 searchlights and the necessary transport.

All lights were placed in the area to the south of the St. Mihiel salient, beginning at the right flank of the proposed attack and extending as far to the left as was consistent with maintenance of sufficient depths of illumination. Since the valley of the Moselle River promised to be the main route for approaching or returning planes operating over the sector proportionately more lights were placed in that area, thus making for not only greater density, but greater depth of lighted area. In selecting the positions for the lights consideration was given to the topography, condition of roads, the noise of transport, and the location of the antiaircraft batteries, and on being placed all lights were carefully dug in and camouflaged.

Before the attack, and especially at night, there was but little air activity, and the lights were under orders not to operate until the night of September 12. On that night all lights were in position and ready, covering a lighted area 35 kilometers in length, with an average depth of 10 kilometers. Due mainly to unsuitable weather conditions enemy bombing planes did not show any activity until the night of September 14, when a number of hostile machines approached the lighted area. Seven were illuminated. On the 15th there was still more activity, 13 planes being illuminated. Enemy night bombing continued until September 20, during which time a total of 54 different hostile planes were illuminated. Company A lighted 21 planes for an average period of 2.6 minutes, and 33 planes were lighted by Company B for an average period of 2.5 minutes.

To cover the ground gained by the advance of the First Army new positions were selected and the searchlights, after having operated in their old positions on the night of September 14, were operating in the new positions on the 15th. The lights then covered a greater length at a slight sacrifice in depth, the lighted area being about 42 kilometers in length and 8 kilometers in depth.

Camouflage operations.—The Army camouflage troops available for the St. Mihiel operations were two companies and a detachment of 135 men, all of the 40th Engineers. The two companies were attached to the various divisions in the First, Fourth, and Fifth American Corps. The detachment was utilized in the operation of the camouflage factory at Nancy, of Army camouflage dumps, and in camouflaging of roads, batteries, and dumps in the rear area. The principal camouflage material used in the advance was the overhead fish net. Approximately 1,000 nets were used for the divisional artillery and about the same number for the corps and Army artillery. In preparation for the preliminary barrage, all divisional batteries were camouflaged and several permanent positions of flat-top burlap on chicken-wire construction were installed. All guns were provided with fish-nets for the advance, a total of 2,095 guns being taken care of on both sides of the salient. When the consolidation of the new lines began the permanent battery positions were camouflaged wherever possible.

Engineer supplies.—On account of transport congestion the supply of Engineer material for the advance was a very difficult matter. Prior to the opening of the offensive large stores of material had been assembled in the Army parks at Mattentout, Leonval, Domgermain, and Menil-la-Tour, and in the corps dumps at Luxemburg, Ansauville, Dieulourd, and Noviant. Also divisional stores were maintained at Mandres, Puvenelle, St. Jean, Manonville, and Bernecourt. Extensive dumps of German material were captured at Bois de la Belle, St. Baussat, Thiaucourt, Vigneuilles, St. Maurice, Vieville, Villy, and Thillot.

Meuse-Argonne Offensive.

The command of the French front extending from east of the Meuse to the western edge of the Argonne on September 22 passed to the American First Army, with headquarters at Souilly. Shortly after the Seventeenth French Corps with its sector was included in the First Army command, thus extending the American front from east of the Meuse to the east of the Moselle. By September 25 the First Army had entirely taken over from the French Second Army and was ready to begin operations.

On the night of September 25–26 the battle order of the First Army from right to left on the sector of attack was as follows: The Third Corps, with the 33d, 80th, and 4th Divisions in the line and the 3d Division in reserve; the Fifth Corps, with the 79th, 37th, and 91st Divisions in line and the 32d Division in reserve; the First Corps, with the 35th, 28th, and 77th Divisions in line and the 92d Division in reserve; in army reserve were the 1st, 29th, and 82d Divisions in rear, respectively, of the Third, Fifth, and First Corps, and the Fifth French Cavalry Division. In addition the appropriate corps and Army troops were available.

The attack on the Meuse-Argonne front began at 5.30 a. m. September 26, when the Artillery changed its three hours of spotted barrage to a rolling barrage. The necessity for securing supplies had forbidden a long Artillery preparation, and as tanks had been unable to precede the Infantry in the initial attack it was the duty of the divisional Engineers to destroy the elaborate system of wire entanglements encountered. Except for the strong point at Montfaucon, the advance was made in the first day without great difficulty. The 79th Division captured that strong point on the morning of the 27th. The general advance then continued until nightfall of the 29th. The First Army line was then approximately Bois de la Cote-Lemont-Nantillois-Apremont, southwest across the Argonne. Some of the divisions had suffered severely. Units had become intermingled on account of the difficult nature of the ground over which they had attacked and the fog or darkness which had covered them. Relief of those divisions had therefore to be made before another coordinated general attack could be launched. Consequently, on the night of the 29th the 37th and 79th Divisions were relieved by the 32d and 3d Divisions, respectively, and on the following night the 1st Division relieved the 35th Division.

At 5.30 a. m. on October 4 the general attack was renewed. The order of battle of first-line divisions and corps from right to left was as follows: The Third Corps, 33d, 4th, and 80th Divisions; Fifth Corps, 3d and 32d Divisions; First Corps, 1st, 28th, and 77th Divisions.

The battle line was extended to the east of the Meuse on October 6 by the participation of the Seventeenth French Corps, which theretofore had remained stationary. The Seventeenth French Corps from right to left had the 26th and 18th French Divisions and the 29th and 33d American Divisions in line. That attack fell on the exact pivot of the enemy salient formed by the whole of his armies in northern France, and the attacking divisions encountered elaborate fortifications and desperate resistance. Although the attack progressed until

the 10th the advance realized was not sufficient to completely relieve troops west of the Meuse from enfilade artillery fire from the east bank.

In the meantime, on October 7, the First Corps launched the 82d Division in an attack northwest toward Cornay to outflank the Germans in the Argonne, and to free the 28th and 1st Divisions from enfilade fire from the eastern edge of the forest. The success of the 82d Division in this attack was marked and did much to break down resistance in the Argonne. The 28th Division was relieved on the night of the 8th-9th by the extension of the front of the 82d Division.

On October 9 the Fifth Corps attacked, with the 1st Division reinforced by one Infantry brigade of the 91st Division and the 32d Division; a stubborn defense was encountered and the fighting was desperate, but an advance was made. On the 10th the Argonne was cleared, and on the night of the 11th the line was approximately Bois d'Ormont (north of Verdun), Molleville Farm, Sivry-sur-Meuse, Bois de la Cote, Lemont, Bois de Foret, Cunel, Romagne, Sommerance, Aire River west to Grand Pre.

On the night of the 11th-12th, the 1st Division was relieved by the 42d Division, and the 80th Division by the 5th Division, both relieving divisions coming from the St. Mihiel front. Local attacks continued on October 12-13, preparatory to a general attack, and on October 14 this attack was delivered on the front from north of Verdun to St. Juvin. The order of battle in line on the front of attack from right to left was: Seventeenth French Corps, with 26th French Division, 18th French Division, 29th and 33d Divisions, Third Corps with the 4th, 3d, and 5th Divisions; Fifth Corps with the 32d and 42d Divisions, and the First Corps with the 82d and 77th Divisions. Stubborn resistance was encountered everywhere, and on most of the front only small advances were realized. Nevertheless La Cote-Dame-Marie fell, and the Kriemhilde line of defense was broken.

On October 18 there was heavy fighting east of the Meuse. On October 23 the Third and Fifth Corps pushed northward as far as Bantheville. It was then necessary to relieve certain troops, consolidate positions, and generally to get forces and supplies in hand before attempting another general attack. The remaining days of October were therefore devoted to preparing for the attack to be launched November 1.

The general objective of the attack launched on the early morning of November 1 continued to be the region Sedan-Mezieres, and its primary purpose was to cut the line of German railroad communications in that locality.

The first and immediate objective of the First Army, however, was the capture of Buzancy and the heights of Barricourt, the outflanking

of the northern part of the Argonne, and establishing contact with the Fourth French Army near Boult-aux-Bois.

The line on the night of October 30-November 1 ran approximately as follows: The Meuse River, Clery-le-Grand, north of Bantheville, northern part of the Bois de Bantheville, south of St. Georges, north of St. Juvin, north of Chevieres. The order of battle from right to left was as follows: Third Corps, with the 5th and 90th Divisions in line and the 3d Division in reserve; Fifth Corps, with the 89th and 2d Divisions in line and the 1st and 42d in reserve; First Corps, with the 80th, 77th, and 78th Divisions in line and the 82d in reserve. The 32d Division was in Army reserve. The attack was preceded by two hours of violent artillery preparation. The Third Corps took Andevanne, and the Fifth Corps pushed forward most rapidly and drove the enemy from the heights of the Bois de Barricourt, a formidable natural obstacle which had blocked the way to Sedan.

On November 2, the First Corps joined more actively in the movement which had become an onslaught that the enemy could not restrain. On the 3d, troops were rushed forward in motor trucks in the pursuit of the demoralized enemy. By the night of the 3d the First Corps reached St. Pierremont, the Fifth Corps had taken Fosse and the Third Corps Beauclair. The enemy's line had been pierced to a distance of nearly 20 kilometers and heavy batteries were rushed forward to fire on the important railroad lines at Montmedy-Longuyon and Conflans. The ultimate object of the whole operation was then within reach.

On the 4th the pursuit was continued and operations were extended to the east bank of the Meuse. By night the left bank of the Meuse, opposite Stenay, had been taken, and on the 5th the line was beyond Stonne, west of the Meuse, while on the east bank the 5th Division of the Third Corps had crossed the river and progressed over 2 kilometers east of Brieulles and Dun-sur-Meuse. Just west of the Meuse the enemy resistance had been completely disorganized. All his reserves had been used up and first-line divisions were in flight. To the east of the Meuse, however, the enemy still held, and progress was slow. On November 6th the First Corps pushed 7 kilometers beyond Raucourt, the great railway artery was within easy artillery range and a continuation of efforts meant the end of all the German armies in northern France.

On November 7 the river line of the Meuse to a point not far from Sedan was in the hands of the Fifth and First Corps. On November 7, 8, and 9, the German forces on the heights southeast of Stenay were pushed into the plain of the Woevre. The attack of the First Army was then directed toward Carignan. The First Corps was withdrawn and its sector taken over by the French Fourth Army.

East of the Meuse the pursuit was continued. On November 10 the Fifth Corps forced a crossing over the Meuse, south of Mouzon, and on the morning of the 11th it crossed at Stenay and occupied that town in liaison with the Third Corps on its right.

DIVISIONAL ENGINEER OPERATIONS.

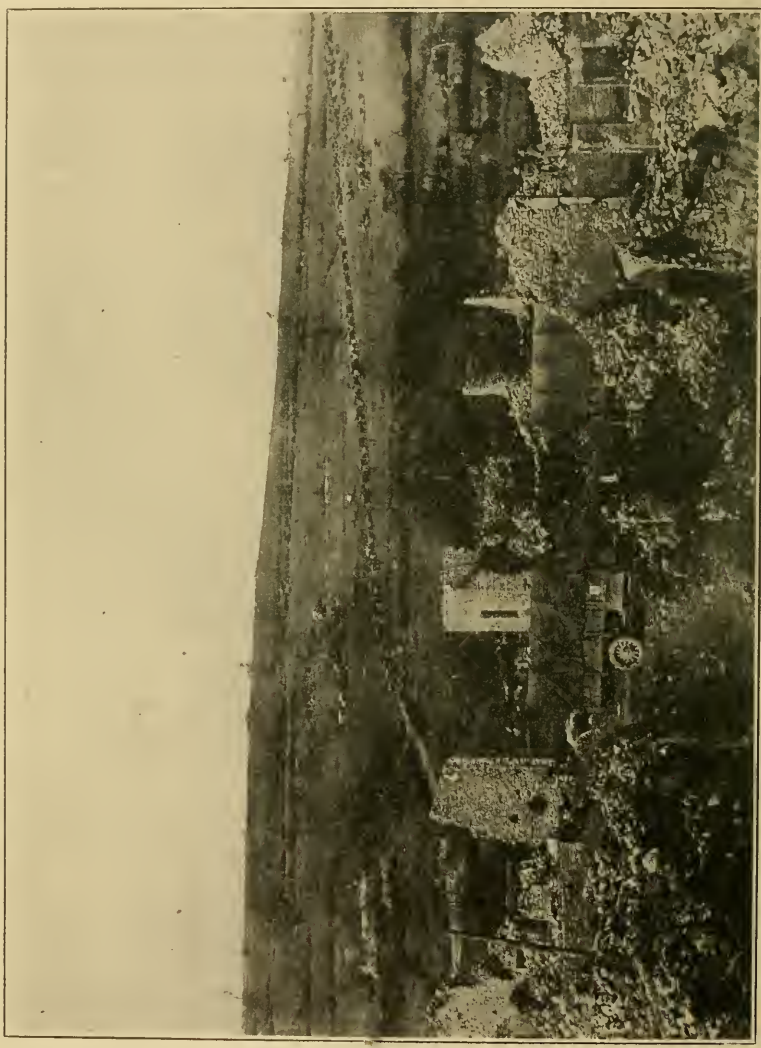
With the foregoing outline of the general operation as a foundation to supply the location and operations of each division concerned, it need only be added that the general duties of the divisional Engineers were practically the same as those performed in previous operations already described. The salient features of divisional Engineers operations in the Meuse-Argonne offensive are presented below.

Having made a thorough reconnoissance of Forges Creek and swamp, which separated the enemy front lines from those of the 33d Division, and chosen several bridge sites, the 108th Engineers of that division, on the night of September 25–26, carried the necessary material forward. With Infantry covering parties, details from the regiment advanced on the early morning of September 26, constructed 6 footbridges of fascines and planks through the swamp and 9 over the creek. One of the bridges, with a width of 5 feet and a span of 26 feet, supported by four bents in 5 feet of water was erected in eight minutes by 25 men. Two other bridges, a 25-foot span and two bents were also completed in the same time. The Infantry began to pass over a fourth bridge before the sway bracing had been fixed, and several of the Engineers were compelled to stand in the water and brace the structure until it could be completed. The foregoing work was accomplished under very heavy enemy artillery fire and machine-gun fire and at the same time was subjected to shorts of the American Artillery. The regiment then built for the division transport a great deal of plank and stone-fill road through the swamps passed over by the advance. Numerous other bridges were constructed or reconstructed by the regiment, keeping pace with the advance of the Infantry.

Outside of slight amount of bridge work and the demolition of enemy defenses, the 305th and 4th Engineers of the 80th and 4th Divisions, Third Corps, were used almost entirely in the construction and maintenance of roads for division transport. All work was done under violent artillery fire and casualties in both regiments were very heavy. The 6th Engineers, 3d Division, in the Third Corps reserve, was employed as a corps Engineer regiment under direction of chief engineer, Third Corps.

The 304th Engineers of the 79th Division, Fifth Corps, found its first heavy work after the beginning of the advance in the construc-

tion of a tank road over the profusely shell-torn "No man's land." That work was commenced at 8.30 on the morning of September 26. Company A was fired upon by machine-gun and sniper nests, and a part of the company attacked the position and captured eight prisoners and a machine gun. An additional machine gun and eight



(977–V8) VIEW FROM CUISY LOOKING TOWARD GERCOURT, SHOWING HEAVY TRAFFIC ON ROADS REPAIRED BY 4TH ENGINEERS.

prisoners were captured by a platoon of the regiment at about the same time. While the regiment was employed almost entirely on the roads following the advance of the 79th Division, the division was relieved on the 30th of September by the 3d Division, and the 304th Engineers continued its work attached to the latter until

October 28, when it was moved to the Verdun sector to relieve the 104th Engineers of miscellaneous construction in the Army areas.

There were no unusual features in the operations of the 112th Engineers, 37th Division. The regiment performed the usual duties of assisting Infantry and tanks through enemy defenses and shell-torn terrain and of repairing bridges and reconstructing roads.

The 316th Engineers, 91st Division, besides performing the usual Engineer duties, participated to some degree as Infantry. On the night of September 27 the 1st Battalion, which had been placed in the division reserve, was moved to protect a gap which existed between the 91st and 35th Divisions. In that position one company of the battalion resisted a strong enemy attack, though it was subjected to severe frontal fire and enfiladed on the left by machine-gun fire. Its casualties were very heavy. During the first week of October, as previously related, the regiment, with its division, was relieved from duty with the Fifth Corps and withdrawn from the area for participation in the French offensive in Belgium.

After the 32d Division relieved the 37th Division on September 28, the operations of the 107th Engineers, 32d Division, were along the usual line. Prior to that time, while its division was in the Fifth Corps reserve, the regiment served as corps troops, Fifth Corps. The regiment's most notable piece of work was the construction of a 100-foot trestle bridge, with an 11½-foot roadway, 20 feet from water, across the Meuse at Sassey, at a time when the location was in advance of the division's front line. The bridge, designed for 8-ton capacity, was built within 48 hours after preparations were started. It subsequently carried 15-ton loads without strengthening.

The divisional Engineers in line with the First Corps on the First Army's left were the 110th, 103d, and 302d, attached to the 35th, 28th, and 77th Divisions, respectively. The 317th Engineers were attached to the 92d Division in the corps reserve, and the 1st Engineers were attached to the 1st Division in the Army reserve.

On the morning of the attack two companies of the 110th Engineers advanced with the Infantry and the tanks of its division. The regiment, less the two companies, and with three companies of the 53d Pioneer Infantry attached, followed the advance, employed in the reconstruction of roads. In connection with the work of preparing the road between Cheppy and Charpentry a detail of mounted men from headquarters detachment rendered valuable aid in regulating the traffic thereon. On the night of September 28, the 1st and 2d Battalions of the regiment were ordered into the divisional reserve and, following the 70th and 69th Brigades, respectively, took positions on the right and left flanks of the division sector. Shortly

before noon, September 29, instructions were received to take a position on the front slope to the right of the Aire, across Chaudron Farm, 1 kilometer north of Baulny. The position was then held until the division was relieved by the 1st Division October 1. The casualties in the regiment were 265.

The 103d Engineers engaged in the usual duties with the 28th Division in line during the advance until October 1, when the division was relieved by the 82d Division.

The 77th Division was the only one in the American First Army that advanced its own front from the beginning of the attack on September 26 to November 11 without relief. During that advance, its divisional Engineer regiment, the 302d, performed its duties in a manner that was a credit to its division.

The 317th Engineers continued with its division in the First Corps reserve throughout the offensive, and during that period served as corps troops, principally on road work.

As the advance progressed various other fresh divisions were thrown in to relieve depleted divisions or to attain additional objectives as follows, from right to left, of the First Army front: October 8, 29th Division, 104th Engineers attached; October 25, 26th Division, 101st Engineers; October 30, 5th Division, 7th Engineers; October 30, 90th Division, 315th Engineers; October 19, 89th Division, 314th Engineers; November 1, 2d Division, 2d Engineers; November 3, 1st Division, 1st Engineers; October 12, 78th Division, 303d Engineers; and November 6, 42d Division, 117th Engineers attached.

The 104th and 101st Engineers with their divisions in the Seventeenth French Corps to the right of the Meuse, performed the usual divisional engineer duties. The 7th Engineers, with the 5th Division in the Third American Corps, west of the Meuse, performed a very important piece of work in bridging the Meuse between Dun-sur-Meuse and Brieulles. There two pontoon footbridges, in addition to one pontoon for light traffic and one pontoon for heavy traffic, were thrown across the Meuse, as well as four pontoon footbridges across the canal. The work was all done between November 2 and 6, and nearly all of it during darkness and under heavy enemy fire from the heights on the east bank. All working parties and the bridges themselves were under direct observation of those hills, and as a consequence the bridges were under continuous artillery and machine-gun fire, not only during their construction, but for some time afterwards. Constant patrol and repair of the structure were, therefore, maintained. On the afternoon of November 6 enemy bombing planes, flying low, made a repeated and determined effort to destroy the heavy pontoon bridge at Dun-sur-Meuse, but were unsuccessful, being finally driven off by the rifle fire of the Engineer troops

(1905–T8) 104TH ENGINEERS REPAIRING ROAD DESTROYED BY MINE CRATER DURING GERMAN RETREAT NEAR SAMOGNEUX (MEUSE). OCTOBER 4, 1918.

(2184–S8) 101ST ENGINEERS FILLING IN SHELL HOLE ON ROAD NEAR ST. RENY. SEPTEMBER 16, 1918.

in that vicinity. The bridges enumerated above were used by all divisional troops, Artillery, and trains as the division continued its operations east of the Meuse. There was nothing extraordinary in the operations of the 315th or 314th Engineers, except that the latter performed considerable bridge work, and that instead of bridging the Meuse early in the morning of November 11, as it had prepared to do, it constructed pontoon rafts and ferried the Infantry across thereon.

The 2d Engineers also threw several pontoon bridges across the Meuse, northeast of Beaumont, and erected a heavy traffic trestle bridge at Pouilly. Of the 1st Engineers, one company attacked and captured the village of Pont Mangis on the 7th of November.

The 78th Division went into line on the left of the 77th at Grand Pre on the 12th of October. The distinctive work of the 303d Engineers attached to the division was the construction of bridges. The bridges were of all types. One of three bridges built over the Aire was a suspension bridge erected by a detail of 20 men in eight hours under direct machine-gun and shellfire. Three heavy bridges for traffic at Grand Pre were also built under intense artillery fire, all being under direct enemy observation. Rifle and machine-gun patrols covered the working details as well as possible. One of the bridges was of trestle-bent construction, 25-foot span; another was a combination crib and bent construction, 68-foot span; and the third, of 150-foot span, was entirely of trestle-bent construction. Up to the time the 78th Division was relieved by the 42d Division, November 6, the 303d Engineers built numerous other heavy traffic bridges and all in time for the passage of heavy artillery. Until November 9, the 117th Engineers continued the work of the 303d Engineers, accomplishing a great deal of road and bridge construction. The 42d Division front was then taken over by the 77th Division.

CORPS ENGINEER OPERATIONS.

Third Army Corps.—The troops assigned to the corps engineer, Third Corps, during the Meuse-Argonne offensive were the 308th Engineers, the 1st Pioneer Infantry, 464th Pontoon Train, and a detachment of the 40th Engineers (camouflage.) Other troops available for a part of the period of the offensive were the 56th Pioneer Infantry, first company of the 37th Engineers, three French pontoon companies, and one company of the 26th Engineers (water supply). The water supply company was divided and attached to the divisions in the line. The 308th Engineers and the Pioneer Infantry regiments were actively engaged in the construction and repair of roads and bridges taken over from the divisional engineers. The 308th Engineers particularly distinguished themselves in the construction

of a heavy two-way traffic bridge across the Meuse, the operation being highly commended in corps orders.

Fifth Army Corps.—The Engineer troops assigned to the corps engineer, Fifth Corps, were the 310th-602d Provisional Engineer Regiments, the 310th Engineer Train, and two battalions of the 52d Pioneer Infantry. During the entire operation the foregoing corps troops were employed in the maintenance of roads, strengthening of bridges, and the maintenance of bridges following the work done by the divisional engineers, and also in supplying the corps and divisional areas with engineer material from the corps dumps in the rear.

First Army Corps.—The corps engineer troops assigned to the corps engineer, First Corps, were the 111th Engineers, as the corps engineer regiment, the 53d Pioneer Infantry, and the 317th Engineers of the 92d Division in reserve. The operations of the corps engineer troops following the divisional engineers were similar to those in the Third and Fifth Corps. The enemy retiring before the advance was extremely effective in his road demolition, and besides numerous craters which had to be filled, many contact and time mines were left at strategic points in the roads. A detachment of the 111th Engineers assigned to mine searching, located and withdrew the charges from 72 mines on September 26 and 27, and from a total of 179 mines prior to October 10. Material for road repair was obtained principally from the walls of ruined villages. Escort wagons and rock-carrying boxes, supplied from the corps dump at Les Islettes, were used for transport. As the advance progressed several units of 92d Division Infantry were assigned to corps road work as well as one battalion of the 114th Engineers, and a truck company of the 414th Supply Train.

On October 6 one battalion of the 317th Engineers was assigned to the reconstruction of the enemy light railway lines, including a connection with the French system across "No man's land," undertaken to relieve the corps road system, and the work was completed on October 28, when the main lines were placed under operation up to Grand Ham, La Besogne, Bois du Marcq.

For the attack beginning November 1, the chief engineer, First Corps, had available the 111th Engineers, five companies of the 317th Engineers, the 114th Engineers from the Army Reserve, the 307th Engineers from the corps reserve, and two companies of the 53d Pioneer Infantry. Those units continued until the cessation of hostilities in the maintenance and improvement of roads and light railways, assisting divisional engineers in the construction of bridges, filling of mine craters and shell holes, and in quarrying rock for road metal and track ballast, as well as in the operation of light railways within the corps area. Details were also made to operate the corps dumps.

Army Engineer operations.—The troops assigned to the chief engineer, First Army, were as in the list set forth below:

11th Engineers (standard-gauge railway)—2d Battalion headquarters and four companies.

14th Engineers (light railway)—regimental and 2d Battalion headquarters and three companies.

15th Engineers (standard-gauge railway)—1st Battalion headquarters and two companies.

16th Engineers (standard-gauge railway)—entire regiment.

21st Engineers (light railway)—regimental, 1st and 2d Battalion headquarters and six companies.

22d Engineers (light railway)—2d Battalion headquarters and three companies.

23d Engineers (roads)—regimental, 3d Battalion and Engineer motor train headquarters, eight companies, four wagon companies, and eight truck companies.

25th Engineers (general construction)—regimental headquarters and six companies.

26th Engineers (water supply)—regimental headquarters and four companies.

27th Engineers (mining)—regimental headquarters and six companies.

28th Engineers (quarry)—2d Battalion headquarters and three companies.

37th Engineers (electrical and mechanical)—regimental, 1st and 2d Battalions and five companies.

40th Engineers (camouflage)—1st Battalion headquarters and four detachments with First Corps, Third Corps, and Fifth Corps, and Army Artillery.

54th Pioneer Infantry—entire regiment.

56th Pioneer Infantry—regimental and 3d Battalion headquarters and 12 companies.

56th Engineers (searchlight)—three companies.

59th Pioneer Infantry—3d Battalion headquarters and four companies.

114th Engineers—regimental headquarters and 6 companies.

1st Provisional Water Train—entire train.

301st Water Tank Train—regimental headquarters and 6 companies.

330th Labor Battalion—entire battalion.

344th Labor Battalion—entire battalion.

527th Service Battalion—entire battalion.

530th Service Battalion—1 company.

537th Service Battalion—entire battalion.

542d Service Battalion—1 company.

544th Service Battalion—entire battalion.

545th Service Battalion—entire battalion.

546th Service Battalion—entire battalion.

603d Engineers (bridges)—regimental headquarters and 3 companies.

604th Engineers (light railway)—regimental headquarters and 3 companies.

802d Pioneer Infantry—entire regiment.

805th Pioneer Infantry—regimental headquarters and 12 companies.

(2319–S8) STONE FROM DEMOLISHED BUILDINGS AT FEY-EN-HAYE, USED BY 315TH ENGINEERS FOR ROAD REPAIR.

807th Pioneer Infantry—regimental, 2d and 3d Battalion headquarters, and 12 companies.

808th Pioneer Infantry—regimental, 1st, 2d, and 3d Battalion headquarters, and 9 companies.

815th Pioneer Infantry—entire regiment.

Prisoner of War Escort Companies Nos. 30, 31, 54, 56, 57, 60, 66, and 67.

STANDARD-GUAGE RAILWAY OPERATIONS.

At the beginning of the offensive, September 26, the standard-gauge railway projects in the Meuse-Argonne sector were in charge of the 2d Battalion of the 11th Engineers, assisted by two companies

of the 15th Engineers and by service troops. Prior to the offensive they had been engaged in the enlargement of railheads by the construction of additional sidings at Aubreville and at Clermont. On the first day of the offensive construction was started to connect the railway at Aubreville with railheads behind the German lines at Apremont-en-Argonne, a distance of 20 kilometers. After building two pile-trestle bridges, respectively 27.4 and 10.9 meters long, that line was completed October 18 and placed in operation on the 25th. The captured yard at Varennes proved to be a vital factor in the final offensive beginning November 1.

On November 7 the main track was completed from Varennes to Chatel-Chehery, with yard facilities at the latter point for 100 cars. The line between Apremont and Grand Pre was completely reconstructed by the 10th and yard facilities established at Chatel-Chehery, Marcq, St. Juvin, and Grand Pre. The rehabilitation of the line from Marcq to St. Juvin involved the construction of a pile-trestle bridge 13 meters long. Prior to the cessation of hostilities on November 11 work had been started on the construction of a standard-gauge line from St. Juvin to Harricourt, a distance of 17.8 kilometers and with prospective completion by November 17.

The work in connection with the rehabilitation of the Verdun-Sedan line was started by one company of the 11th Engineers, assisted by one company of the 16th Engineers and two service companies. Just prior to the November 1 offensive the entire 16th Engineer Regiment was for the sake of speed put on the work. Up to Charny the line was in good condition, and work had been started carrying the line northward from that point on the 9th of October. As fast as it was uncovered by the advancing troops the line was rebuilt, a total distance of 36 kilometers. The location of the enemy did not permit the work to proceed north of Forges until after November 1. In order to place one main track in service between Charny and Montigny the construction of four small bridges was necessary. The reconstruction of the line was completed to Dun-sur-Meuse and open for operation November 12. On the 20th it was open for operation through Montigny-Devant-Sassey. In addition to the one main track all the way through, trackage at railheads was reconstructed and placed in service at Charny, Chattancourt, Consenvoye, Vilosnes, Brieulles, Dun-sur-Meuse, and Montigny.

In the Meuse-Argonne operations the First Army captured approximately 80 kilometers of double-track lines, 72 kilometers of single-track line, and 32 kilometers of yards and sidings. The Verdun-Sedan-Meuse River line was left by the enemy in fair condition, with the exception of bridges, frogs, and switches in yards and one stretch of main track about 14 kilometers in length. All bridges were damaged or destroyed and 75 per cent of frogs and switches were de-

(263–G8) FOOTBRIDGE ACROSS MARNE NEAR MEZY. CONSTRUCTED WITH AID OF GASOLINE CANS BY 6TH ENGINEERS. JULY 24, 1918.

(1189–V8) BRIDGE CONSTRUCTED BY 316TH ENGINEERS AT WAEREGHEM (BELGIUM), USING TRUCK BODY FOR SUPPORT.

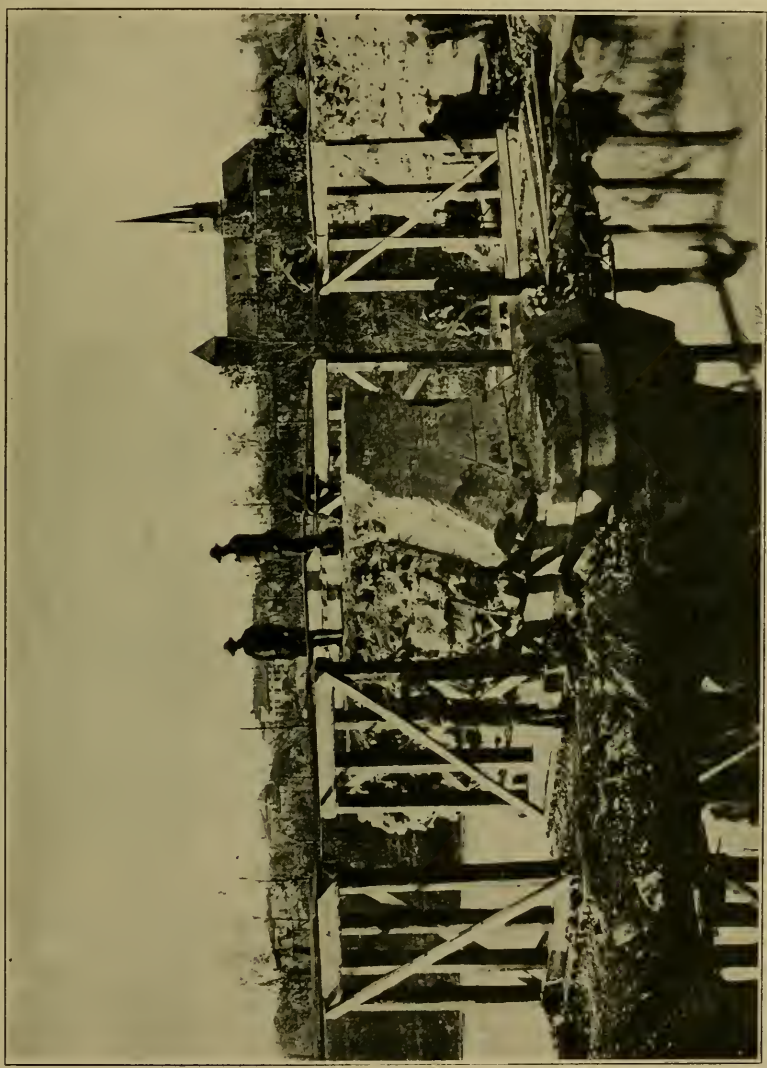
stroyed. From Apremont to Grand Pre all bridges were destroyed, as well as 75 per cent of all frogs and switches, and approximately 10 per cent of rail in main track. The damage to main track was mostly the result of American artillery fire. The demolition of the line from Marcq to Autrecourt via Harricourt was thorough. Approximately 75 per cent of all rails were broken, all frogs and switches were destroyed, 20 bridges were wrecked, and the roadbed was mined at several points.

LIGHT RAILWAY OPERATIONS.

Prior to the taking over of the Meuse-Argonne sector by the American First Army, French troops were operating a light railway system in the area between Souhesme, Dombasle, Esnes, Fleury, Les Islettes, Aubreville, La Barricade, and extensive lines in and around Verdun. Due to the difficulty of familiarizing American personnel with the system in the time available, arrangements were made whereby the French troops were to continue the operation of those lines. It was agreed, however, that American light railway troops would take over the maintenance of all such existing lines, with the American material extend those lines to connect with the German lines, take over the operation and maintenance of any new and captured lines, and furnish additional rolling stock and personnel to handle the increased tonnage contemplated. The troops arriving in the area for the accomplishment of that work between September 19 and 26 were the 2d Battalion, 14th Engineers; 2d Battalion, 22d Engineers; one company, 27th Engineers; three companies, 808th Pioneer Infantry; and two companies, 54th Pioneer Infantry. Work was started at once on the maintenance of the existing lines and in bringing forward light railway material for the proposed connections with the German system. On September 26 the connections were begun as follows: Aubreville-Neuvilly-Varennes, 13.5 kilometers; Le Triangle-La Barricade-Cheppy, 4 kilometers; Esnes-Bois de Malancourt-Montfaucon, 7.5 kilometers. Because of the fact that the terrain over which those lines had to pass was a sea of mud, and no suitable ballast was available, the connections were made under enormous difficulty. 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. Also American artillery had severely damaged the German lines. On October 10 the curvature and grade corrections and rehabilitation of the German lines, and the ballasting of the connections on the Esnes-Montfaucon, and the La Barricade and Cheppy lines were completed, and the lines put into operation, with a large tonnage of rations, ammunition, and water for points forward. From the 10th an

average of six divisions were rationed daily over those lines in addition to the handling of considerable ammunition.

By October 20 approximately 100 kilometers of captured German lines had been rehabilitated and put into operation, in addition to 28 kilometers of new lines built and 36 kilometers taken over from



(1037-V8) 303D ENGINEERS REPAIRING BRIDGE AT GRANDPRE, DESTROYED BY GERMANS. OCTOBER 29, 1918.

the French. On October 9 the 1st and 2d Battalions of the 21st Engineers had arrived from the Toul sector and relieved the 1st Battalion of the 11th Engineers. From the 20th to November 1, light railway troops were actively engaged in preparation for the continuation of the offensive, handling heavy tonnage of rations, ammunition and Engineer material from the railheads at Aubreville, Dombalse,

and Rampont. A total tonnage of 11,257 was handled with 1,149 trains in the week preceding November 1, the net ton-kilometers amounting to 175,887.7.

In the meantime light railway troops were also engaged in completion of the new line Aubreville to Varennes, construction of additional track at the Aubreville, Dombasle, and Varennes railheads, construction of new tracks for various ammunition dumps, principally at Charpentry, Montzeville, and Montfaucon, and the construction of a 4-kilometer low-grade connection on the Cheppy-Montfaucon line.

Immedately following the new advance on November 1, and progressing with the advance, light railway troops completed the rehabilitation of the following captured German lines: Cierges-Romagne, 4.5 kilometers; Loop: Romagne-Landres et St. George-Remonville-Bantheville-Romagne, 21.5 kilometers; Montfaucon-Brieulles, 8.5 kilometers; Bantheville-Aincreville, 1.5 kilometers; Bois Brieulles-Dannevuox, 7.9 kilometers; Andevanne-Montigny, 14 kilometers; Chatel-Chehery-Marcq-Grand Pre, 10.5 kilometers; Lancon-Senuc-Grand Pre, 8.5 kilometers; Gesnes-Apremont, 6 kilometers; Crocket-River Dump, 6 kilometers; Grand Pre-Briquenay, 9 kilometers; Briquenay-Buzancy, 8 kilometers; and Buzancy-Verrieres, 12 kilometers.

The further work of the light railway troops following the advance is set forth in the summarized daily record following.

November 1.—The line north from Montfaucon through Cierges and Romagne to Landres et St. George was reconstructed and during the night ammunition was delivered at Landres et St. George (which was practically the site of the front line trenches 12 hours previously).

Ammunition trains reached the point about one-half mile south of Marcq in the First Corps area, though one gasoline tractor with cars of ammunition was struck and almost completely destroyed by high explosive shell fire.

Two divisions were rationed by 60-centimeter from Aubreville to Chatel Chehery. Two divisions were rationed from Dombasle to Cierges and West Montfaucon. One division was rationed from Rampont to South Montfaucon. One division was rationed from Les Islettes to Lancon.

November 2.—During the night ammunition trains on the Lancon-Grand Pre line reached a point of one-half mile south of Grand Pre. Ammunition trains reached Marcq in the First Corps area. The repair of the line Grand Pre was completed and the Montfaucon-Dannevoux line opened for traffic for the first 3 kilometers out of Montfaucon.

Six divisions were rationed by the 60-centimeter at Chatel Chehery, Cierges, Lancon, and Montfaucon, a few of the rations being delivered at points along the line farther to the north.

November 3.—The Montfaucon-Dannevoux line was put in operation to within 1 mile of Dannevoux. Work was being pushed on the loop, Romagne-Landres et St. George-Andevanne-Bantheville, which was now completed except at Landres-Andevanne-Bantheville. The Lancon line on the west was put in operation for ration trains as far as Grand Pre.

Rations were again handled for six divisions to points as far north as the condition of the track would permit.

(266–G8) TRESTLE AND CRIB BRIDGE BUILT ACROSS MARNE RIVER AT MEZY BY 6TH ENGINEERS. JULY 24, 1918.

November 4.—Romagne-Landres et St. George-Andevanne line was completed and rations delivered at Andevanne. A total of 256 cars were handled from railheads at Aubreville, Dombasle, and Rampont, including rations for six divisions.

November 5.—The Montfaucon-Brieulles line was completed. The 305th Engineers assisted Army Engineers in repair of loop, Romagne-Landres et St. George-Andevanne-Bantheville. Rations were handled on these lines as far north as the road crossing southeast of Remonville.

November 6.—The new Cheppy-Montfaucon low-grade detour (previously in service for light tractors) was put in service for steam ration trains en route Aubreville to Landres et St. George, Ande-

vanne and Bantheville. The Montfaucon-Bois Brieulles-Dannevoux line was completed. Two hundred and thirteen cars were handled to the front, including rations for six divisions.

November 7.—New sidings in the ammunition dumps at Marcq and Romagne were completed and gasoline tractors with Army Engineer crews sent to these dumps to work under orders of ordnance officer in charge of dump. These tractors were engaged in switching in the yards and handling ammunition to near-by positions.

November 8.—The Grand Pre-Briquenay line was completed the night of November 8 and ready for ration trains which had already started from Aubreville. Romagne-Bantheville-Andevanne line completed 3½ kilometers north of Bantheville. Andevanne-Montigny line completed for 2½ kilometers north from Andevanne, and rations delivered at this point.

November 9.—The loop, Romagne-Landres et St. George-Andevanne-Bantheville-Romagne, was completed for tractor service, thus permitting a continuous one-way traffic and largely increasing the traffic density.

Three divisions were rationed by 60-centimeter from the standard-gauge railhead at Varennes to Romagne, Landres et St. George, and South Remonville (near Andevanne). One division was rationed from Chatel Chehery to Grand Pre and two divisions from Aubreville to Briquenay.

November 10.—Loop was being prepared for steam power and work being pushed on the Briquenay-Buzancy line and Andevanne-Montigny line. Three divisions were rationed from Varennes to Romagne-Landres et St. George-South Remonville, and one division from Chatel Chehery to Grand Pre.

November 11.—The line was completed and put in operation from Briquenay to Buzancy and heavy tonnage of rations and ammunition handled.

November 13.—The Buzancy-Verrieres line, on which the 37th Engineers had been working for the last five or six days, was put in operation as far as Harricourt and on the following day to Verrieres. The Andevanne-Montigny line was completed and heavy movement of ammunition started.

An idea of the traffic handled by the 60-centimeter railways during the last operation may be gained from the following table, giving data for the last seven days of the offensive (Nov. 3 to 10):

Total tons handled	10,822
Number trains run	1,117
Total locomotive-kilometers	18,601
Net ton-kilometers	247,032
Total cars handled	13,179
Car-kilometers	68,783
Average haul (kilometers)	21.64

Roads.—The Army road troops in position for road work on the Meuse-Argonne front, September 17, were 3 technical companies, 3 truck companies, and 3 wagon companies, 23d Engineers, and 3 service battalions. Between September 26 and October 1 the road personnel was reinforced by 12 companies, 56th Pioneer Infantry; 10 companies, 54th Pioneer Infantry; 2 companies, 28th Engineers; and 2 additional wagon companies, 23d Engineers. After November 2, 20 prisoner-of-war companies of 450 men each were added to the road forces.

The road plan adopted provided that corps and division troops should maintain all roads north of the Verdun-Dombasle-Clermont-

(478–M8) CAMOUFLAGE ERECTED TO SCREEN MINING OPERATIONS NEAR MENIL-LA-TOUR.

Les Islettes highway. Arrangements had been made whereby the French would maintain all roads south of and including that highway. Thus, the First Army road troops were left free to concentrate near Clermont in order to be available for immediate work upon the vitally important road running north from that town to Varennes, and on the road from Aubreville to Neuvilly. Following the advance and until October 1, the Army road troops were concentrated upon the above roads. The road from Clermont to Varennes was worked in 4 sections, with another section from Aubreville to Neuvilly. A two-way detour approximately 1,000 feet in length was

built around an enormous mine crater between Boureuilles and Varennes.

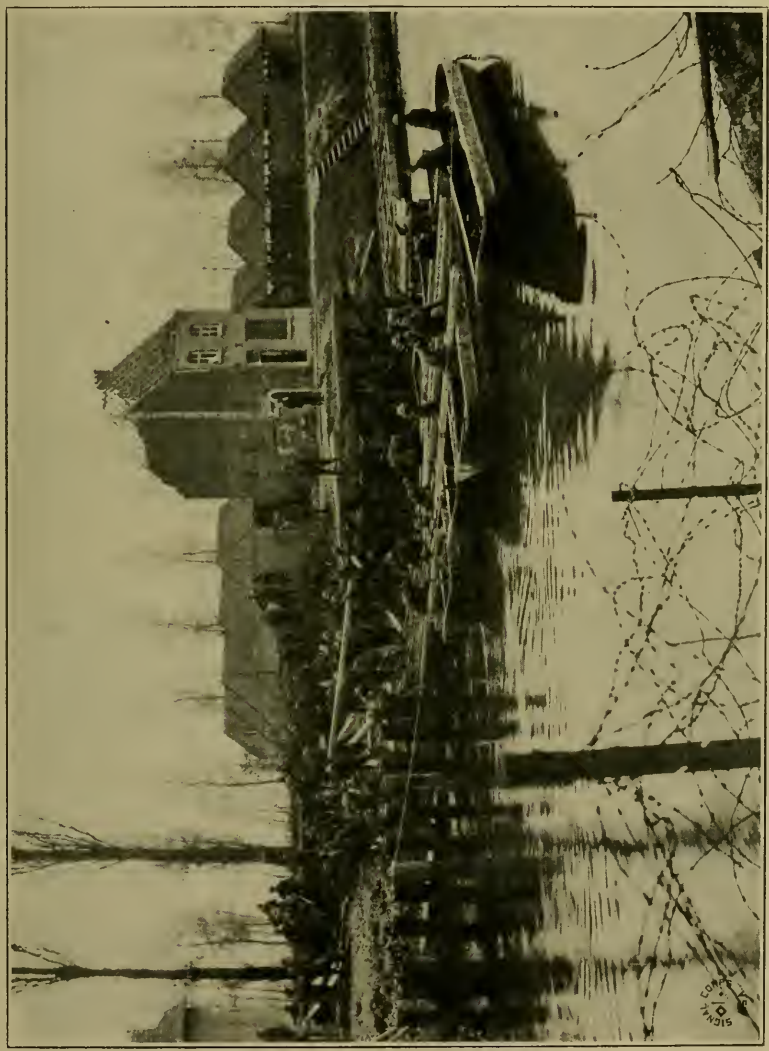
After October 2, 12 labor companies were left on the Army trunk roads to widen metaled portions to 6 meters, and all other road forces were assigned to additional roads in the Army area. After October 16, Army road troops took over the roads of the corps engineers, and thereby permitted them to move forward. The approximate line of demarkation then between the activities of Army and corps road troops was the line Apremont-Montfaucon. The Army area was divided into 5 districts, covering a total length of roads amounting to approximately 110 kilometers. Available forces and material were distributed to the districts so as to maintain a uniform rate of progress. Up to October 26, exclusive of the work done on the Army trunk roads, there were approximately 25,000 tons of rock used by Army troops in the construction and maintenance of the roads in the Army area. The Army roads area was divided into 8 districts on October 31. The First Army's advance, which began November 1, resulted in the opening of the Fleville-St. Juvin-Grand Pre road, and then the roads north and west of St. Juvin and Grand Pre, resulting in the creation of 4 new districts, from which the corps road troops were relieved. The Army road troops, following the advance to the ultimate line, took over the road work up to the rear corps boundaries as they existed upon the cessation of hostilities.

Bridges.—In assigning duties to the Army Engineer troops for the Meuse-Argonne offensive, the 27th Engineers, because of its experience in timber work, was designated a bridge regiment, and 2 companies were assigned to bridge work. On November 1, 3 additional companies of the 27th Engineers and 3 companies of the 603d Engineers were assigned to Army bridge work. The function of the Army bridge troops was to repair or rebuild bridges erected by divisional or corps troops but too light for heavy and continuous traffic; to build railway bridges as required by advancing lines, and to build new highway bridges of a permanent and substantial character. Army bridge troops had instructions to render all possible assistance to corps or divisional Engineers by furnishing men, tools, and material, or by taking over construction entirely. With such instructions, the Army bridge troops were employed not only in the rear areas, but also on structures in the front lines. In some instances divisional, corps, and Army bridge troops worked on crossings in the same locality at the same time.

Various structures erected by Army bridge troops are enumerated below.

On the night of September 26 a one-way bridge for heavy traffic was completed across the Aire at Boureuilles, and paralleled by a second bridge on the following night. Also, on this night a bridge

was built over a road crater north of Boureuilles. A partially demolished highway bridge across the Aire at Varennes was reconstructed, and the bridges across the Buanthe at Cheppy and Carpentry were widened for two-way traffic. As the advance continued heavy bridges were built across the Aire at Apremont and Chatel-



(1169-D8) PONTOON BRIDGE OVER THE ESCAUT NEAR AUDENARDE (BELGIUM), BUILT BY 316TH ENGINEERS.

Chehery. At Varennes a pile bridge was built over the Aire to parallel the main highway bridge. Standard-gauge railway bridges to carry the 243-ton naval guns were built across the Aire opposite Apremont and across the creek south of that town. Another standard-gauge railway bridge of timber-crib piers was built across Forges Creek at Forges.

The rapid advance of the front, which began November 1, produced results which led to a large increase in the work of Army bridge troops. The retreat of the enemy to the north made the crossings of the Aire at Grand Pre and St. Juvin of first importance. The way was cleared for the extension of both broad and narrow-gauge railways to Grand Pre, and for the narrow gauge beyond Grand Pre. The rapid advance was followed by the swing of the entire Army front to the east with a new front on the Meuse River. The result was that Army bridge troops had bridges to build on the front, flank, and rear of the advancing army. The enormous increased demand for bridges was met by sending all available bridge troops to the Aire front near St. Juvin and Grand Pre, and to the Meuse front at Consenvoye and Vilosnes. Two trainloads of bridge timber were shipped to the furthermost railheads. (Apremont on the westerly line, and Chattancourt on the line north from Verdun.)

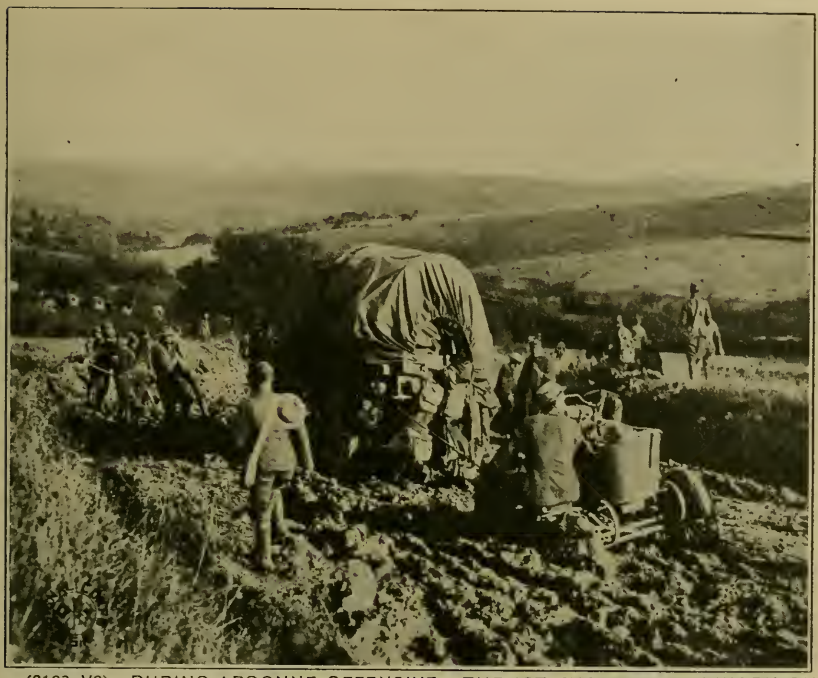
Following the advance, the highway bridges at Fleville and St. Juvin were strengthened to take the heavy guns, and the standard-gauge railway bridge across the Aire at Grand Pre, which had been demolished by the enemy, was reconstructed. Highway bridges at Grand Pre were strengthened, and a new one-way bridge for heavy traffic was built, supplying two-way bridge facilities at that point.

On the Meuse River, work on the Consenvoye bridge was begun on the morning of the 9th, the enemy still occupying the heights east of the Meuse. The work on the bridges at Vilosnes was begun the same day. On these bridges the Army Engineers were assisted by one company of the 308th Engineers, which built the bridge across the canal. The remaining three bridges at Vilosnes, including the main bridge, 162 feet long, across the river, were completed in four days' time, and opened for heavy traffic on the night of the 13th. The bridge at Consenvoye, which was built from the existing piling and framed structure, was completed the same night, the 13th, four days after work was begun.

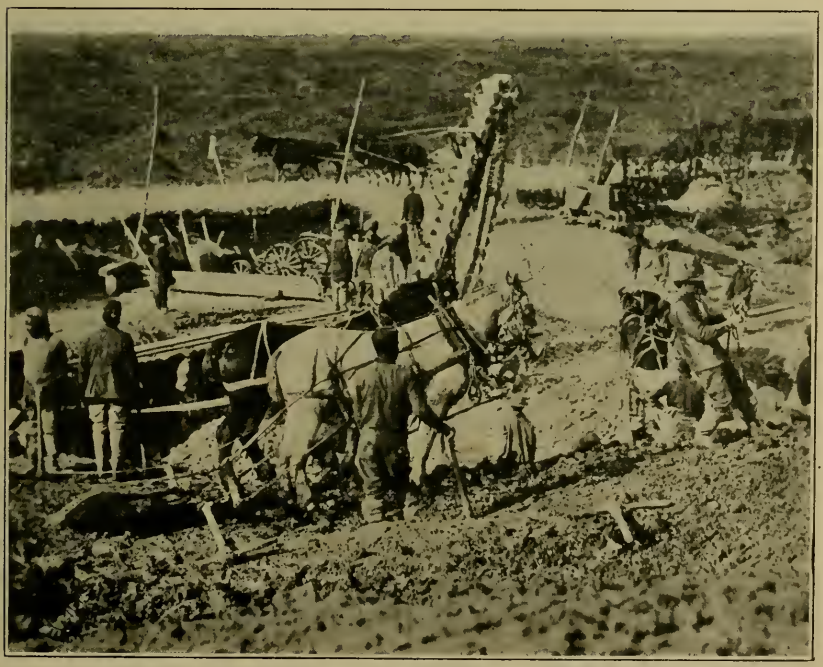
While the bridges across the Meuse River were being built the bridges on the main highway, which had been destroyed, were replaced by Army bridge troops, and the highway on the west bank was opened from Chattencourt to Dun-sur-Meuse.

During the period November 1 to November 11, inclusive, 383 linear feet of two-way bridges, 631 linear feet of one-way highway bridges, 319 linear feet of normal-gauge railway, and 552 linear feet of narrow-gauge railway bridges were built new, or rebuilt from demolished structures. A total of 27 bridges were built new, rebuilt, or strengthened during that period.

Water supply.—At the time of the St. Mihiel offensive the water supply service was composed of about 54 officers and 1,800 men. The



(2183–V8) DURING ARGONNE OFFENSIVE. THE 1ST ENGINEERS AT WORK ON ROAD NEAR BARRICOURT (ARDENNES).



(2820–V8) ROCK-CRUSHING PLANT OPERATED BY 28TH ENGINEERS NEAR HAUCOURT. NOVEMBER 10, 1918.

magnitude of the Meuse-Argonne operation called for additional troops for water supply, and the force was increased to include approximately 90 officers and 2,250 men. The former territorial organization was modified so as to provide a sector organization with three districts to the sector, and arrangements were made with the French at Verdun to continue to operate their water points in that vicinity and east of the Meuse. Before September 26, water points, each fitted with pumping plant and storage and purification system were installed at Ville-sur-Cousances, Dombasle, Vraincourt, Aubreville, La Chalade, Les Islettes, Foret de Hesse, and Bois de Bourrus.

Water supply details followed the advance on September 26, each equipped with animal-drawn transportation, carrying tools, hand

(1181–S8) HORSE-WATERING POINT ESTABLISHED AT BOUCQ. SEPTEMBER 3. 1918.

pumps, and one power pump, together with materials necessary to quickly develop local resources and to install canvas reservoirs.

In the area between former "No man's land" and the line Brieulles-Romagne-Sommerance-Lancon, there were installed, temporarily, the following: Twenty-six hand pumps at springs or wells which were cleaned out or developed, with facilities for supplying men and animals; 23 canvas tanks, of which 12 were filled from local sources, and 11 by water-tank trains; 10 horse-watering points equipped with horse troughs, in addition to those found undamaged and to watering points prepared at streams; and 10 mobile purification trucks.

Semipermanent or permanent installations in the same area, consisting of power pump with elevated tank, piping, facilities for filling water carts, motor trucks, and canteens, and, in most instances, horse-watering troughs were subsequently installed at the following points, replacing either hand pumps or mobile purification trucks: Bethincourt (2 installations, 1 for men and 1 for animals); Moulin de Raffecourt; Brabant (1 kilometer southeast); Consenvoye (2 kilometers southeast); Gercourt-Drillancourt-Bois de Forges (rehabilitated German pumping plant and pipe line distribution system); Avocourt; Avocourt (3 kilometers northwest); Cheppy; Montfaucon (4 kilometers south); Montfaucon (1 kilometer south); Cuisy; Ivoiry; Septsarges; Gercourt (2 kilometers west); Cierges; Gesnes; Abri du Crochet; Varnnes; Charpentry; Apremont; Exermont; Exermont (1 kilometer east).

The work was done by detachments sent out from water supply troops held in reserve at the respective district headquarters. The distribution of the permanent water points was determined by existing troop densities.

Gravity installations with storage and facilities for filling carts and canteens, and watering animals, were made at the following places: Lancon; Malancourt (1 kilometer north); Cuisy; Cuisy ($1\frac{3}{4}$ kilometers east); Cuisy ($2\frac{3}{4}$ kilometers east); Brabant ($\frac{1}{2}$ kilometer south); and Samogneux ($1\frac{1}{4}$ kilometers southeast).

The drive starting November 1 was prepared for in much the same way as the previous one, except that owing to the line having been stabilized for some days past, the usual work necessary for the troop concentration had already been completed by having the forward water points well up to the front, and mobile purification trucks released (by being replaced by stationary pumps) and ready to move with the forward parties.

The area had been well developed and maps made and distributed to the combatant troops, showing the water points in operation in all the troop concentration area, from "jump-off" line back to old "No man's land," also the probable location of water points in the advance areas.

On November 1, pioneer parties started forward with animal-drawn transport in rear of the combatant troops. Personnel and equipment were practically the same as in the previous advances, as was also the class of work performed. Semipermanent and permanent installations were made by detachments sent from the company reserves as rapidly as the conditions permitted.

Temporary installations included the following: Twenty-two hand pumps at cleaned out springs or wells, with facilities for men and animals; eight canvas tanks filled by water tank trains; and

nine horse-watering points, exclusive of existing undamaged installations.

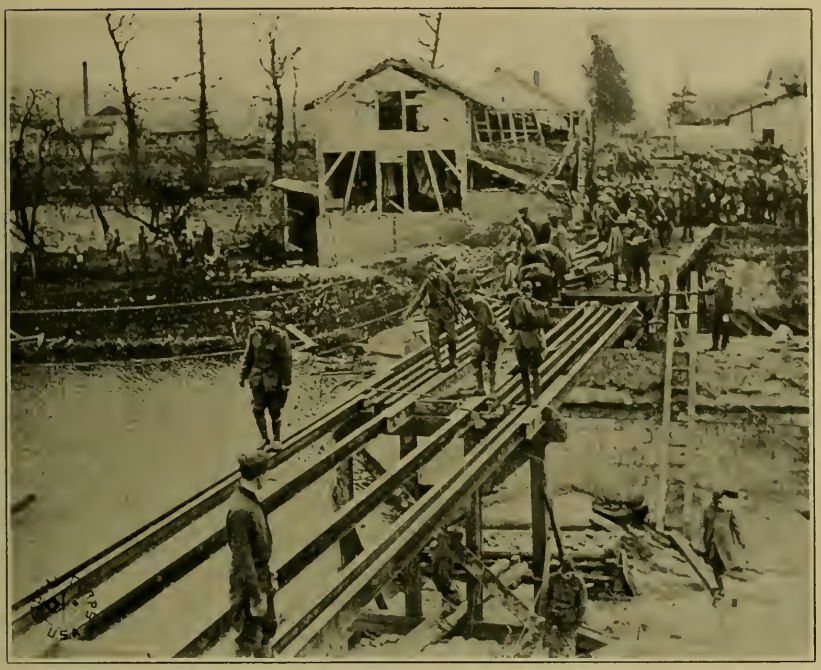
Permanent installations consisting of power pumps with pipe lines to elevated tanks were installed at the following points: Buzanty, La Dhuy Ferme, Liny-devant-Dun, Romagne, Sivry-sur-Meuse, Fleville, Nantillois, and Sommauthe.

For the water supply of several points motor tank trucks and light railway tank cars were used throughout the offensive. Parts of the 1st and 2d Provisional Water Tank Trains, which had been used in the St. Mihiel operations, were transferred and used in the Meuse-Argonne operations. Sections of the two truck trains were used to convey water from filling points in the rear to advance canvas tanks from which it was drawn by troops. The largest haul for any one day was 53,000 gallons. The average daily haul was about 31,000 gallons. The largest daily haul of the 2,000-gallon light railway tank cars was 14,000 gallons. Water from the light railway tanks was either discharged into canvas or concrete tanks, or drawn directly from the cars.

Watering points for standard-gauge locomotives were provided at Aubreville, Varennes, Dannevoux, Chatel-Chehery, Marcq, Grand Pre, and St. Juvin, and for light railway locomotives at Aubreville and Cheppy. During the reconstruction of the Verdun-Stenay line, temporary locomotive filling points were established at Charny, Chattencourt, Forges, Brieulles, Dun, Saulmery, and Stenay.

Electrical and mechanical.—The electrical and mechanical work in the Meuse-Argonne offensive was performed by five companies of the 37th Engineers, each assigned to work in one of the three American corps areas. Detachments from the three companies, however, remained in the Army area for the performance of electrical and mechanical duties in connection with facilities in the rear. Besides making all electrical installations, the electrical and mechanical troops made most of the heavier pumping installations for the water supply service in the forward areas, and operated all power plants and shops in the rear areas.

General construction.—A large amount of general construction was accomplished by Army Engineer troops. The troops used on such work were the 25th Engineers, one company of the 59th Pioneer Infantry, one-half company of the 805th Pioneer Infantry, nine companies of the 807th Pioneer Infantry, and one company of the 59th Pioneer Infantry. The construction accomplished included 8 ammunition dumps; 12 kilometers of light railway; 14 prisoner-of-war inclosures; 115 buildings for Army headquarters (33 at Ligny, 72 at Souilly, 10 at Chehery); 36 barracks for various small projects; 54 barracks for winter shelter for 3,000 men, and 2 highway bridges.



(2543–V8) 308TH ENGINEERS CONSTRUCTING BRIDGE AT DUN-SUR-MEUSE. NOVEMBER 8, 1918.

(2560–V8) 316TH ENGINEERS REPAIRING STANDARD GAUGE RAILROAD AT WAEREGHEM (BELGIUM).

Searchlights.—The Army Engineer troops employed in the operations of searchlights for antiaircraft defense consisted wholly of elements of the 56th Engineers. The 26 searchlights available to the First Army about the 26th of September were only sufficient to give a band of lights from the valley of the Moselle on the east to the large forest east of the Meuse River. Those lights were later transferred to the Meuse-Argonne region and on the 23d of September 18 lights were in position along the Meuse. The lighted area in that region comprised about 325 square kilometers, covering the natural approaches from Verdun on the east to Nixeville on the west, as well as the valley of the Meuse from Verdun south to Rouvrois-sur-Meuse; the searchlights thus protected the main and important approaches to back areas, as well as the troops and large railheads in rear of the lines of searchlights.

Searchlight section No. 3, French Army, equipped with 90-centimeter lights, had been assigned to the First Army, and was in position near Clermont-en-Argonne. On October 5, a detail of the 56th Engineers placed a captured German searchlight in operation. Eight searchlights were moved from the valley of the Moselle to new positions on the western flank of the lighted areas between Recicourt and Clermont-en-Argonne on October 6. The lighted area was then 425 square kilometers, fourteen 90-centimeter lights manned by personnel of the 56th Engineers arrived in the Army area October 18, and were grouped into positions in the general line of Esnes-Montfaucon-Varennes. On the 19th, 13 of the searchlights were moved from positions along the Meuse up to the general line Haudainville-Verdun-Esnes. Four lights of the French searchlight section No. 3, together with four additional French lights were moved to cover the territory south of the lighted area, along the valley of the Meuse, thus making a continuous lighted area to St. Mihiel, comprising about 455 square kilometers.

On October 10 an additional high-intensity searchlight was located near the airdrome of the first pursuit group at Rembercourt. That light was used in cooperation with the air service in night antiaircraft defense, the object being to illuminate the enemy bomber so that American planes aloft might attack him. Pursuit planes then defended the area from the south of La Croix-sur-Meuse to Verdun, and from Verdun to Varennes, and antiaircraft batteries defended the following areas: South of La Croix-sur-Meuse; northeast of Verdun between the Meuse River and the Verdun-Metz highway, including Verdun; west of the eastern edge of the Argonne forest; and south of the lighted areas.

Camouflage.—Of the Army camouflage troops belonging to the 40th Engineers, assigned to the First Army, 1 officer and 12 men were assigned to each of the divisions, and 1 officer and 20 men were

assigned to the Army artillery. An advance camouflage factory was established at Ste. Menehould, and civilian labor used. Camouflage dumps were established in connection with the corps dumps at Dombasle and Aubreville, the necessary material being secured from the central camouflage factory at Dijon.

During the 10 days preceding the attack, every effort was made to conceal signs of preparation, especially those of the artillery. The broken character of the soil rendered hasty camouflage fairly easy. In that period 52 American and 45 French artillery positions were camouflaged; in addition 298 batteries, with a total of 1,500 guns of corps artillery, were treated.

During the advance the camouflage detachments accompanied divisional and corps organizations and prepared new positions as they were taken up. Between September 26 and November 1, about 12 kilometers of road screening was accomplished in the advanced areas, besides some work on "P.Cs.", parking places, and dumps. From the beginning to the end of the Meuse-Argonne operations, 370 battery positions were treated, materials used including 1,473 nets and 159,360 square meters of other camouflage material.

Engineer supply.—The troops employed in the supply of Engineer material under direction of the chief engineer, First Army, were the 24th Engineers and detachments of the 37th Engineers, until October 7, when all Army Engineer troops were relieved in the operation of parks and dumps by the 808th Pioneer Infantry. About the middle of September the French engineer dumps at Les Islettes, Aubreville, and Dombasle were taken over, and, with their stocks, assigned as corps dumps of the First, Fifth, and Third Corps, respectively. At the same time a large French dump at Souhesme-le-Grande was taken over and operated as the Army engineer park. Great quantities of additional Engineer material were secured from the Service of Supply, from the French, and from the Second Army's St. Mihiel area.

During the period September 22-November 11, the receipts of Engineer material totaled 31,000 tons, and the issue 14,000. The foregoing totals are over and above the thousands of tons of captured material used in the field.

ENGINEER OPERATIONS, AMERICAN SECOND ARMY.

The American Second Army, which was created October 10, 1918, took over on the 26th from the First Army the Toul sector, including the territory wrested from the Germans in the St. Mihiel drive. Offensive operations on a front of 50 kilometers, from Fresnes-en-Woevre to Port-sur-Seille, the latter place being about 8 kilometers west of the Moselle, were begun on November 10. On that date, keeping touch with the sweeping movements of the American First Army

on the left, the Second Army attacked with all energy in the general direction of Conflans and Briey, aiming to envelop Metz in conjunction with the French Tenth Army on the right, whose attack northeast and east toward the Saar and the Rhine was to have been launched on November 14.

In the line on November 8, from right to left, were the Sixth Corps with the 92d Division, the Fourth Corps with the 7th and 28th Divisions, and the 33d Division, which was assigned to the Seventeenth French Corps. In support, or moving into support, the Second Army had the 88th, 4th, 35th, and 82d American and 26th French Divisions, besides the 85th American Division, which could not be counted specifically as a reserve division because it was the replacement division of the Army. Of the front line divisions, the 92d held from Port-sur-Seille to a point south of Preny, about 4 kilometers west of the Moselle; the 7th from Preny to the east bank of the Rupt de Mad; the 28th from the Rupt de Mad across Lachaussee Lake to about La Seigmulle Brook, a short distance north of Hattonchatel; and the 33d from this brook to Fresnes.

Preparations for the attack of November 10 and 11 were initiated in Second Army orders of November 1, which were to be put into execution in event of enemy withdrawal. It was directed that the Seventeenth French Corps advance toward Conflans, the Fourth Corps toward Vionville, and the Sixth Corps stand fast, but maintain close contact with the enemy by means of strong reconnaissances. On November 9 intelligence report indicated that the enemy was withdrawing progressively from west to east, leaving a very thin line to cover his departure. At 6.30 p. m. on that date, therefore, an order was issued making the original plan effective at once. It was followed by information issued at 1.30 a. m. on November 10, which announced that the enemy, disorganized, was withdrawing along the entire front. The zero hour was designated at 7 a. m., and at that time the Second Army attacked.

When hostilities ceased at 11 a. m. on November 11, 58 square kilometers of territory had been taken and 185 prisoners captured and the attack was progressing favorably.

DIVISIONAL ENGINEER OPERATIONS.

317th Engineers, 92d Division.—Only one company of the 317th Engineers was attached to the 92d Division in the Second Army's attack. It was employed in road construction, bridge repair, and work on observation posts in the front line. The French guards on mined Moselle River bridges were also relieved by detachments of the company.

5th Engineers, 7th Division.—The 5th Engineers moved to the 7th Division's area in the Second Army sector on October 30 and began

offensive preparations. In the advance three companies were assigned to accompany the Infantry, one company to make the main forward road passable, and two companies were held temporarily in reserve.

103d Engineers, 28th Division.—The 103d Engineers with the 28th Division performed the usual Engineer duties for its division in the attack.

108th Engineers, 33d Division.—The 33d Division passed to the control of the Second French Corps (later the Seventeenth French Corps) on October 22. The 108th Engineers immediately undertook the maintenance of a large mileage of roads, a great variety of construction and repair, and other duties in preparation for the attack. Previous to the offensive reconnaissance patrols were sent out to obtain information in the forward areas. Engineer detachments also assisted Infantry patrols in getting through obstacles, receiving high commendation therefor from infantry commanders. The work of repairing roads was continued constantly under very adverse conditions, which included exposure to high explosive and gas shells.

CORPS ENGINEER OPERATIONS.

Sixth Army Corps.—When assigned to the Second Army on October 13, the Sixth Corps possessed, as corps troops, the 115th Engineers, engaged in road construction in the forward areas and barrack construction, which were continued throughout the month. The first ten days of November were occupied in preparing the sector for attack by the establishment of dumps, repair of roads and bridges, and provision of a pontoon train and light footbridge equipage. The 92d Division in line, having but one sapper company, detachments of the 115th Engineers were placed in line with the division. In the attack of November 10, the corps engineer had at his disposal one battalion of the 804th Pioneer Infantry and the 115th Engineers, less one company in line, which were held in alert position in Puvenelle Forest.

Fourth Army Corps.—The 301st Engineers was assigned to the Fourth Corps as corps troops and was engaged principally upon road work and the construction of the second position. Prior to the advance the 51st Pioneer Infantry was also employed on road work under the corps engineer.

ARMY ENGINEER OPERATIONS.

The Army Engineer troops assigned to the chief engineer, Second Army, were:

11th Engineers (standard gauge railway)—2 companies.

12th Engineers (light railway)—2 companies.

15th Engineers (standard gauge railway)—battalion headquarters and 1 company.

21st Engineers (light railway)—headquarters and 5 companies.

22d Engineers (light railway)—headquarters and 9 companies.

23d Engineers (roads)—2 companies, 3 truck companies, and 1 wagon company.

24th Engineers (supply and shop)—2 companies.

25th Engineers (general construction)—1 company.

26th Engineers (water supply)—headquarters and 5 companies.

28th Engineers (quarry)—headquarters and 2 companies.

29th Engineers (surveying and printing)—1 company.

37th Engineers (electrical and mechanical)—1 company.

56th Engineers (searchlight)—1 company.

505th Service Battalion—entire battalion.

522d Service Battalion—entire battalion.

524th Service Battalion—headquarters and 2 companies.

528th Service Battalion—headquarters and 3 companies.

530th Service Battalion—headquarters and 3 companies.

535th Service Battalion—entire battalion.

543d Service Battalion—entire battalion.

These troops under the chief engineer of the Army executed the work described in the following sections.

Standard-gauge railways.—Important railway construction was begun previous to October 10 in the area assigned to the Second Army, and considerable work was accomplished prior to the offensive. The railroads at Woinville and Bernecourt and the standard-gauge railroads from Commercy to Woinville and from Ansauville Junction to Bernecourt were completed and placed in operation. Various surveys were made and troops engaged in ballasting and maintaining all lines operated by the Americans in the sector and in improving the facilities at both railheads.

Narrow-gauge railways.—The operation of 60-centimeter lines in what had been the Toul sector of the First Army was assigned to the 12th Engineers. For operating and maintenance purposes the sector was subdivided into three districts, namely, the Belleville or eastern district, the Menil-la-Tour or central district, and the Sorcy or western district. Extensive ballasting was done on existing lines, and an extension 7 kilometers in length, involving considerable grading was constructed; right of way on old German lines was made wider to accommodate United States equipment, tracks broken by shells were repaired, and three terminal yards were completed. Light railway construction forces, sent to Vieville-sous-les-Cotes and Boney previous to the offensive, had laid a considerable length of track in extension of existing lines by the morning of November 11.

Roads.—To facilitate road work, the Second Army area was divided into four sections, namely, the Toul, East Toul, West Toul, and St. Mihiel sections. Priority roads were established and work was done on 12 national highways, which passed through the area. The rock used was obtained both from the French and from quarries

(1981-V8) 304TH ENGINEERS REPAIRING ROADS AT REGNIEVILLE (MEUSE) WITH STONE FROM SHELLED BUILDINGS.

operated by or under the supervision of the 28th Engineers. Labor on road projects was furnished by Pioneer Infantry and Service Battalions, and back of the 30-kilometer line by prisoners of war, working under the supervision of technical troops of the 23d Engineers. At the close of October approximately 10,000 men were employed on over 145 kilometers of roads.

Advance dumps of road material were established just previous to the advance. It was provided that Army road troops be assembled ready to assist corps or divisional Engineers, or to follow immediately after them as the advance progressed. All troops and equipment reported at their stations in ample time, but the advance made

(1216-V8) RAILROAD TRACKS DESTROYED BY GERMANS, WAEREGHEM (BELGIUM), BEING REPAIRED BY 316TH ENGINEERS.

before the cessation of hostilities was insufficient to necessitate their employment beyond the original front line. Road forces in the rear maintained the main Army highways from dumps and railheads to the front.

Water supply.—The Army area was divided into two districts for water-supply work, St. Mihiel and Toul. Existing facilities were

repaired and improved at various points by water-supply troops, and German water systems were restored and operated. Two purification plants, each with a capacity of 50 gallons per minute, consisting of sedimentation basins, rapid sand filters, chlorinating devices, and clear-water basins were installed. Railway and cart filling stations, shower baths, and delousing stations were placed in operation. Operators were placed at pumping plants previously operated by the French or by Engineers of the First Army. A water-tank train hauled water to points which could not be supplied in any other way.

Companies A and B, 26th Engineers, and a detachment of the 24th Engineers were employed on the waterwork in the area. Truck-filling stations were established previous to the advance and water supply material stocked well forward. A detachment was located at St. Maurice ready to follow the attack and install reservoirs, rehabilitate wells, and perform other usual duties.

Supply and electrical and mechanical.—The depot at Leonval, already of considerable size, was enlarged to meet the requirements of an Army depot, and the supplies on hand supplemented by substantial requisitions. Previous to the offensive, therefore, it was able to make large shipments to corps and other dumps that were established forward. Three shops, capable of various kinds of manufacture and repair in quantity were established and two sets of motor-truck shops for small repairs were provided. About 50 portable artillery bridges were manufactured by the shop section. That work was largely executed by the 24th and 37th Engineers.

Searchlights.—The searchlight troops, one company, 56th Engineers, were active in the Army area, and with six 60-inch lights did much valuable work against hostile aircraft. During the attack reconnaissances were made and emplacements located to which searchlights could be moved as soon as the lines had become sufficiently advanced.

Camouflage.—Camouflage troops, detachments of the 40th Engineers, distributed among the divisions on the front lines, did considerable work with the divisional artillery and dumps.

General construction.—Unloading ramps, warehouses, barracks, and prisoner-of-war inclosures were constructed at various parts of the Army area and repairs made to barracks and hospitals.

ENGINEER OPERATIONS AFTER THE ARMISTICE.

The organization of the American Third Army was inaugurated November 7, 1918, and completed on November 15. Most of the veteran corps and divisions of the First and Second Armies became components of the new Third Army, organized to become the American Army of Occupation.

The reconstituted First and Second Armies, then relieved of their duties as combatant organizations, so disposed themselves as best to facilitate a program of training ordered by general headquarters. The Third Army moved by marching and by train to the American sector on the Rhine.

ENGINEER OPERATIONS, FIRST ARMY.

The Engineer troops attached to the commands remaining in the First Army engaged in the removal of mines and traps, salvage, and the reconstruction of the necessary roads and railroads over which the troops of occupation and their supplies were to pass. Light railway troops built lines across "No man's land" to connect with the German narrow-gauge system. Standard-gauge tracks, laid to points close behind the front before hostilities ceased, were extended and joined with existing lines beyond which were repaired where necessary.

In its reorganized form the First Army embraced the following:

First Corps—114th Engineers attached.
- 36th Division—111th Engineers attached.
- 78th Division—303d Engineers attached.
- 80th Division—305th Engineers attached.

Fifth Corps—603d–604th Engineers (Provisional) attached.
- 26th Division—101st Engineers attached.
- 29th Division—104th Engineers attached.
- 82d Division—307th Engineers attached.

Eighth Corps—605th Engineers attached.
- 6th Division—318th Engineers attached.
- 77th Division—302d Engineers attached.
- 81st Division—306th Engineers attached.

First Army headquarters had the following Army Engineer troops:

11th Engineers (standard-gauge railway)—headquarters and four companies.

12th Engineers (light railway)—headquarters and 4 companies.

14th Engineers (light railway)—headquarters and entire regiment.

15th Engineers (standard-gauge railway)—3 companies.

16th Engineers (standard-gauge railway)—entire regiment.

21st Engineers (light railway)—8 companies.

22d Engineers (light railway)—6 companies.

23d Engineers (roads)—headquarters, 10 companies, 7 truck companies, 4 wagon companies.

24th Engineers (shop and supply)—headquarters and 4 companies.

25th Engineers (construction)—headquarters, 5 companies.

26th Engineers (water supply)—1 company.

27th Engineers (bridge)—headquarters, 6 companies.

28th Engineers (quarry)—3 companies.

37th Engineers (electrical and mechanical)—headquarters, 4 companies.

508th Service Battalion—1 company.

524th Service Battalion—2 companies.

527th Service Battalion—entire battalion.

528th Service Battalion—1 company.

534th Service Battalion—2 companies.

537th Service Battalion—entire battalion.

544th Service Battalion—entire battalion.

545th Service Battalion—entire battalion.

Headquarters of the First Army remained at Souilly for a period and later removed to Bar-sur-Aube. Operations extended over a wide area from points well in advance of the line on which hostilities ceased to divisional training areas far in the rear, to which many of the divisions moved. Divisional and corps Engineers were employed largely upon road maintenance and upon general construction and repair in divisional areas or embarked upon a period of training with the commands to which they belonged.

In compliance with orders issued on November 19, which assigned to the transportation department the responsibility for all standard-gauge railroad construction and repair, the 11th, 12th, 14th, 15th, 16th, 21st, and 22d Engineers were soon thereafter transferred to that department. On December 10 the duties, lines, equipment, and personnel pertaining to light railways and roads passed from the control of the armies to the chief engineer, American Expeditionary Forces. Through those changes the army was relieved of practically all the Army Engineer troops.

In the succeeding weeks various divisions and units were ordered to the Service of Supply for duty or for embarkation to the United States. Other divisions were assigned to the Third Army and moved forward to the Rhine to replace returning divisions. April 19, 1919, the First Army was dissolved.

ENGINEER OPERATIONS, SECOND ARMY.

None of the divisions comprising the Second Army when hostilities ceased were transferred to the new Third Army. The Engineers attached to such divisions, therefore, remained in the old line and engaged in road repair, salvage, policing, removal of mines, and other duties. The 108th Engineers alone removed approximately 6,000 mines. The 110th Engineers of the 35th Division, which entered the Second Army November 12, was placed at the disposal of the chief engineer, Seventeenth French Corps, and employed on quarry and bridge work, road repair, and salvage operations. Light

railway troops made connections with the German light-railway system across "No man's land," opening various routes, which permitted operation as far as Conflans.

The 313th Engineers of the 88th Division was moving in as reserve when the armistice was signed. In order to open the railroad leading into Metz, the regiment march 34 kilometers to Pont-a-Mousson on November 15, and on the 16th continued the march to Norroy, 10 kilometers beyond, arriving there at 10.30 a. m. Repair of the main line from Nancy to Metz was at once begun and rushed with the result that at 2.30 p. m. of the same day the first train bearing many distinguished Allied officers passed through Norroy to Metz. Other railroad repair in the vicinity of Conflans was afterwards undertaken by the regiment.

When the Third Army started forward, small water-supply detachments of the Second Army preceded both of the advance columns as far as Briey, searching out and placarding water points and making minor repairs to existing installations. Sterilabs were sent to advance points and examination of the quality of water supplies was continued in the area occupied by American troops for some time after the armistice.

The Second Army was reconstituted as follows in the latter part of November:

Sixth Corps—115th Engineers attached:
- 7th Division—5th Engineers attached.
- 5th Division—7th Engineers attached.
- 28th Division—103d Engineers attached.
- 92d Division—317th Engineers attached.

Ninth Corps (newly organized)—313th Engineers attached:
- 33d Division—108th Engineers attached.
- 35th Division—110th Engineers attached.
- 79th Division—304th Engineers attached.
- 88th Division—(313th Engineers, serving as corps troops).

Second Army headquarters had the following attached:

11th Engineers (standard-gauge railway)—2 companies.

12th Engineers (light railway)—2 companies.

15th Engineers (light railway)—battalion headquarters, 1 company.

21st Engineers (light railway)—headquarters, 5 companies.

22d Engineers (light railway)—headquarters, 9 companies.

23d Engineers (roads)—2 companies, 3 truck companies, 1 wagon company.

24th Engineers (shop and supply)—2 companies.

25th Engineers (construction)—1 company.

26th Engineers (water supply)—headquarters, 5 companies.

28th Engineers (quarry and mining)—headquarters, 2 companies.

29th Engineers (surveying and printing)—1 company.
37th Engineers (electrical and mechanical)—2 companies.
505th Service Battalion—entire battalion.
522d Service Battalion—entire battalion.
524th Service Battalion—headquarters, 2 companies.
528th Service Battalion—headquarters, 3 companies.
530th Service Battalion—headquarters, 3 companies.
535th Service Battalion—entire battalion.
542d Service Battalion—1 company.
543d Service Battalion—entire battalion.
546th Service Battalion—entire battalion.

Headquarters of the Second Army remained at Toul throughout the period of its operations. As in the case of the First Army, an extensive program of training was begun in which Engineer units participated, except when their services were required for road repair, construction, and other engineer duties. Standard-gauge railroad lines were repaired and maintained until December 17. when they passed to the control of the transportation department. Narrow-gauge railways were maintained and operated until midnight of December 18–19, when they were transferred to the director of light railways and roads. The responsibility for road work was transferred to the section engineer, advance section, service of supply, at midnight, December 18–19. The Second Army, by the same order that abolished the First Army, was dissolved on April 19, 1919.

ENGINEER OPERATIONS, THIRD ARMY.

Upon the signing of the armistice the enemy withdrew his armies and marched them toward Germany. The American First and Second Army "fronts" then became First and Second Army areas. In those areas was organized the American Third Army. It was first composed of six veteran divisions which had demonstrated exceptional worth in the First Army's Meuse-Argonne advance.

The Third Corps headquarters was transferred from the First and the Fourth Corps from the Second Army to the Third Army. To the two corps commands were assigned the six divisions. The tactical and Engineer organization of the Third Army when the advance toward the Rhine began November 17, 1918, was:

Third Army headquarters, 24th, 26th, 37th (Provisional) Engineer Regiment (composed of regimental headquarters and 2 companies, 24th Engineers; 2 companies, 26th Engineers; 1st Battalion headquarters, and 2 companies, 37th Engineers), attached to the Third Army as Army Engineer troops.

Third Corps—308th Engineers attached:

2d Division—2d Engineers attached, in line.
32d Divison—107th Engineers attached, in line.
42d Division—117th Engineers attached, in line.

Fourth Corps—301st Engineers, attached:
1st Division—1st Engineers, attached, in line.
3d Division—6th Engineers, attached, in line.
4th Division—4th Engineers, attached, in support.

The Third Corps advanced on the left and the Fourth Corps on the right. The French Fifth Army continued the advancing line on the Third Army's left to the junction of the Third Army's northern boundary with that of the British Second Army. The French Tenth Army carried the advance on the Third Army's south.

The advance divisions of the Third Army had reached the 1914 French frontier, November 18, where they were held by the Allied high command until the 20th. On that date the advance continued through Luxemburg and arrived at the German frontier on the 23d. The Army, under orders, then remained on the Luxemburg-German frontier until December 1.

In the meantime the Seventh Corps had been organized and as a reserve corps moved up to the 1914 French frontier. Its tactical and Engineer composition was:

Seventh Corps headquarters—310th–602d (Provisional) Engineer Regiment, attached as corps Engineer troops.
89th Division—314th Engineers, attached.
90th Division—315th Engineers, attached.

Also the 5th Division, 7th Engineers, attached, of the Second Army had been advanced and distributed along the line of communication to serve as Third Army line-of-communication troops.

On the 1st of December the entire Third Army and the 5th Division again proceeded in the advance. On December 8 the 2d Divisional Cavalry reached the Rhine. On the 9th, 10th, and 11th advance elements of the 2d, 32d, 1st, and 3d Divisions came to a stop on the Rhine. Thus, on December 12, the Third Army was well established on the west bank of the Rhine.

The divisions in line arrived on the Rhine in accordance with the sector then assigned to the Third Army—from Rolandseek on the north to near Trachtingshausen on the south. However, a rearrangement of the sector left the north limit the same, but on the south it was reduced, the southern boundary being set to include Berncastle, Wittlich, Cochem, Mayen, Coblenz, Montabaur, and Westerburg. The Third Army sector included the bridgehead at Coblenz, less that part cut off by the new southern boundary, which was occupied by the French Tenth Army. That bridgehead was the territory on the right bank of the Rhine within a circle with a 30-kilometer radius and a center at the eastern abutment of the Pfaffendorfer bridge at Coblenz.

The change in sector limits made necessary a reconstitution of the Third and Fourth Corps and a shifting of the troops on the left

bank of the river. Consequently, on the morning of the 13th of December the 1st Division passed to the command of the Third Corps, which was designated as the corps to occupy the northern sector of the Coblenz bridgehead, with the French on the south. The 1st, 2d, and 32d Divisions then comprised the Third Corps.

The Third Corps began crossing the Rhine at 7 a. m. December 12. The 2d Division, on the left, crossed at Remagen; the 32d, in the center, at Engers; and the 1st, on the right, crossed on the two bridges of Coblenz. The Fourth Corps, in support of the Third Corps, occupied with its divisions Mayen, Ahrweiler, Adenan, and Cochem. The Seventh Corps with its divisions occupied the Regierungsbezirk of Trier. The foregoing, completed December 18, was the final disposition of the American Army of Occupation on the Rhine.

Subsequently various changes were made in the Third Army command. The 42d Division was relieved by the 4th Division April 1 and transferred to the Service of Supply for transport to the United States. The 6th Division (318th Engineers attached) was transferred from the First Army to replace the 4th Division. The 32d Division was transferred to the Service of Supply April 8 for embarkation. The Sixth Corps was transferred from the First Army to the Third April 1, and with its two divisions, the 5th (7th Engineers attached) and 33d (108th Engineers attached), occupied the Duchy of Luxemburg. The Sixth Corps was broken up shortly after, however, and the 33d Division returned to the United States. It was replaced by the 7th Division (5th Engineers attached) from the Second Army. The 5th Division remained in Luxemburg as a component of the Seventh Corps. In May the 5th and 7th Divisions relieved the 89th and 90th Divisions of the Seventh Corps, and the two latter were returned to the United States. Thus before the end of May the American Army of Occupation was composed entirely of Regular Army divisions—the 1st, 2d, 3d, 4th, 5th, 6th, and 7th.

ENGINEER OPERATIONS.

During the Third Army's advance from the American front of November 11 to the Rhine the provisional Army Engineer regiment was distributed as follows: One-half of a water-supply company (26th Engineers) to each of the four leading divisions; an electrical-mechanical company (37th Engineers) to each corps; one shop and one supply company (24th Engineers) to the 1st and one to the 3d Division.

The chief engineers of the First and Second Armies were charged with the Engineer work incident to getting the Third Army forward beyond the American front of November 11. No difficulty was experienced in the movement across "No man's land." In fact, the only serious engineering problem was that of railway transportation

for rationing the advancing units. Although that was the duty of the Transportation Corps, the only troops operating in the area were two companies of the 37th Engineers and a detachment of the 21st Engineers, who were sent forward by the chief engineers, First Army, to open up the railway lines. In view of the serious Army supply situation, the commanding general, Third Army, directed his chief engineer to assume direction of all railroad operation in the area. Under his supervision much rolling stock was taken over from the Germans and put in operation, pumping plants were placed in operation, and railhead sites were reconnoitered well to the front. A number of Engineer dumps containing a good assortment of Engineer material were found during the advance. The chief activities of the Army, corps, and divisional engineers during the advance to the German frontier were forward reconnaissance of railroads, roads, bridges, and quarries, and the provision of lights for the headquarters of the various commands. The divisional engineers of the leading divisions after crossing the German border on December 1 found the roads in fair condition, but on the whole much narrower and steeper than those of France. The difficulty of transport was therefore increased, but nothing could be done by the engineers except in the way of traffic control.

On December 4 two companies of the 37th Engineers advanced along the railroad to and beyond the Rhine developing railheads and reconnoitering public utilities en route. Also, as the leading divisions advanced their Engineer regiments inspected the public utilities in all towns passed through and took remedial measures where they were necessary. In towns where utilities were rendered insufficient by the increased load due to the occupation supplemental installations were made and detachments left for their operations.

A forward inspection of bridges showed that all were ready for the crossing of the leading divisions except that the pontoon structure across the Moselle at Treis. That bridge which had previously been built for the withdrawal of the German columns and then removed, was replaced by the same contractors and ready for use when the troops reached that point.

The rather poor condition of the roads in the Third Army's sector began to assume a considerable degree of importance as the effect of American motor transport became apparent after the middle of December. About that time the question of road maintenance in the occupied territory was taken up with the German authorities by the Allied high command. In the meantime an organization of the corps and divisional Engineers was developed for the upkeep of the roads. It was arranged that the corps and divisional Engineers should assist the local German road administration system which supplied the labor, by supplying the necessary motor and wagon transport. It

very shortly became necessary to also use Engineer labor on the roads. Eventually, it was arranged that the German road administration's system supply all the labor while the Engineer troops were used only in supervision and transport. Road maintenance necessitated the operation of numerous German quarries which was done under the supervision of American Engineer personnel.

Gradually the number of Engineer troops employed in the road and the public utilities services was reduced to the minimum needed for technical supervision in accordance with a policy of leaving to the Germans the performance of the actual work. The Germans on their part lived up to the requirements very well in the main. Their public utilities were operated with little basis for criticism, their railroads were operated as satisfactorily as could be expected under the circumstances, their roads were brought to a very fair state, all, however, as a result of the positive insistance of the Army Engineer organization.

During the latter half of December the detachments of the 24th, 26th, and 37th Engineers were relieved from duty with Third Army headquarters and returned to their regiments in the Service of Supply. They were replaced as Army Engineer troops by one company of the 301st Engineers (Fourth Corps regiment) and one company of the 310th Engineers (Seventh Corps regiment).

Beside their public utility and road work, the divisional Engineers were employed in such purely divisional construction as buildings for housing and entertainment, stables and dipping vats for animals, and rifle ranges, also a considerable amount of improvement and construction was accomplished with respect to wharves and landing stages. Gradually the greater part of all Engineer personnel became engaged in drill and Engineer training, for which excellent facilities existed in and near the Rhine, particularly for pontoon training upon a very extensive scale.

REFERENCE DATA, ENGINEER OPERATIONS WITH ARMIES.

	Appendix number.
Regimental histories and monthly reports	R–1 to R–605, inclusive.
Reports, corps engineers	C–1 to C–9, inclusive.
Reports, chief engineers, armies	A–1 to A–3, inclusive.
Maps, major offensives	Appendix No. 1.

Part III.

ENGINEER SUPPLY AND CONSTRUCTION.

ENGINEER SUPPLIES.

Engineer supplies which had been procured for American Expeditionary Forces operations, amounted to more than 3,000,000 tons; the total cost involved was approximately $450,000,000. The procurement, storage, and distribution of this material was the main function of the division of military engineering and engineer supplies. After the division was abolished January 27, 1919, its duties in connection with supplies were assigned to the Engineer purchasing officer.

Supplies were obtained both by shipment from the United States and by purchase in Europe. From the United States there were received a total of 1,416,167 tons, the first shipments being received in March, 1918, and the last in December, 1918. Of this total tonnage, 963,816 tons were classified as Engineer supplies and 452,351 tons as director general of transportation supplies. European purchases were of three classes: Open-market purchases, contract purchases, and purchases from Allied Governments. They represented mainly wood barracks, hospitals, and other buildings, heavy building material and material which could not have been economically transported to France from the United States.

Taking into consideration deductions due to cancellations after the armistice, the net total of open-market European purchases to April 1, 1919, represented 799,645 tons, valued at 463,338,871 francs; the cancellations referred to amounted to 89,540 tons, valued at 90,589,290 francs. Under the classification of European purchases by contract, to March 17, 1919, 182 contracts had been executed, representing an expenditure of 523,832,000 francs; of this total, however, 77,215,500 francs were canceled and 211,578,500 francs were canceled but still under settlement.

The purchases from Allied Governments consisted mainly of camps, barracks, and forests. Prior to the incorporation of the forestry section, Engineer purchasing office, with the division of construction and forestry, all negotiations for acquiring forests were made by the Engineer purchasing office. Forests and forest products thus purchased from the French Government amounted to 72,365,682 francs, a tonnage of 1,856,771. The camps, etc., acquired from the

French Government were handled by the division of construction and forestry, the Engineer purchasing office being the disbursing office. The number of barracks acquired by the Engineer purchasing office from the French Government was as follows: Hospital barracks, 1,118; troop barracks, 3,681; stables, 500. General Engineer supplies to the value of 176,966,370 francs, with a tonnage of 97,047, were also secured.

ENGINEER SUPPLY SECTION.

The supply organization grew almost insensibly, beginning to operate when the first representatives of the American Expeditionary Forces arrived in France. Its early operations were necessarily informal, and its distinct existence began only several months later. Late in September, 1917, the supply section of the office of the chief engineer, American Expeditionary Forces, had developed three main lines of activity: (1) Purchasing and disbursing; (2) requisitions and requirements; (3) Engineer depots. In the year and a half during which Engineer supplies were purchased, stored, and distributed for American Expeditionary Forces use, many changes and developments took place in methods of handling this business. The internal organization finally adopted for the Engineer supplies' section subdivided the work as shown in the following schedule. This was the organization in force during the latter months of the war, and until January, 1919.

A. Production and procurement section:
   1. Front-line supplies.
   2. Unit equipment.
   3. Light railways and roads.
   4. Railways and general construction.
   5. Electrical and mechanical.
   6. Water supply.

B. General depot section:
   1. Front-line section.
   2. Electrical section.
   3. Forestry section.
   4. Structural steel, etc.
   5. Cement section.
   6. Construction plant.
   7. Motor and other vehicles.
   8. Standard railways.
   9. Light railways.
   10. Roads.
   11. Water supply.
   12. Hardware and tools.
   13. Retail issue.

C. Section Engineer depots:
   1. Advance section.
   2. Intermediate section, east.
   3. Intermediate section, west.
   4. Base section No. 1.
   5. Base section No. 2.
   6. Base section No. 4.
   7. Base section No. 5.
   8. Base section No. 6.
   9. Base section No. 7.

D. Shop and repair section.
E. Traffic section.
F. Statistical section.

SUPPLIES FROM THE UNITED STATES.

The procurement section of the Engineer supply office assumed the routine of preparing requisitions for purchase. These were placed on the Paris and London purchasing offices if the supplies were susceptible of purchase on the Continent or in England; if not, the requisitions were placed, through channels, with the Chief of Engineers in Washington. Naturally the great majority of Engineer supplies had to come from the United States. By December 31, 1917, requisitions 1 to 12, covering the bulk of the initial and automatic supplies estimated to be needed in France, had been placed on order, and some shipments had already been made and received. As these requisitions were the main basis of current supplies, a tabulation of them is given herewith:

Requisition No. 1,	dated July 10, 1917	Camouflage materials and steel products.
Requisition No. 2,	dated July 10, 1917	Water supply stores.
Requisition No. 3,	dated July 10, 1917	Electrical supplies.
Requisition No. 4,	dated July 10, 1917	General Engineer construction tools.
Requisition No. 5,	dated July 10, 1917	Road construction material and equipment.
Requisition No. 6,	dated July 14, 1917	Railroad construction material and equipment.
Requisition No. 7,	dated July 26, 1917	Mining supplies and equipment.
Requisition No. 8,	dated Aug. 6, 1917	Construction tools and materials.
Requisition No. 9,	dated Aug. 18, 1917	Trench track material and equipment.
Requisition No. 10,	dated Oct. 10, 1917	General Engineer supplies.
Requisition No. 11,	dated Nov. 24, 1917	General Engineer supplies, including combatant supplies.
Requisition No. 11A,	dated Dec. 29, 1917	Special Engineer supplies (steel shelters, repair parts, etc.).
Requisition No. 12,	dated Jan. 17, 1918	General Engineer supplies, including combatant supplies.

All of the above requisitions were based on an Army of 500,000 men and provided for an initial supply of materials to be delivered in France before May 1, 1918, and an automatic monthly supply thereafter. An exception to this practice was made in requisition No. 12, from which the automatic supply was eliminated. Requisitions 10, 11, and 12 were also placed in the hands of the Engineer purchasing officer in England for purchase, coincident with their transmission to the United States and he was able to procure a large part of the initial supplies called for on requisition No. 10, and had made some progress on requisition No. 11. The wisdom of this step was fully justified by the fact that the inflow of supplies from England was soon established, and their early receipt made it possible to meet the demands for Engineer supplies, which were assuming large proportions before the systematic arrival of supplies from the United States. There was also a considerable saving in trans-Atlantic tonnage involved, since a number of items of supply were obtained entirely from England.

Table 1 shows the total tonnage of Engineer supplies floated to December 15, 1918.

TABLE 1.—*Statement of total United States tonnage floated to Dec. 15, 1918.*

	Weight tons.	Ship tons.
General machinery	45,454	81,525
Iron and steel products	242,226	145,100
Hardware and hand tools	26,780	44,850
Railway rolling stock	343,888	521,575
Railway motive power	144,066	284,450
Lumber	39,086	55,400
Track materials and fastenings	488,793	488,800
Automotive transportation, etc.	22,127	37,650
Horse-drawn transportation	7,967	20,850
Building materials and supplies	98,671	116,400
Liquids	7,067	5,425
Explosives and accessories	952	975
Unit accountability	7	25
Engineer supplies	52,106	103,325
Miscellaneous office supplies	2,239	3,925
Floating equipment and accessories	10,093	11,625
Materials and tools for locomotive and car repair and erection shops	10,407	12,875
Total	1,541,929	1,934,775

The remainder of the American Expeditionary Forces' Engineer supplies were secured by purchase in France, England, Switzerland, and Spain.

EUROPEAN PURCHASES.

Supplies and materials bought in Europe were handled by the Engineer purchasing officer at Paris, under approval, after August 20, 1917, of a general purchasing board.

The purchase of large quantities of Engineer supplies in Europe was made necessary primarily by the lack of ocean tonnage to transport them from America. The priority amount of ocean tonnage for Engineer supplies was determined for each month by the general

staff. The items to be shipped from the United States each month under this tonnage allowance were determined by the Engineer supply section. They were based on estimates of material needed as furnished by the Service of Supply and the field armies, the latter being given preference. It was an established principle that everything possible should be bought in Europe, for the monthly overseas tonnage was always insufficient to bring to France requirements that could not be obtained in the European markets.

The officers in charge of the Engineer purchasing office, which throughout the war was located at Paris, were:

Col. T. H. Jackson, August 4, 1917, to December 26, 1917.

Col. J. A. Woodruff, December 26, 1917, to February 5, 1918.

Col. C. McD. Townsend, February 6, 1918, to October 21, 1918.

Col. F. C. Boggs, October 21, 1918, to January 7, 1919.

Col. T. H. Jackson, January 7, 1919 to ———.

On August 20, 1917, a general purchasing board was formed, in accordance with General Orders, No. 23, General Headquarters, August 20, 1917. The Engineer purchasing officer and the purchasing officers of other branches of the service formed this board. From that date all purchases in Europe required the approval of the general purchasing board before being consummated.

About August 1, 1918, the purchasing offices in England, Switzerland, and Spain, which had up to that time been handled directly by the Engineer purchasing officer at Paris under assistants in the three countries, were taken over by the general purchasing agent.

Material procured in Europe.—The amount of material procured in Europe is estimated at 1,729,172 tons, valued at 1,185,275,913 francs. These amounts may be divided as follows:

TABLE 2.—*Summary of European purchases.*

Material.	Tons.	Francs.
Procured in France from commercial sources	993,990	621,662,566
Procured in France from French Government	241,124	149,910,097
Procured in England from commercial sources	66,000	55,354,000
Procured in England from British Government	330,000	269,048,000
Procured in Spain from commercial sources	1,191	4,605,000
Procured in Switzerland from commercial sources	96,867	84,696,250
Total	1,729,172	1,185,275,913

The method of handling purchases in France became the subject of discussion very soon after the establishment of the office. It was claimed by the French authorities that if the Americans were permitted to go into the market and make purchases at their own price it would not only upset the market for the American Army but also seriously interfere with the purchases for the French Army.

Under these circumstances the method was adopted about October 15, 1917, by the American authorities and approved by the French

authorities that all purchases over a certain amount would have to be referred to the French mission, and by that mission to the various branches of the French Army service for approval as to price and as to the furnishing of the material.

In many instances the French Government would return these orders with the statement that the material would be furnished by the French Army, rather than by the contractor with whom the material had been originally located. While it is doubtless that this method saved a considerable amount of money to the American Government, yet it is equally doubtless that the delay in handling the orders through the French mission and from there through various French services has in many instances given rise to considerable dissatisfaction, if not actual interference, with important work.

Every effort was made in the purchasing office to expedite these requests, but after they were once in the hands of the French mission there seemed to be absolutely no way in which they could be hurried, and it was merely a matter of waiting until the French service reported. It is noted that in many instances the material which was purchased in this way could have been obtained from the United States in less time.

Purchases were also rather involved and delayed, due to the establishment of the control board in the office of the general purchasing agent. It was the duty of this board to scrutinize the orders, following the requirements of General Orders, No. 41, Service of Supply, 1918, to see that the material called for was in the particular category of the service placing the order. It is thought that the control board handled the orders as promptly as could be done under the circumstances, but even with this there were frequent delays of several days before these orders were passed on by the board.

While there may have been variations in the methods adopted in the early days, the final method of handling purchases can be stated as follows: All orders which were not definitely stated to be emergency orders were required to be referred to the control board or the general purchasing agent before being sent to the dealer. If the amount of the order was in excess of 5,000 francs, the control board forwarded the order to the Inspection des Forges of the French service, where it was examined in connection with the subject of replacement of raw material. If this service returned the orders with a certain particular wording, they were referred back to this office by the control board with authority to purchase. If the wording in the reply from the Inspection des Forges was of another character, it then became necessary for the control board to send the order to the French service for further approval. For emergency purchases under 5,000 francs orders could be placed directly either by the purchasing office in Paris or by the field purchasing agents.

STORAGE SPACE OCCUPIED.

The Engineer open and covered storage actually occupied at the various depots in France on November 11, 1918, amounted to more than 15,000,000 square feet, divided among the depots as shown in Table 3:

TABLE 3.—*Engineer storage space occupied November 11, 1918.*

Depot.	Covered storage (square feet).	Open storage (square feet).
Gievres	350,375	6,000,000
Is-sur-Tille	169,000	2,600,000
Montierchaume	15,000	1,500,000
St. Supice	96,970	1,274,560
Montoir	86,800	2,215,000
La Pallice	40,000	270,000
Marseille	6,000	492,500
Total	764,145	14,352,060

An item of technical interest can be deduced from the figures given, taken in relation to the tonnage actually stored at each depot. The data and the results are given in Table 4:

TABLE 4.—*Square feet of storage per ton.*

Depot.	Storage occupied (square feet).	Amount stored (tons).	Area divided by tonnage (square feet per ton).
Gievres	6,350,375	123,200	52
Is-sur-Tille	2,769,000	58,990	47
Montierchaume	1,515,000	42,911	35
St. Supice	1,371,530	65,560	21
Montoir	2,301,800	119,300	19
La Pallice	310,000	20,000	16
Marseille	498,500	16,750	30
Total and average	15,116,205	446,711	34

MEN EMPLOYED ON DEPOT WORK.

The force engaged at the headquarters of the Engineer supply section grew as follows:

Date.	Officers.	Enlisted men.	Civilians.	Total.
Apr. 1, 1918	14	15	10	39
June 1, 1918	20	31	13	64
Aug. 1, 1918	13	44	11	68
Sept. 1, 1918	12	56	12	80
Oct. 1, 1918	24	62	13	99
Nov. 1, 1918	35	79	22	136
Nov. 11, 1918	40	88	22	150
Jan. 1, 1919	26	61	16	103

During the same period the forces engaged at the various Engineer depots increased as indicated below:

Forces at depots.	Officers.	Men.	Total.
Sept. 1, 1918	74	3,073	3,147
Nov. 11, 1918	116	5,012	5,128

The relative importance of the different depots is to some extent indicated by the forces employed, and therefore the following statement as of November 11, 1918, is of interest here:

Depot.	Officers.	Men.	Total.
Gievres	42	1,871	1,913
Is-sur-l'ille	25	997	1,022
St. Sulpice	13	735	748
Montoir	13	648	661
Montierchaume	4	324	328
La Pallice	6	180	186
Brest	4	150	154
Marseille	5	80	85
Le Havre	4	27	31
Total	116	5,012	5,128

METHODS OF DISTRIBUTION.

In the preceding pages quantitative features have been emphasized, and data have been given in tonnage, costs, storage space, etc. There remain to be considered certain points which, though not so striking, are of more direct utility to the Engineer in some future emergency. The points now to be discussed relate to the methods by which the vast tonnages of supplies acquired were distributed to the troops who needed and utilized them.

RECEPTION AT BASE PORTS.

Soon after January 1, 1918, ships carrying Engineer supplies began to arrive in numbers from the United States and from England. During the fall of 1917 great difficulty had been experienced at Gievres and other depots because of the piling up of material received in too great quantity to be satisfactorily handled. It was realized that with the far heavier shipments now in prospect such overloading of the interior depots would have to be prevented and that, therefore, some satisfactory system for the reception of supplies at base ports and for their forwarding to secondary points would have to be worked out. This was accordingly done in the following manner:

On the arrival of ships carrying Engineer supplies the depot Engineer officer at the ports secured copies of the manifest and immediately extracted items of Engineer material. A telegram was then

sent to headquarters (Tours) stating the Engineer material listed and the order number. This telegram reached the officer who was in charge of this branch of the work in the Engineer depot office at headquarters. His duty then was to look up the orders, identify the material, and secure disposition on it from the various sections of the depot Engineer office at headquarters, noting the points to which material should be shipped in order to relieve the existing shortage or to take care of expected demands. During the same day this information was wired back to the depot Engineer officer at the port, who made shipments of the material as unloaded.

In carrying out these operations every effort was made to prevent unnecessary shipments to the inland depots. For the ports of St. Nazaire, Bordeaux, La Pallice, and Marseille ample storage was available at the near-by depots of Montoir, St. Sulpice, La Pallice, and Miramas, and as much as possible of the arriving shipments was sent to these primary storage reservoirs for classification. Whenever possible, direct shipment was effected from these primary depots to the point of utilization. The careful following out of this plan prevented such rehandling of supplies, saved thousands of ton-miles of transportation, and secured to a large extent promptness and directness of distribution.

REQUISITIONS.

General Orders, No. 44, effective March, 1918, defining proper channels for requisitions to Service of Supply also caused the standardization of routine work in the office of the Engineer depot officer at headquarters and at the various depots, and the system then inaugurated obtains at the present time.

Two distinct methods of requisitioning supplies were followed: First, the credit system, as authorized in General Orders, No. 44; and, second, the requisitioning of material by officers in charge of projects through their chief of department. In order to make this clear the procedure is explained in detail.

Credit requisitions.—Credit requisitions were used both by the combat units of the Army and by the Service of Supply. At first various divisions acting independently made their requisitions through organization supply officers direct to the Engineer depots as class 3 supplies, General Orders, No. 44. This early developed the fact that supplies which were limited in quantity, due to shortage of available tonnage would soon be exhausted, and that divisions with the more active and aggressive supply officers and divisions in the rest areas would obtain the total of supplies available at the expense of those engaged in actual combat. To meet this condition a bulletin was prepared, approved by G-4, general headquarters, placing all Engineer supplies in class 4, General Orders, No. 44, American Expe-

ditionary Forces, 1918. In order to make it unnecessary for G–4, general headquarters, to pass on many individual requisitions, and in order that Engineer officers in the field should have complete information as to the Engineer supplies available for their use, these class 4 supplies were placed on Army credits. Many difficulties developed when the credit system was inaugurated, due to lack of experience and misunderstandings as to the object to be obtained. Familiarity with the system soon overcame these difficulties, and at the time of the signing of the armistice it was working well. The system consisted in submitting requisitions through proper military channels to G–4, general headquarters, and after approval by him, in holding at the depots such quantities of material as were estimated to be required by the armies during the following month, subject to direct call by their supply officers. This reserve material was not available for any other purpose, and had to be held until the expiration of the credit at the end of the month. When material called for by the armies to be held on credits was not in stock at the designated advance depot, it was procured at once from the base depot or purchased. The details of the preparation of the Army credits were handled by the deputy Engineer supply officer stationed at general headquarters. Credit requisitions were sent to the depots concerned and shipments were made on call. Shortages were cared for by the Engineer depot officer at headquarters, Service of Supply.

For the month of August the credit allotted the combatant armies amounted to 40,000 tons, of which 24,000 tons were delivered; during September 42,000 tons were alloted to the armies; during October 40,000, and during November 46,000 tons. With rare exceptions all demands of the armies were met by shipments from the advance depots. The above credit tonnages represented all Engineer supplies, including standard railway material and lumber, with the exception of crushed stone. Practically the same method of obtaining material was followed by the section Engineers of the Service of Supply excepting that their requisitions were approved by their chief of service, instead of by G–4, and that the material instead of being actually reserved was placed at a credit to be drawn on without further reference to the chief of department. If, however, an ordinary requisition was placed for the same material as included on a credit requisition from a section Engineer, it would be shipped from that available in stock, after the material required by the armies had been reserved.

Credit requisitions allotted to the section Engineers made possible the supply of emergency and unforeseen demands on short notice. It often happened that the regular routine requisition was not sufficient to complete the project outlined. With the credit at

the depot the Engineer officer could wire for immediate shipment or drive in to the depot with a truck and take away just the material necessary, thus preventing the delay which would otherwise result. To further expedite matters, depots were instructed, by memorandum, that the Engineer supply service existed primarily to permit all services to function properly and directed to honor emergency requisitions even though the material had not been previously placed on a credit requisition. Certain material, however, was not issued, except on authority from the office of the division of military engineering and engineer supplies at headquarters, Service of Supply.

Routine requisitions.—The second method of requisitioning Engineer supplies, i. e., by ordering direct, after approval by the chief of service under whom the requisitioner was serving, is as follows:

Requisitions were forwarded from the job through the chief of service, who, on approval, submitted requisition in duplicate to the Engineer depot officer at headquarters, Service of Supply. On receipt by the Engineer depot office, disposition was made of the various items to the nearest depot, those items not in stock or on order being placed on the Engineer purchasing officer for purchase. In writing up in the Engineer depot office, all items placed on the depots were covered by one requisition showing from which depot the material was to be supplied; the items placed on Paris for purchase were carried on another requisition. The depot requisitions were carried under an "A" series and showed the name of the service submitting the requisition and their number, the field number, the project and the class of material. The items were numbered on the requisitions as written up in this office. Two copies were made for each depot from which the material was to be shipped, one copy for the office of the requisitioning service at these headquarters, one copy for the consignee in the field, one copy for the section Engineer, and two copies for the files of the Engineer depot officer. Any items that could not be filled were indicated on the consignee's copy as not being in stock or available.

On receipt of requisitions at the depot they were divided by the office force among its various departments to collect material, packing slips were made out, the various items made ready for shipment, and sent forward at the earliest possible moment. At the time of shipment, if a carload lot, a complete packing list of the material was tacked on the inside of the car in a conspicuous place. If less than a carload shipment, a packing list was placed inside of the package containing the material. The packing list indicated what material had been supplied and whether the requisition had been completely shipped from the depot. On receipt of this, the consignee, by using his copy of the requisition as sent from the Engineer depot office

at headquarters, was able to check up the missing items. In making shipments the Ordre de Transport (corresponding to a shipping invoice) was forwarded along with the notification of shipment and an extra packing list, and acknowledgment was requested by indorsement thereon, of receipt by the consignee. During the latter part of October, it was found necessary, in addition to mailing the notification as indicated above to the consignee, also to send telegraphic notification in order that the consignee might know in advance when to expect the material.

If the material was completely shipped from the depot from which ordered one copy of the requisition as sent the depot was returned by indorsement to the Engineer depot officer at headquarters, Service of Supply, showing action taken. As soon as received the Engineer depot officer sent notification to the chief of service from whom the requisition came advising of action taken and the file was closed. If the material was not completely shipped extracts by the depots at Is-sur-Tille and Gievres were made of the unfilled items, copies being sent by each to the other for possible completion and to the office at headquarters to serve as information of the action taken.

TRANSPORTATION.

Throughout the operation of the Engineer depots in France the lack of sufficient rail transportation prevented the rapid shipment of Engineer supplies. Cars were always short and hard to get, and with the many restrictions imposed on Engineer supplies, which ordinarily came fourth in priority, many difficulties had to be overcome.

In forwarding supplies from the depots three classes of shipments had to be provided for: First, those small shipments for the points in the immediate localities of the depots which could be delivered by trucks; second, less-than-carload shipments; and, third, carload shipments. For those points in the immediate vicinity of the depots trucks were used when they were available. The material was collected on shipping platforms at the depots and notification sent to the consignee by telephone or telegraph, and when trucks arrived they were at once loaded and dispatched, thereby preventing the delay arising when trucks came for the material before it had been assembled. Shipments of less-than-carload lots of material were at first taken care of by making the shipment by rail by what the French call "Petit Colis" or "Grande Vitesse." The transportation authorities soon discovered that facilities were not available to handle the vast number of these shipments and placed an embargo on them. Instructions were then issued by the transportation service that cars

must be fully loaded for one destination. This delayed less-than-carload shipments until such a time as enough material could be collected from the various services operating at the general depots to make a carload shipment. Very frequently these delays extended from two weeks to a month and necessarily many construction jobs that needed a few essential items for completion were held up. Steps had to be taken to alleviate this condition and in September, 1918, an arrangement was made with the division of construction and forestry, the largest user of Engineer supplies, for the designation in each base section of one or more distributing centers to which material destined for towns in the neighborhood could be shipped in carload lots and thence delivered by motor trucks. Accordingly the following centers were named:

Advance section.—Langres, Neufchateau, Liffol-le-Grand, Pacy-sur-Armencon, Chatillon-sur-Seine, Demange-aux-Eaux, Barizey-le-Cote.

Intermediate section, east.—Nevers, Etais, Clermont-Ferrand, La Guerche-St. Amend.

Intermediate section, west.—Le Mans, Orly, Gievres.

Base section No. 1.—Saumur, Nantes, St. Nazaire.

Base section No. 2.—Bordeaux.

Base section No. 4.—Le Havre, Rouen.

Base section No. 5.—Brest, Landerneau.

Base section No. 6.—Marseille.

Base section No. 7.—Aigrifeuille.

The use of these distributing centers made possible the clearing of the Engineer depots of a very large number of requisitions awaiting shipment because the material was in less-than-carload lots. The value of the system was readily shown, the limiting condition being the number of trucks available for the use of the section engineer for distribution of material from the centers.

Shipments of the carload lots of material were limited by the number of cars available. Very frequently the Engineer depots were not permitted to use American box cars, high-side gondolas, and various classes of French cars. When sufficient cars were available shipments depended altogether, of course, on the rapidity of loading at depots.

INVENTORY AND SETTLEMENTS FOLLOWING ARMISTICE.

An inventory of Engineer depots as of the date February 1, 1919, showing the materials on hand valued at $96,535,058. A similar inventory of the central shops of the division of light railways and roads at Abainville as of April 11, 1919, showed materials on hand valued at $10,405,862. The grand total of material in the Engineer

depots at Abainville, therefore, was $106,940.920. Negotiations for transferring all of this property to the French were in progress at the time this report was submitted.

Following the armistice, instructions were received to cancel certain contracts and orders unfilled at that date. Such cancellations were made immediately, and following thereafter large numbers of claims for indemnity on account of such cancellations were received.

Settlement for the cancellations is still in progress, but it is evident that settlements satisfactory to the United States will be reached in almost all cases. The work of settlement has been aided in a large measure by the arrival in France of the United States Liquidation Commission, War Department. Through the coordination of work with the commission, the interests of the United States are in every way safeguarded and justice is given the contractor or dealer in each case of a canceled contract or order.

Purchase orders amounting to 33,795,478.73 francs have all been settled with the exception of one, amounting to 12,138.40 francs.

Seventy-one contracts, involving 72,442,834.50 francs, were canceled, and to May 10, 1919, 32 were settled by supplemental agreement with an expenditure of 2,885,104.40 francs.

REFERENCE DATA, SUPPLY.

	Appendix number or file reference.
Report, chief supply section, division of military engineering and engineer supplies	Appendix No. 34
Reports, Engineer purchasing officer	Appendix No. 36 and 37
Operations, shop section, division of military engineering and engineer supplies	Appendix No. 35

Cement Supply.

A cement section was created in the office of the Engineer purchasing officer February, 1918. Seven French cement mills were operated either partly or entirely by Engineer troops at Mortagne-sur-Gironde (Charente-Inferieure), Le Teil (Ardeche), Cruas (Ardeche), Couvrot (Marne), Beaumont (Seine-et-Oise), Guerville, near Mantes (Seine-et-Oise), and La Souys, near Bordeaux (Gironde). The mills at Couvrot, Beaumont, Guerville, and La Souys were operated by their owners, a portion of the production each month being assigned to the American Expeditionary Forces, the American Expeditionary Forces furnishing coal, technical service, and skilled and common labor. The other three mills were operated entirely by the American Expeditionary Forces, but of these three, two produced hydraulic lime. About 1,000 men were finally engaged in cement production, which produced a total of 48,000 tons prior to November 11, 1918, while 122,000 tons were bought prior to that date.

REFERENCE DATA, CEMENT SUPPLY.

	Appendix number or file reference.
Report, January 29, 1919, Engineer purchasing officer to chief engineer, American Expeditionary Forces	Appendix No. 36
Report, May 27, 1919, Engineer purchasing officer to chief engineer, American Expeditionary Forces	Appendix No. 37
Report, cement supply for American Expeditionary Forces, by Capt. E. C. Eckel	Appendix No. 38

CONSTRUCTION.

Ports and Docks.

To provide adequate debarkation facilities for the American Expeditionary Forces, first estimated at 500,000 men, later at 2,000,000 men and finally announced as 4,000,000 men, the Engineer Department had recourse to two lines of action: The acquisition of existing French docks and the construction of new installations. Based on a per capita consumption by the American Expeditionary Forces of 50 pounds per day, it was necessary to make provision for the discharge first of 12,500 tons, then of 50,000 tons, and finally of 100,000 tons.

The crowding of the channel ports by British war shipping at first restricted the American Army to the ports south of Brest. Our immediate necessities demanded the acquisition of wharfage from the French. Following certain recommendations made in an appendix to the report submitted by the "Railway Commission to France and England," in addition, new construction was decided upon at the western terminals of the main lines of communication that stretched across France to the front.

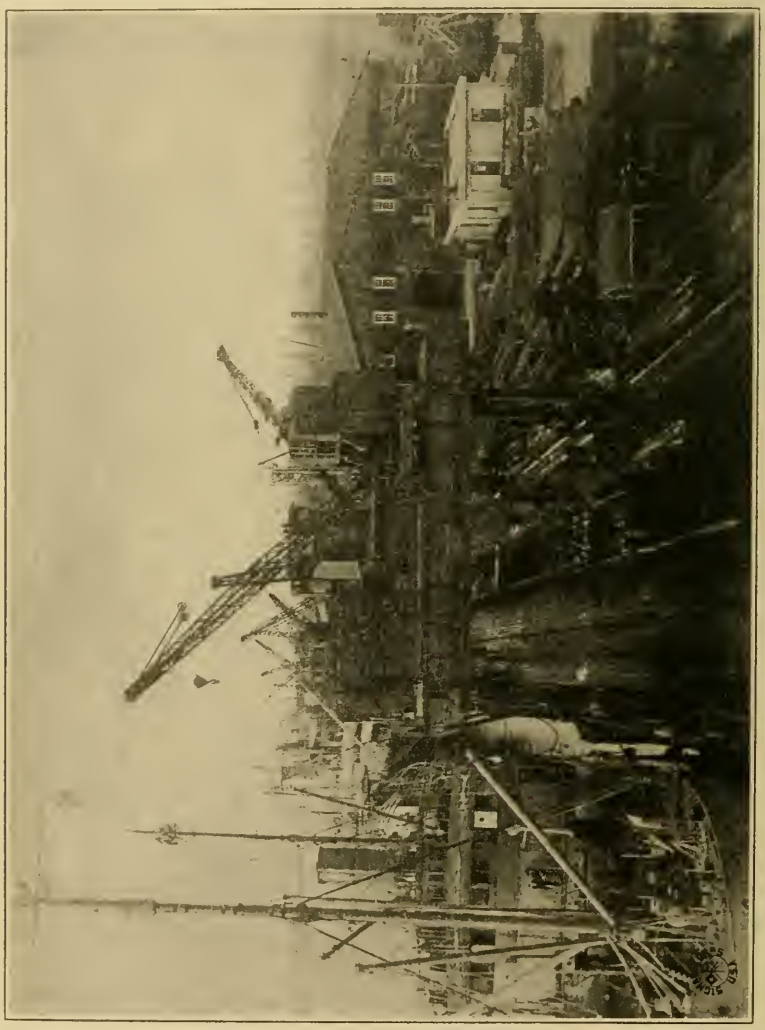
The first of these installations at which actual construction was undertaken was a 10-berth pile dock at Bassens, on the Garonne River, 5 kilometers below Bordeaux; the second was a 2-berth pile dock in the Port du Commerce at Brest; and the third was an 8-berth pier in the Loire River at Montoir, near St. Nazaire. All three of these had been studied before the first Engineer regiments arrived in France.

BASSENS.

Proximity to an existing French dock, allowing the landing of material and equipment near the site of the proposed dock, accessibility to the main line of the Paris-Orleans Railway, from Bordeaux to Paris, and the possibility of installing storage facilities near-by, were controlling factors in the selection of Bassens as the site for the first and largest of the American dock installations.

The first troops to start work on the Bassens project, which, in its ultimate development included not only a 4,100-foot dock for medium

draft vessels, but a powder dock for the use of the French, other smaller docks, receiving yards, departure yards, two river yards, two French powder yards, warehouses, water supply, sewerage and all incidental small construction, was a detachment of 200 men from the 15th Engineers, the regiment commanded by Col. Edgar Jadwin,



(3486-F9) BASSENS DOCKS NEAR BORDEAUX EQUIPPED WITH HEAVY GANTRY CRANES.

later brigadier general and director of construction and forestry. Early in August this detachment, commanded by Maj. Elbert A. Gibbs, arrived at Bassens and began on the preliminary survey of the site. Before the detachment was relieved by the 18th Engineers, on September 1, 1917, the first bridge and the first railroad cross-over built by American Engineers in France had been completed.

When the 18th Engineers, under the command of Col. J. B. Cavanaugh, took over the work at Bassens, the dock site was occupied by concrete and tile barracks, erected for the use of the Indo-Chinese employed by the French in a powder factory near-by. The first six weeks were devoted to demolition of these barracks, erection of dikes for hydraulic fill, the construction of pile drivers and barges, the requisition of material and the receipt of equipment, much of which was bought in France.

During November active construction began, and by the end of the month four land drivers and two floating drivers were working. Capping and decking did not start until sometime after, but as soon as heavy timbers began to arrive in appreciable quantities work progressed rapidly.

The original design of the Bassens dock called for a structure that would sustain the load imposed by 5-ton and 10-ton gantry cranes, the heavier imposing a wheel load of 86,000 pounds; piling and heavy timbers had to be brought from the United States, at least until forestry troops, arriving late in September, were able to produce them in France. Long piling was needed and was obtained with difficulty and was slow in arriving from the United States. Also steel I beams, to be used under crane rails, though ordered in July, were undelivered when needed because of the lack of sufficient ocean tonnage.

These two handicaps led to the appointment of what was known as the "Bassens board" by the director general of transportation, under whom the dock was started and under whom construction of railroads and docks was carried on until the formation of the Service of Supply, March 12, 1918.

A board, composed of Cols. Edgar Jadwin, J. B. Cavanaugh, J. A. Sewell, and H. C. Booz, Lieut. Col. H. W. Hodge, and Capt. J. H. Graham, met in Bordeaux December 28, 1917. Three questions were placed before the board:

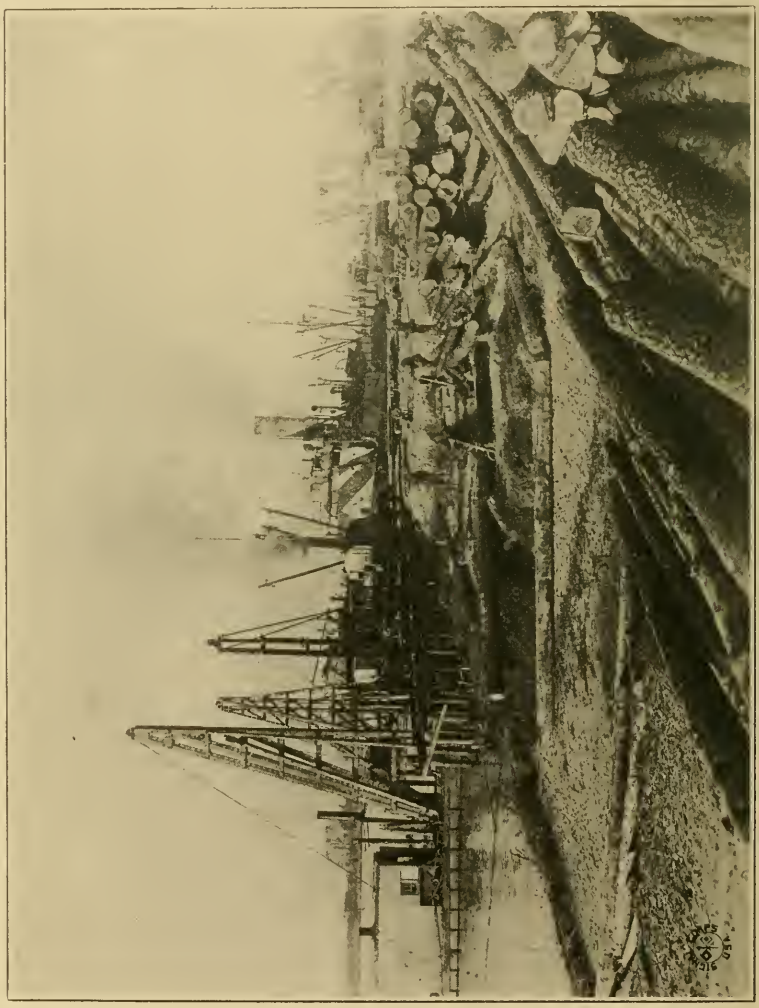
(*a*) Is the dock as now being constructed, considering the known conditions, the character of the materials available and the proposed loads, safe?

(*b*) If the present plans will not provide a safe structure, what can be done to make it safe for the proposed loads?

(*c*) If the dock can not be made to sustain the proposed loads safely, what alternative plan is suggested?

To the first of these questions the board answered that the quality of the materials used in construction made the dock unsafe to support the loads for which it was designed. They found that the piles were sometimes "small, some worm-eaten" and others "had broken in handling." The design the board declared to be safe.

To the second question the board answered that, although the strengthening of the dock was physically possible, the operation was considered impracticable because the time required in which to secure the proper length and grade of piles, and size of timbers, as well as the steel I beams, was too great. For that reason the board recom-



(3478-F9) PILE DRIVERS AT WORK IN THE VICINITY OF THE BASSENS DOCKS NEAR BORDEAUX.

mended that the use of gantries be abandoned for eight berths and that these eight berths be redesigned to carry locomotive cranes or other types of unloading equipment which would not impose a greater wheel load than that of the locomotives; 20,000 pounds per wheel not less than 5 feet center to center. The other two berths the board recommended to be constructed to carry the gantry cranes.

Proceeding in accordance with this revision, work on the Bassens dock progressed rapidly, for construction could be carried forward with available materials, and when steel I beams did arrive, 2 of the 10 berths were constructed, as originally intended, to carry the gantry cranes imposing a wheel load of 86,000 pounds.

One of the main difficulties met by Col. Cavanaugh, who had become the first section engineer of base section No. 2, was the shortage of labor. Two companies of his regiment, the 18th Engineers, were diverted to other work in the base section, and the remaining four formed details of every description. Troops from almost every arm of the service were used as laborers. Thus during the month of January, 1918, there were employed at Bassens, besides those from the 18th Engineers, men from the following organizations: 25th Engineers, four companies of the 6th Marines, three troops of the Third Cavalry, the 301st and 302d Stevedores, the 309th, 310th, 311th, 312th, 313th, and 314th Labor Companies, the 505th and 506th Engineer Service Battalions, German and Austrian prisoners of war, Spaniards, Chinese, and Indo-Chinese. The above troops for the most part were transient, being employed at Bassens while awaiting definite assignment, and naturally lacked the interest necessary for the best results. Besides these there were skilled pile driving and capping crews from the Phoenix Construction Co. to whom a contract for dock construction in France had been let in July, 1917.

All during the winter of 1917–18 work on the Bassens project was prosecuted with vigor. As a result of this continuous labor of all organizations involved in its construction the Bessens docks were ready in April to receive the first vessel.

The dock consists of 10 berths, each 410 feet long, with a four-track trestle approach at each end. These four tracks are connected with the depressed unloading tracks in the rear of the dock, which tracks connect at the south end with the receiving yard, and at the north end with the departure yard, both yards being about half a mile from the dock itself.

The dock proper is 86 feet wide and consists of pile bents 10 feet center to center, typical sections containing 17 bearing piles and 1 fender pile per bent. Caps and subcaps are 12 by 12 inches, and double stringers 12 by 12 inches by 20 feet are laid under all tracks. Gantry crane rails, 44 feet center to center, were laid throughout the entire length of the dock, but only berths No. 9 and No. 10 were at first built to accommodate the gantries. Batter piles were driven in pairs at alternate bents and subcapped. Eleven thousand and fifty piles, ranging in length from 50 to 100 feet, were used in the original construction and 4,500,000 feet board measure of lumber. The dock contains 3.53 miles of trackage, 12 split switches, and 9 double slip switches. On the dock are classification sheds 66 feet wide, 6 of

the 8 sheds being 312 feet in length and the others 204 feet. This open and covered storage area, 4,100 by 66 feet, has 4,250 cubic yards of concrete floor, supported by a dredged fill of 46,000 cubic yards, retained by a wall containing 3,267 cubic yards of concrete, involving 8,000 cubic yards of excavation, and a dike containing 9,000 cubic yards of embankment and 725 cubic yards of concrete apron. In the approaches, in the depressed tracks immediately behind the classification sheds, and in the river yards, 8 diked basins were provided for the retention of 177,000 cubic yards of hydraulic fill and ballast. In the river yards are 5 miles of tracks, 21 switches, and 4 double-slip switches.

The construction of the departure yard, one-half mile northeast of the docks, required a fill of 271,593 cubic yards, the laying of 20 miles of track, and the placing of 104 switches and 4 double slips. One hundred and twenty-thousand cubic yards of the fill were furnished by steam shovel working in a pit at an average haul of 3,000 feet from the fill. The receiving yard, a quarter of a mile southeast of the docks, necessitated approximately 19,000 cubic yards of fill, 65 per cent of which was from the same pit, the remainder being hydraulic fill. There were laid 6.5 miles of trackage in this yard, as well as temporary engine facilities, 32 switches, and 2 double slips.

GENERAL PORT POLICY.

Other new installations were made after careful study by section Engineers of possibilities for local port development. Some new installations were approved upon the reports of individual section Engineers, though, in the case of the largest projects, boards of Engineers usually went over the ground, making thorough investigations and submitting their reports upon which future action was based.

Thus it was that the Montoir Board, composed of Col. Edgar Jadwin (chairman), Col. J. S. Sewell, Col. R. E. Wood, Col. H. C. Booz, Lieut. Col. H. W. Hodge, and Capt. J. H. Graham, was appointed to report upon the feasibility of building a pier or piers at Montoir, near St. Nazaire. Montoir had been recommended by the French in 1917 as a possible site for a pier, and they were invited to have representatives at a meeting of the Montoir Board in St. Nazaire, in February, 1918. The Montoir Board was unanimous in its opinion that a pier be constructed at Montoir.

In its report, dated March 2, 1918, the Montoir Board recommended that the new construction at Montoir take the form of piers set across the channel of the Loire River, affording from 10 to 16 berths. The actual number of berths to be built would necessarily depend upon more extended hydrographic surveys, as the pier or piers were to rest upon a reef on the shore side of the channel.

No definite action was, however, taken in the case of Montoir until after the report of the Townsend Board. This board was convened by paragraph 54, Special Orders, No. 20, Headquarters, Service of Supply, dated April 2, 1918. It was charged with formulating a definite program of port development, and it was furnished by the general staff with a definite statement of the amount of tonnage that would have to be handled. The Townsend Board was composed of Col. C. McD. Townsend (chairman), Col. W. J. Wilgus, Col. H. C. Booz, Lieut. Col. J. R. Holman, and Capt. J. H. Graham. Cols. Wilgus and Booz represented the transportation department, charged with design, and the other two members represented the division of construction and forestry, in which division lay the construction. The first meeting of the board was held in the office of the chief of utilities April 7, 1918. It made an exhaustive study of the entire port situation, visiting French ports from Brest to Bayonne, and its findings constituted the eventual foundation for our whole program of development. While various other reports were later made, the Townsend Board formulated the working basis of port development in France.

Instructions from the general staff were to the effect that a daily tonnage of 22,000 tons should be reached by September 1, 1918; 40,000 tons by April 1, 1919; and 50,000 tons by July 1, 1919. The board was also instructed to report upon the advisability of reinforcing the Bassens dock to carry gantry cranes, and was informed that the use of Marseille as a port could not be counted upon.

Although the board was in accord as to the general procedure for port development, some divergence of opinion caused the transportation department members of the board to submit a minority report. However, the board recommended immediate and extensive construction at Montoir, and upon that recommendation authorization was given to start work on the Montoir pier late in March, 1918. Talmont, at the mouth of the Gironde River, considered as a possible site for a deep-water dock when the first surveys of port possibilities were submitted, proved to be a subject of disagreement among the members of the Townsend Board. Although the minority members signed the board report that recommended simultaneous construction at Talmont, their separate report did not support Talmont, except in the event that adequate facilities could not be provided elsewhere.

The second serious difference in opinion between the majority and the minority members of the board was over the Bassens dock. The majority members recommended utilization of the dock as it existed by means of light cargo handling devices. It was their opinion that for miscellaneous cargoes, such as would normally arrive at the dock, the light cargo handling devices could handle the freight as fast as it could be raised from the hold. The majority report indicated that

the number of piles necessary to strengthen the dock would be sufficient to build four new berths at Talmont.

The contention of the minority members that gantry cranes be installed was based on the theory that, due to the 19-foot tide at Bassens, locomotive cranes or other like devices would be unable to handle cargo at all tides. This, coupled with their belief that the efficiency of the dock would be materially increased, led them to recommend in their report the installation of gantry cranes on all berths.

On June 17, 1918, authorization was given for the construction of a 10-berth dock at Talmont, construction to begin for not to exceed a daily unloading capacity of 5,000 tons. Authorization as well was given for the installation of gantry cranes on all berths at Bassens, but not until an overseas force of 4,000,000 men was announced and the utilization of every available berth to its utmost capacity became necessary.

MONTOIR.

Although construction at Montoir was authorized late in March, 1918, no work on the pier itself was done until late in June. The exact location of the pier, which, after many revisions in design, was to be an 8-berth pier built approximately parallel to the channel of the Loire River, was not determined until Lieut. Col. Sturtevant, 15th Engineers, had, in June, made an examination of the proposed site, including test piles, soundings, and borings, and based upon his recommendations, construction began.

Montoir was unique in that it was to be built upon a rock reef and from material almost entirely obtained in France. Soundings and borings indicated that, except near the lower end, mud covered the reef to an extent sufficient to give piles, driven to the rock, proper bearing power. But as it was necessary to dredge in front of the dock in order to give the required 28 feet at low tide, it was deemed essential to take off a portion of the mud covering so that when the dock was completed and the dredging commenced on the channel side of the dock there would be no sliding of material, endangering the structure itself.

The dock as designed called for a structure 3,230 feet long and 119 feet wide over all. There were to be three tracks on the channel side of the dock and two tracks on the short side separated by emergency warehouses. The channel side was to receive deep-draft vessels, and the shore side to be used for lighterage in emergencies. All tracks were to be connected with the Montoir yards by a double-track approach.

In the scheme of construction, under the direction of Lieut. Col. W. G. Atwood, who relieved Col. Sewell as section engineer, and who in turn was succeeded December 16, 1918, by Maj. F. B. Maltby, two

floating pile drivers were started simultaneously, driving on the dock proper near its middle. One driver worked upstream, driving the four piles to support the tracks in the rear of the dock and two piles on the dock proper to give additional stiffness. The other driver worked downstream, driving piles for the full width of the dock. A

(3596) RAILROAD TRESTLE APPROACH TO MONTOIR PIER.

skid driver was at the same time working on the approach, and this was later superseded by a third floating driver, which continued with the work on the main dock. The system of driving followed was designed to furnish docking space as soon as possible.

Dredging the dock site and securing sufficient plant for this dredging and that of the basin on the channel side of the dock proper

were the chief difficulties met in the construction of the Montoir pier. In June, 1918, the use of a ladder dredge for one month, including the crews and two self-propelling dump scows, was secured from Col. Paul Tartrat, the French engineer of roads and bridges, at St. Nazaire. This dredge began a cut 100 feet wide and 25 feet deep at

(3594-F4) VIEW FROM END OF THE MONTOIR PIER, SHOWING RAILROAD TRESTLE APPROACH IN BACKGROUND.

low tide under and along the line of the channel face of the proposed pier. Approximately 50,000 cubic yards were thus removed.

The ladder dredge had to be returned at the expiration of the month. Later a suction-hopper dredge was put to work dredging the sand from the south side of the basin and dropping it on line with the dock at the lower end, as the covering over the rock reef at

that point was not sufficient to give the piling the proper bearing. This dredge had to be returned, and as a portion of the pier was nearing completion the ladder dredge was again borrowed to dredge the channel side of the completed pier. Dredging there continued through late winter and early spring, 1919.

The cessation of hostilities temporarily stopped work on the pier at Montoir. At the time orders were given to discontinue work the outer end of the completed portion of the pier was about 2,000 feet from the approach and piling had been driven the full width of the dock for a distance of 650 feet. Most of the piling had been capped. The row of six piles along the back or shore side of the pier had been completed to the connection with the approach. However, the pier was in such condition that it was deemed advisable to complete part of it, so authorization was given after all work had been canceled there to complete three of the eight berths.

In a memorandum from the assistant chief of staff, G-4, to the chief engineer, American Expeditionary Forces, dated December 5, 1918, authorization was given not only to complete three berths, making them available as soon as possible, but also to complete the trestle carrying the tracks to the front of the pier.

The three berths and construction incidental thereto were declared completed March 25, 1919, though the first vessel to dock at the pier was the *Polar Sea* on February 17.

The double-track approach that connects the pier with the shore is 4,200 feet long, contains 288 bents and a total of 2,242 piles, and required 2,000,000 feet board measure of lumber. The pier proper, 1,360 feet long, contains 3,405 bearing piles, 153 fender piles, 205 batter piles, 20 mooring piles, and 97 piles in dolphins. A total of 4,765,000 feet board measure of lumber was used in the construction of the pier and 10,870 linear feet of trackage were laid in the five-pier tracks. Barracks, 50 by 300 feet, were erected for the use of the stevedores working on the pier.

Practically all of the piling and heavy timbers used in Montoir construction were produced by the forestry troops, though approximately 1,000 long piles originally intended for Bassens were brought from the United States. The maximum length of piles used was 100 feet.

BREST.

The third piece of new construction for docking vessels of medium draft was undertaken in the Port du Commerce in the Brest Harbor. Recommendations were made early that timber pile docks be built on both the east and the south dikes inclosing the Port du Com-

merce; that the use of the west dike be secured; that by timber construction the opening between Piers 3 and 5 of the port be closed, and that Piers 1 and 2 be secured for lighterage purposes. It was also contemplated to build lighterage facilities in front of the Chateau of Brest. Seven berths would thus have been provided for vessels of a 35-foot draft, two berths for vessels of 19-foot draft, and 2,400 feet of lighterage space. Only the pile dock on the east jetty, 900 feet in length, was built. The French had put in concrete piles, but these were not to be depended upon. The American Engineers began work on the timber pile dock the latter part of July, 1918, and the work was completed without serious difficulty. Construction work involved the building of the two-berth dock, the erection of warehouse, 102 by 800 feet; dredging in front of the docks for the required depth of 27 feet at low tide; and fill behind the dock. The dredging done by the French, under contract, amounted to 25,000 cubic yards. Fill on the east side of the dock was discontinued after a temporary trestle had been put in and 9,000 cubic meters of rock and 1,000 cubic meters of dirt had been placed. The completed fill would have accommodated 16 parallel tracks.

Improvements in the Port du Commerce included a cover over the ramp at Pier No. 3, giving an additional 8,140 square feet of storage on the dock, and the installation on Pier No. 5 of six double-boom, stiff-log derricks with a capacity of 5 tons per boom.

Material used included 1,660 pieces of piling, 1,132,000 feet, board measure, of lumber, 135,700 square feet of corrugated iron, 10,500 bolts of an average length of 20 inches, 4,800 three-quarter inch rods, and 432 ½ by 2 by 12 inch angle irons.

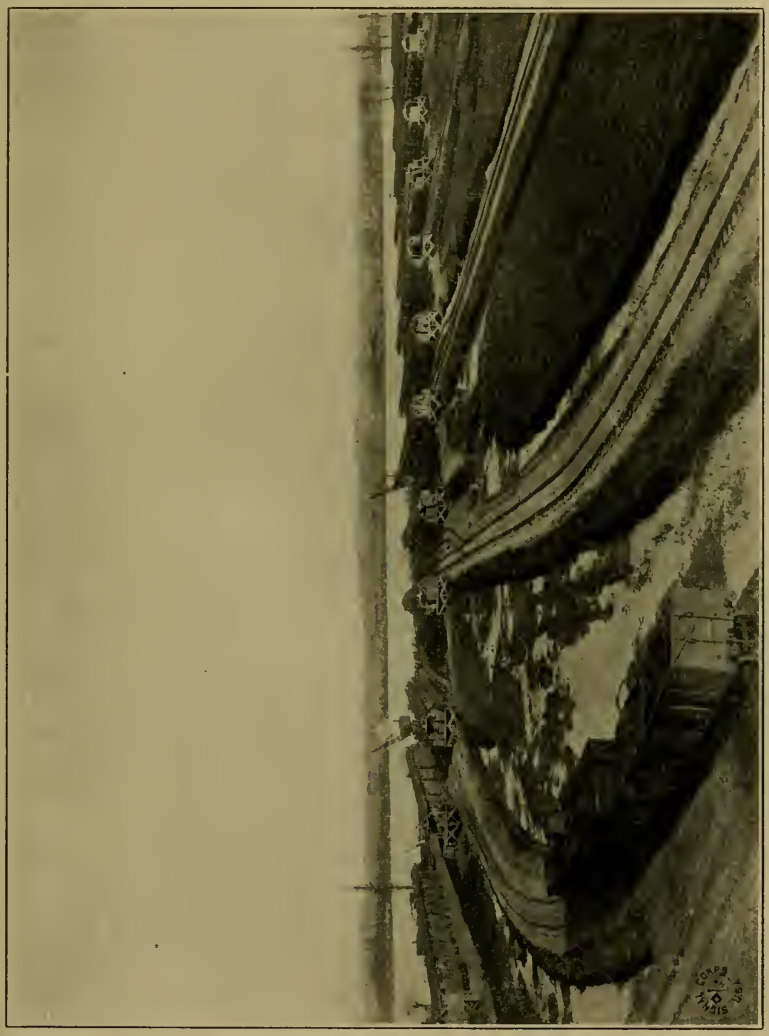
LIGHTERAGE WHARVES.

In all predictions as to possible tonnage capacities at available berths, no account was taken of possible delays at docks through accidents, so the construction of lighterage wharves was considered more or less as a safety factor. However, it was also considered best to handle ammunition by lighterage, and early in the fall of 1917 St. Loubes was surveyed as a possible lighterage site for an ammunition wharf.

St. Loubes lay on the Dordogne River, not far from its confluence with the Garonne. Its proximity to the American-built third track from the Bassens Dock to the great storage at St. Sulpice on the main line of the Paris-Orleans Railroad, as well as the facility of reaching it by lighter from the confluence of the two rivers, made it the choice for the first lighterage wharf.

The dock is 750 feet in length, 33 feet wide, and required approximately 1,900 piles and 500,000 feet, board measure, of lumber. The

dock is unusual in design, being of a "finger" type, that is, with roadways, or "fingers" running 100 feet apart at right angles to the dock. These served 14 sorting sheds, where ammunition was temporarily stored, until shipped to ammunition warehouses near the dock.



(3557-F9) AMMUNITION DOCKS AND SORTING SHEDS AT ST. LOUBES NEAR BORDEAUX.

Little difficulty was entailed in the construction of the dock. It was designed to care for a maximum of 3,600 tons daily, requiring twenty-four 300-ton lighters for successful operation, although but eight lighters of that capacity could be accommodated at a time. The dock was in operation in September, 1918.

IMPROVEMENT OF EXISTING FACILITIES.

In the rehabilitation of existing berths to meet American demands, more or less extensive improvements were made at Brest, St. Nazaire, Nantes, Bordeaux, Bassens, La Pallice, Marseille, and Toulon by the installation of new trackage, erection of additional storage space, and the change in existing track layouts. Almost all berths acquired by the American Army were served by track layouts requiring the use of turntables for switching cars, a system which excluded the use of American rolling stock.

The St. Nazaire basin had been turned over to the Americans shortly after the arrival of the 17th Engineers, August 19, 1917, and there was then but one ship's berth in the basin that could be reached by American equipment, for transfer of packages from ship direct to cars. By the addition of 100,000 square feet of warehouse, office. and miscellaneous storage space; the laying of 9,750 linear feet of track, 32 switches, and 4 crossings, the St. Nazaire basin was put in shape for the prompt evacuation of cargo.

At Nantes the first work done on acquired docks was the laying of 2.33 miles of tracks on the Quai des Antilles, eliminating the necessity of switching by the turntable method. Closely allied to this was the building of 4.35 miles of additional storage tracks and the erection of five warehouses on the Isle St. Anne providing a total floor space of 117,350 square feet. On the Quai Pirmil, additional warehouse space was also provided.

At Usine Brulee, 2 miles below Nantes, 3 warehouses, providing 45,000 square feet of storage, were built; 1.32 miles of trackage were laid, and 3,000 cubic yards of grading was done.

In the improvement of harbor facilities in Bordeaux and other ports along the Garonne and Gironde Rivers, the greatest amount of work was done at French Bassens. The American Army had been given the use of certain berths at French Bassens in July, 1917, with the understanding that the Americans would put in certain trackage and erect warehouses. The total amount of trackage installed at French Bassens by the American Engineers was 8.26 miles, and several large warehouses were erected late in 1917 to store the first American supplies received.

The work at Marseille, on those docks acquired for American use, included demolition, grading of 6,500 cubic yards of material; the laying of approximately 3 miles of trackage; and the installation of 37 turnouts and 57 crossings. Due to the late date at which Marseille was acquired the rehabilitation work was but 50 per cent complete when the armistice halted construction.

NEW PROGRAM.

When in July, 1918, it was announced that the overseas force of the American Army would number 4,000,000 men by July 1, 1919, a new program of port facilities, including new construction and rehabilitation, was formulated. New projects were planned and authorized. It was evident that all ports would have to operate to the maximum to meet the increase in the tonnage to be handled, and to guarantee a daily tonnage of 100,000 by July 1, 1919.

Under this new program one of the first pieces of work was the reinforcement of the American docks at Bassens to care for heavy gantries on all berths. A total of 3,200 piles and approximately 500,000 feet, board measure, of lumber, and three and a half months of labor were needed to insure the use of gantries on the eight remaining berths. One berth was vacated at a time so that as little time as possible would be lost in the reconstruction.

At the time the armistice was signed, the division of construction and forestry was superintending or planning work at 26 new ships' berths. Those projects, on which actual construction had been going on for some time were: Talmont, at the mouth of the Gironde, 10 berths; Montoir, near St. Nazaire, 8 berths; Donges, near St. Nazaire, 2 berths for ammunition; and the south dike, Port du Commerce, Brest, 4 berths. Besides these there were contemplated 2 ships' berths authorized at Clere-Cailly, but not Grand Couronne, where ammunition was to be handled. In addition to all these ships' berths, lighterage facilities were either authorized or under consideration at three principal points—St. Pardon, on the Dordogne River near the storage depot of St. Sulpice; Bassens, adjoining the American docks; and in the St. Nazaire basin. All of these projects, except the three berths that were being completed at Montoir, were canceled November 15 by General Orders, No. 54, Headquarters Service of Supply.

Of all projects under construction at the cessation of hostilities, Talmont would have been the largest. Considerable reconnaissance work had been carried on at Talmont prior to the date of its authorization, June 17, 1918. In November, 1917, hydrographic and topographic surveys had been made by detachments from the 18th Engineers, under command of Col. Cavanaugh. Preliminary surveys indicated that 35 feet of water would be available at low tide. The proposed site was on the east side of the Gironde and more or less exposed to westerly winds. In addition, the possible presence of "teredo," the distance of Talmont from railroads, and the need for long piles and heavy timbers served as arguments against early development at Talmont. However, the need for deep-water ter-

minals became so urgent, that these objections, some of which were not well founded, were ignored and construction ordered to proceed on a basis not to exceed a daily unloading capacity of 5,000 tons, with future extension if found desirable or necessary.

The site lay in front of a limestone bluff that had a height of 80 feet from the dock site. The site also lay in a deep pocket, rendering heavy dredging unnecessary. As the elevation of top of dock was placed at 26 feet, it was necessary to grade down the bluff immediately behind the site. Thereby a double purpose was served; roadways to the dock were provided, and fill secured for it.

The material at the site was a surface covering of from 5 to 6 feet of mud, then the same thickness of hard clay, then rock. As the depth of mud and clay would be insufficient to give piles the proper bearing power, the preliminary design called for alternate pile bents and timber cribs. In actual construction it was decided to put in pile bents wherever possible and cribbing elsewhere.

Before beginning work on the dock, it was necessary to put in a 6-mile spur track from the line of the Etat Railroad running from Pons to Royan. This piece of work, including the erection of a 30 pile-bent timber trestle, spanning a ravine of 40 feet depth, was undertaken by Company F, 18th Engineers. The 6-mile spur, together with a 4-mile extension to a proposed borrow pit, had been laid by mid-November.

When the armistice was signed, Talmont presented a scene of activity. Much material and equipment had been received, and warehouses had been erected back of the dock site for its storage. The first steam shovel had been moved into place. Barracks had been erected for working forces, officer personnel, and necessary office space had been provided. Camps had been prepared for labor battalions, and prisoner-of-war inclosures had been erected. Heavy machinery was being received. All of the 4,500 tons of special equipment ordered in the States for the Talmont job had been delivered to ports in France. Piling and heavy timbers had been assembled at Pauillac, across the river for barging to the dock site. A complete lighting plant of 1,500 horsepower had arrived from the United States, and a foundation was being prepared for it. American crews met French trains at Pons, 20 miles away, every day, and hauled trainloads of material to the dock site. A working force of approximately 2,000 was scattered in five widely separated camps.

The completion of the dock would have entailed the use of 6,000,000 feet, board measure, of lumber; more than 6,000 piles, ranging in length from 50 to 100 feet; 860,000 linear feet of crib logs; the excavation of approximately 1,000,000 cubic yards of material and an equal amount of fill; and would have provided berth

space for vessels of the heaviest draft, with an estimated capacity of 10,000 tons of supplies per day.

Donges, on the Loire River, was another point at which a new dock was being constructed. Donges was to have been similar to St. Loubes, but the French objected to having ammunition handled at Donges by lighter, so two ships' berths were started. Preliminary work at Donges did not begin until late in August, 1918, and when the project was canceled but 5 per cent of the total work had been done, a total of 20 bents, spaced at 14 feet centers, being the only work done on the dock itself.

Other berths authorized included four on the south dike in the Port du Commerce at Brest. The contemplated project specified that timber piles be driven at the south dike as a foundation for a dock 1,400 by 138 feet to carry a warehouse the full length of the dock for a width of 80 feet. The south jetty was to be connected to the east jetty by a double-track system, also on piling. Ships then could have unloaded directly onto the dock and the freight loaded directly into awaiting cars, thus materialy increasing the amount of tonnage handled.

Authorization of the project was given after considerable discussion over its feasibility, due to the necessity for the importation of long piles and heavy timbers. Work did not start on the project until October 23, 1918, and when it was stopped on November 17 but 5 per cent of the work had been done.

New lighterage facilities were to be provided at St. Pardon, Bassens, and in the St. Nazaire basin, though St. Pardon was the only project on which any great amount of work was done before the armistice. St. Pardon was to have had a lighterage wharf 600 feet long, and a long trestle approach. The wharf was to be connected to the St. Sulpice storage yard by a spur track less than a mile long. One-third of the work on this project had been done when the armistice stopped it. The lighterage wharves at Bassens and St. Nazaire were to be 600 and 650 feet in length, respectively. Little work was done at either place.

In all the new installations put in by American Engineers, there was but one serious accident to completed structures. In December, 1918, a portion of the dock on the east jetty, Port du Commerce, Brest, collapsed under a heavy loading of sugar and canned goods. A board of engineers appointed by the section engineer of base section No. 5 found the failure of the dock due to excessive loading, estimated at 1,200 pounds per square foot. Reconstruction of the dock was completed during the week of January 10, 1919.

With the closing of hostilities and the movement of the Third Army into Germany, certain small installations were made along the Rhine River, in order that materials for the supply of the Third

Army could be barged from Rotterdam, thus avoiding a long rail haul across France from Atlantic ports.

REFERENCE DATA, PORTS AND DOCKS.

	Appendix number or file reference.
Board reports:	
Report, Railway Commission to France and England: Wilgus Appendix on Ports.	
Report, Bassens Board	D. C. & F. Files
Report, Montoir Board	Appendix No. 42–a
Report, Townsend Board	Appendix No. 42–a
Reports of sectional engineers:	
Report of S. E. O., B. S. No. 1	Appendix No. 43
Report of S. E. O., B. S. No. 2	Appendix No. 44
Report of section engineer, B. S. No. 5	Appendix No. 47
Operations reports:	
Monthly reports and histories, 18th Engineers	Appendix No. R–18
Monthly reports and histories, 17th Engineers	Appendix No. R–17
Monthly reports and histories, 15th Engineers	Appendix No. R–15
Correspondence:	
On Bassens, Talmont, Montoir, St. Loubes, Jetee de l'Est, Donges, St. Pardon, etc. Authorization dates also obtainable from D. C. & F. Files	D. C. & F. Files 230/10
Personal experience reports:	
Report of Lieut. Col. C. W. Sturtevant	Hist.-Tech. Files 1175
Report of Capt. Carl F. Brush	Hist.-Tech. Files 491
Report of First Lieut. A. F. Chittenden	Hist.-Tech. Files 180
Report of First Lieut. E. B. Tolman	Hist.-Tech. Files 1121
Report of Capt. L. D. Cornish	Hist.-Tech. Files 367

Railroads.

Prior to May 1, 1919, 967 miles of standard-gauge railroad track, principally in yards, had been constructed by American Engineer troops in France. Of this total, 79 miles were built under the direction of the chief engineer, line of communications, and 62 miles were built by Engineer troops under the control of the director general of transportation. The division of construction and forestry took over railroad construction from the transportation department on March 12, 1918, and in the eight months before the armistice was signed. November 11, 1918, engaged on 448 railroad projects, on which approximately 25,000 men were employed, increasing the trackage to 937 miles. In addition there were built such accessories as engine terminals, machine shops, car-repair and coal-storage facilities. Construction necessary after the cessation of hostilities, notably for the provision of embarkation facilities, raised the mileage to the total of 967 miles.

In 1917 the French Government designated for American use certain existing main lines of communication. The new trackage built by American Engineers, therefore, was almost entirely on docks, in

yards at storage depots, and at regulating stations, engine terminals, etc.

The main lines of communication for American traffic extended from the ports of Brest, St. Nazaire, La Pallice, and Bordeaux eastward, converging within the quadrangle Tours, Chateauroux, Bourges, Orleans, thence radiating to Is-sur-Tille, Chaumont, Liffol-le-Grand, and St. Dizier, points in close proximity to American front. The railroads utilized were the Paris-Orleans, the Paris-Lyon-Mediterranean, the Etat, and the Est. From Marseille and Toulon the Paris-Lyon-Mediterranean was also used, but with the exception of a few track changes at these ports this route involved no American construction, supplies being transported by the French. The routes mentioned are shown on the accompanying map.

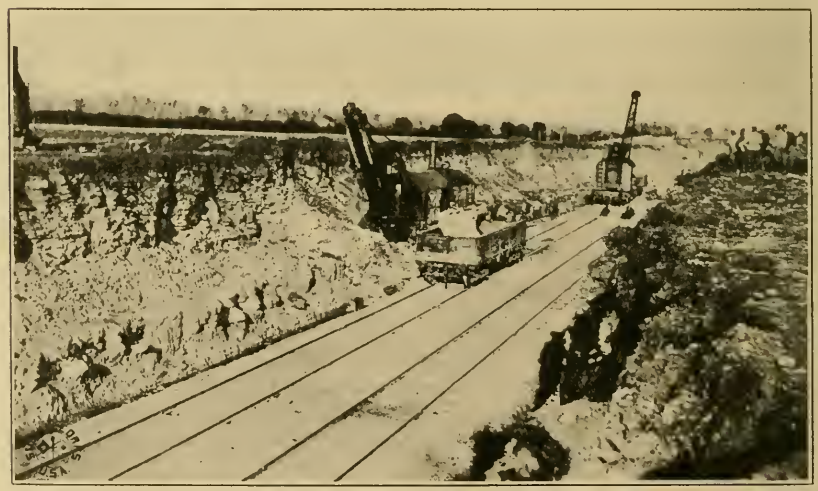
The account of American railroad construction in France is inseparably linked with that of ports and storage depots. At the large depots extensive receiving, classification, departure, and storage yards were essential parts of each project. These and other related facilities are considered elsewhere in connection with the various ports and depots.

Plans prepared by the transportation department were executed by the Engineers. The shortage of materials and men, the rapid increase in troop arrivals during 1918, and the necessity of meeting the actual situation called for execution of only the absolutely essential work. It was often necessary to decide from day to day what tracks should be put down in order to provide facilities urgently needed. This is well illustrated in the construction of track serving warehouses. The original plans contemplated four tracks for each line of storehouses, two on either side of each row, but it was early found that all traffic could be handled on a single track on each side without unreasonably delaying the loading and unloading of cars. Later this single-track arrangement was adopted throughout.

TRACK REARRANGEMENT AT PORTS.

At the ports taken over for American use the existing tracks were laid out according to French standards, which involved the use of turntables operated by hand, resulting in slow and cumbersome operation. In order to secure maximum efficiency and to use American railway equipment, a complete rearrangement of the tracks was made in spite of troubles incident to street crossings and the removal of buildings. At St. Nazaire, the first port used by the American Expeditionary Forces, the changes involved the rearrangement and construction of a total of 23 miles of track. The work at Bassens consisted of both reconstruction on French docks, new construction on American-built docks, and the creation of large receiving and departure yards, aggregating 52 miles of track.

(3398–F9) RAILROAD YARDS AND WAREHOUSES AT THE ST. SULPICE DEPOT.



(312–V8) STEAM SHOVELS IN CUT FOR NEVERS RAILROAD CUT-OFF.

LA GARON

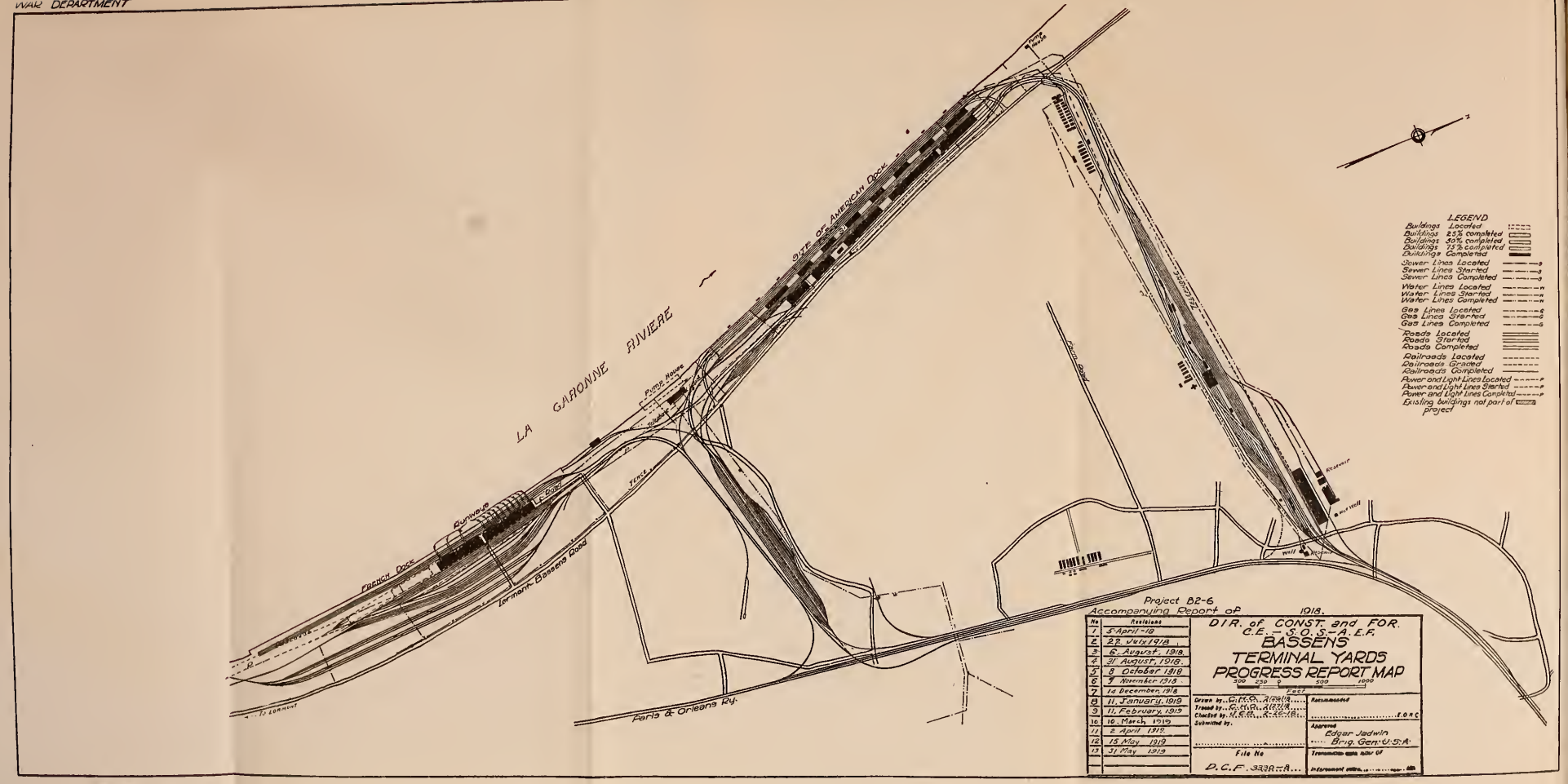
It was imperative to get supplies away from the ships' side rapidly, and to do this tracks were built connecting the docks directly with the base depots. The double track, 1½ miles long, between St. Nazaire and Montoir, which is described in the account of the Montoir depot, was for this purpose. A single track, 0.4-mile long, was built at Nantes, between the Etat and Paris-Orleans Railways, to provide access from the docks on the Isle St. Anne to the storage yard at St. Luce. The largest installation of this character was the third track, 6¼ miles long, constructed from the head of the departure yard at Bassens to the storage yards at St. Sulpice, to permit the operation of trains from the docks to the depot without interference with the heavy traffic on the Paris-Orleans Railway, which it paralleled. The project, which was finished in July, 1918, involved 50,000 cubic yards of grading, construction of 25 culverts, 3 overhead arches, and 2 girder bridges, moving of telephone and telegraph lines and automatic signal devices, removal and relocation of 10 houses, and the laying of the necessary track.

THE NEVERS CUT-OFF.

It was also necessary to undertake other main line improvements. Congestion had resulted between Bourges and Pont Vert, owing to the junction of traffic from the ports of St. Nazaire and Bordeaux. Two additional tracks, 3.7 miles long, paralleling two French tracks, were constructed between these points. The existing single-track main line of the Paris-Orleans Railway through the city of Nantes was not sufficient to care for the increased traffic from the port of St. Nazaire and the depot at Montoir, and an additional track 3 miles in length was accordingly constructed there.

The largest project of main line construction, however, was the Nevers cut-off. Completed in October, 1918, four months after construction started, this double-track line, involving a large volume of cut and fill and a bridge spanning the Loire River, opened up a route by means of which hours of valuable time were saved in transporting men and materials to the combat areas. The value of the line lay in the means which it provided for by-passing the city of Nevers, where several French railroads converged and where, consequently, congestion of traffic delayed train movements. With the cut-off in operation, trains en route for the advance areas avoided the busy terminal and yards and also a long loop which formerly had to be followed in running through the city.

The cut-off was 5⅓ miles in length and required 190,000 cubic yards of cut and 414,000 cubic yards of fill. The largest continuous fill was of 180,000 cubic yards, the roadbed in this section being about 40


LA GARONNE RIVIERE
SITE OF AMERICAN DOCK
Pump House
Runway
Dock
French Dock
Lormont-Bassens Road
To LORMONT
Paris & Orleans Ry.
Fence
Reservoir
Well
LEGEND
Buildings Located
Buildings 25% completed
Buildings 50% completed
Buildings 75% completed
Buildings Completed
Sewer Lines Located
Sewer Lines Started
Sewer Lines Completed
Water Lines Located
Water Lines Started
Water Lines Completed
Gas Lines Located
Gas Lines Started
Gas Lines Completed
Roads Located
Roads Started
Roads Completed
Railroads Located
Railroads Graded
Railroads Completed
Power and Light Lines Located
Power and Light Lines Started
Power and Light Lines Completed
Existing buildings not part of project
Project B2-6
Accompanying Report of 1918.
No. Revisions
1 5 April 1918
2 22 March 1918
3 6 August, 1918
4 31 August, 1918
5 8 October 1918
6 9 November 1918
7 10 December, 1918
8 11 January, 1919
9 11 February, 1919
10 10 March, 1919
11 2 April 1919
12 15 May 1919
13 31 May 1919
DIR. of CONST. and FOR.
C.E. — S.O.S.—A.E.F.
BASSENS
TERMINAL YARDS
PROGRESS REPORT MAP
500 250 0 500 1000
FEET
Drawn by C.H.S. 4/9/19
Traced by C.H.S. 4/9/19
Checked by H.E.G. 4/10/19
Submitted by
Recommended
E.O.R.C.
Approved
Edgar Jadwin
Brig. Gen. U.S.A.
File No.
D.C.F. 333A-A

feet above the original surface of the ground. This fill, the key to the entire project so far as time of completion was concerned, involved the construction of a high timber trestle from which side-dump cars, loaded by steam shovels operating in a cut to the west, discharged. These dump cars, American-made, were the first of their kind used in France. In addition, a number of wheel scrapers and 400 horses were employed. The construction forces numbered about 3,000 men.

The bridge portion of the cut-off, 2,190 feet long, was composed of ninety-nine 14-foot timber spans and sixteen 50-foot steel girder spans. This was the longest bridge which the Engineers of the American Expeditionary Forces built in France. Other smaller

(314–V8) STEEL GIRDER SPAN AND PILE FOOTINGS FOR THE LOIRE RIVER BRIDGE, FORMING PART OF NEVERS RAILROAD CUT-OFF.

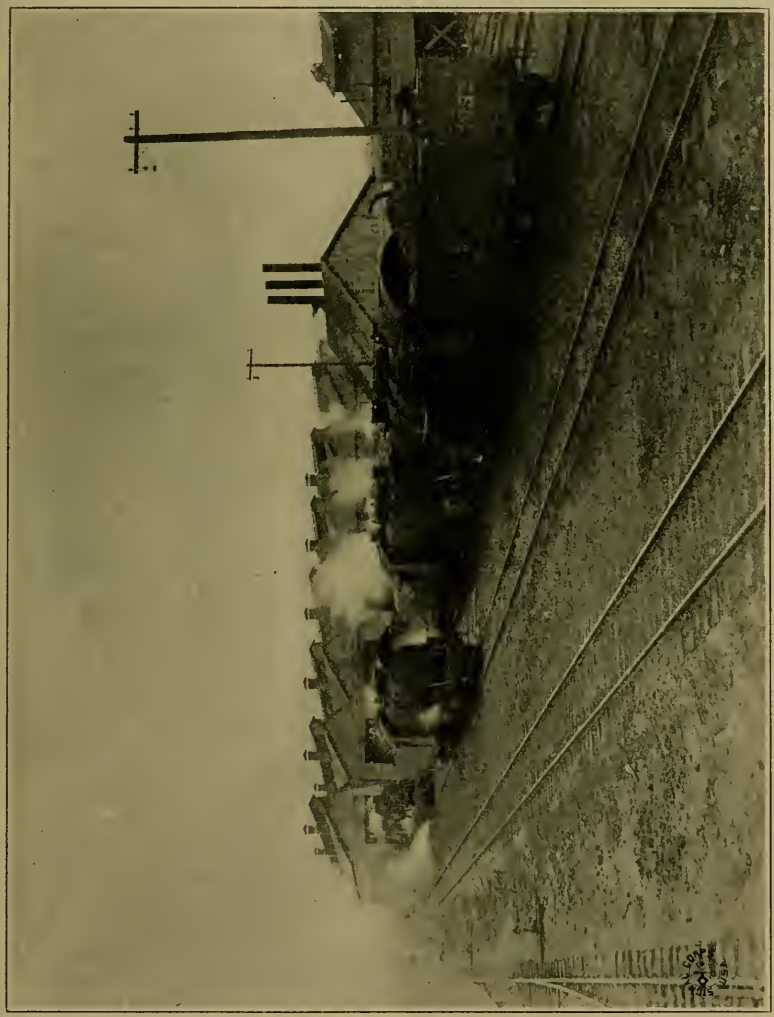
bridge structures had also to be built in connection with the Nevers cut-off. For example, a canal was spanned; a steel girder bridge was built over the Paris-Lyon-Mediterranean Railway; and several overhead and undergrade crossings for highways were constructed. Many highways were relocated and rebuilt.

ENGINE TERMINALS.

Existing engine terminal facilities along the French railways could not handle the heavy American traffic. Accordingly new terminals, solely for our use, were built along the principal lines of communication at Montoir, Samur, Gievres, Marcy, Is-sur-Tille, and Liffol-le-Grand, at Bassens, St. Sulpice, Nexon, Perigueux, Montierchaume, and at St. Luce. Most of these were ready for operation on August 1,

1918. All were similar in design, and therefore the terminals at Marcy, in the intermediate section (east) and at Samar, in base section No. 1, which were the largest, are alone described.

Marcy, on the Nevers-Chaugny line of the Paris-Lyons-Mediterranean Railway, about 28 miles southeast of Nevers, was selected as



(3591-F9) ENGINE TERMINAL AT MONTOIR YARDS.

a site for an engine terminal because of level ground, the proximity to a good water supply, and its location nearly midway between the intermediate supply depots and the regulating stations, where changes of engines were necessary. To obviate the undesirable operation of trains across the main tracks to reach the yards, the westbound main track of the Paris-Lyon-Mediterranean Railway was

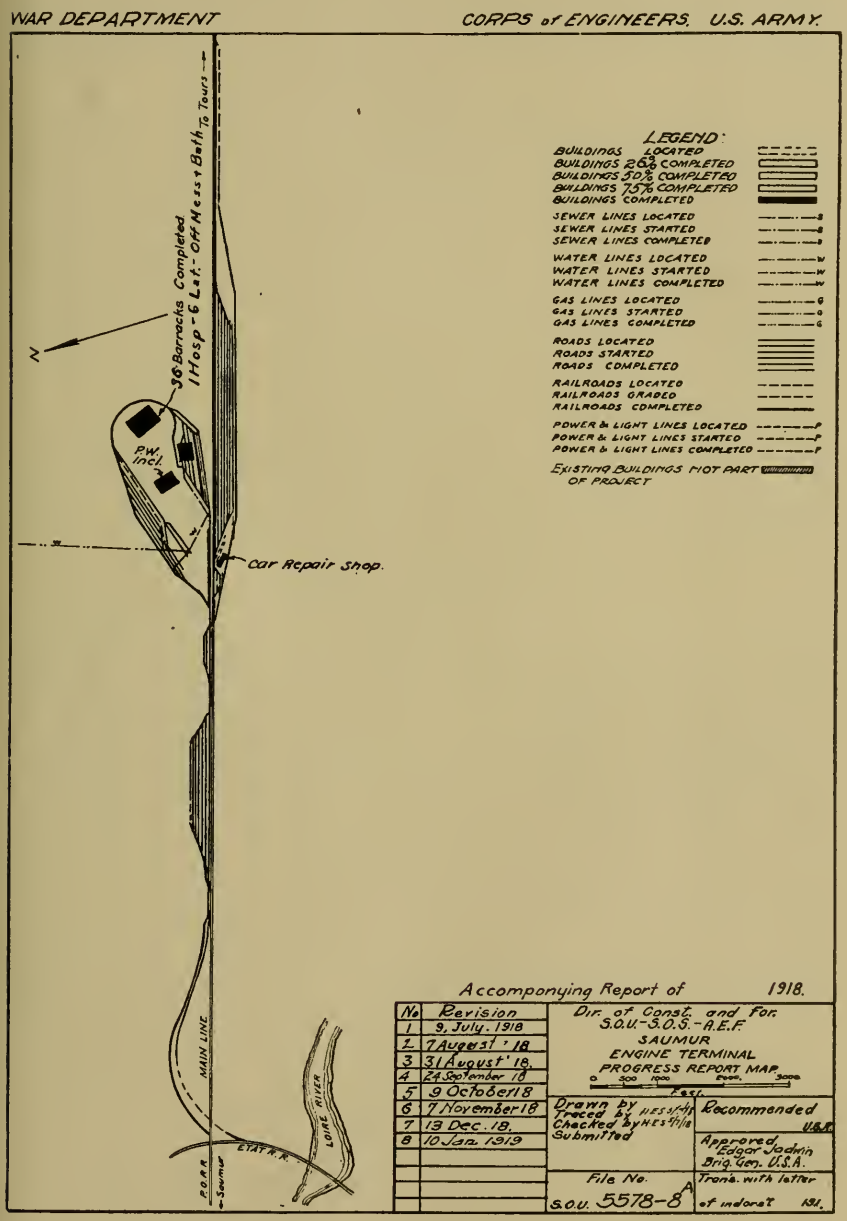
diverted for 4,800 feet and to a distance of 115 feet from its former location at the point of greatest deviation. In the space thus provided, were placed engine standing tracks and five westbound yard tracks with a minimum length of 2,000 feet. These facilities were duplicated for eastbound movements at a point west of the diversion. A thoroughfare track with a loop in the form of a half-circle with a 450-foot radius was built for the purpose of turning engines. The two legs converged at a point just east of the eastbound engine standing tracks. Between the legs of the loop were 9 tracks, each 1,000 feet long, 5 of which were covered for a length of 200 feet by a building in which inspection pits and machine shops were installed. Adjacent thereto were a boiler house and oil house. Along the other leg were 5 tracks, 500 feet long, for storing engines, and at the end of these, coal storage bins and piles, with tracks for unloading coal and for coaling engines. Two ash pits and two inspection pits were provided. Water from a plant on the Aron River was pumped through 1,000 feet of 8-inch pipe to two 50,000-gallon tanks, centrally located. The Marcy project involved the construction of 18 miles of track.

At Saumur, east of Nantes, the railroads from La Pallice, Rochefort, and La Rochelle, joined with the northern line of communication from port of St. Nazaire. Facilities for the inspection, coaling, storing, watering, and minor repairing of locomotives, together with the necessary yards, involving in all 15 miles of track, were constructed at this point. The Etat Railway here had a crossing over the Paris-Orleans Railway, and to reach the yards, which lay parallel with and on the same grade as the Paris-Orleans Railway, it was necessary to build a trestle of 198 bents, with a 50-foot girder span over the Paris-Orleans Railway, and a heavy fill on a 1 per cent grade to the yards. This crossing was nearly completed when the armistice was signed, all the engine facilities having been installed, 13 miles of track laid, and the terminal put in service.

The miscellaneous mileage constructed, included many sidetracks, built in French yards and at stations to accommodate long American trains, and also sidings and spurs at various hospitals, aviation centers, camps, and forestry projects not on main traffic routes.

Administration of railroad construction was accomplished by the director of construction and forestry through the railroad and dock section at director of construction and forestry headquarters and through the various section Engineers, in control of construction in their respective territories, who, in turn placed an Engineer officer in charge of construction on each project. In the execution of the work a great variety of labor was employed, the Engineer technical troops being used largely for supervision and for skilled operations. The usual difficulties were encountered, because all the con-

struction was done in a thickly settled and intensely cultivated foreign country. Private property had to be scrupulously respected and all needed land obtained through the proper bureau of the



French Army. Many roads and streets had to be changed and the traffic maintained meanwhile. Telephone, telegraph, and power lines had to be moved; bridges and culverts had to be rebuilt or

extended; undergrade or overhead crossings had to the installed, all without interrupting business or hindering the main work.

Railroad mileage would have been nearly doubled had hostilities continued. General Orders, No. 54, headquarters, Service of Supply, issued November 14, 1918, canceled 827 miles of track that had been authorized for construction. The proposed mileage was largely at ports and in depots. The mileage of main-line improvements, however, would also have been increased. In connection with the construction of a large dock at Talmont on the Gironde River, 85 miles northwest of Bordeaux, preparations had been made to double-track the existing single track of the Etat Railroad from la Traverserie to Sanjon, a distance of 43 miles. At the time the armistice was signed, work had commenced on the double tracking of the main line of the Paris-Orleans Railway from Le Mans to Tours, a distance of 37 miles, thus affording a double track from Brest to Tours, which was essential because of the then increasing importance of Brest as a debarkation point for American troops. Studies were made, and in some cases construction was started on other engine terminals in order to further increase the American traffic, but these, like nearly all else, were suspended after the signing of the armistice.

REFERENCE DATA, RAILROADS.

	Appendix number or file reference.
Report D. C. and F. to C. G., S. O. S. (through C. E.)	Appendix No. 40.
Project reports of section engineers	Appendix No. 43–52, incl.
Monthly reports and histories:	
16th Engineers (railway)	Appendix No. R–16.
17th Engineers (railway)	Appendix No. R–17.
18th Engineers (railway)	Appendix No. R. 18.
Monthly progress charts, D. C. and F	D. C. & F. Files.

Storage Depots.

Covered storage space in depots ready for occupancy or occupied when hostilities ceased aggregated 13,256,351 square feet. Not included in this total were warehouses at the Montoir depot, with an area of more than 1,000,000 square feet, complete, except for flooring, and an additional 1,000,000 square feet of warehouses built after November 11, 1918. The resulting total depot covered storage space was equivalent to a warehouse 50 feet wide and 58 miles long. Dock and miscellaneous storage, not included in the space for the storage of reserve supplies, were also essential features of the construction program. How the requirements of these three classes were met is indicated by the tabulation following: Depot storage, 15,329,272 square feet; dock storage, 3,255,788 square feet; miscellaneous storage, 3,857,692, making a total of 22,442,752 square feet. These figures are taken from the progress report of director of construction and

forestry dated February 1, 1919, at which time the total space was a maximum. Thereafter the storage space decreased slightly owing to the dismantling of camps and depots and to the return to the French of warehouses leased from them. The accompanying map shows the location of the principal storage projects.

Originally it was believed that a 90-day reserve in France for the American Expeditionary Forces would be necessary. This supply was to be distributed as follows: Forty-five days' supply in base depots, 30 days' supply in intermediate depots, and 15 days' supply in advance depots. It was estimated on this basis that 21 square feet of covered storage space would be required for each man in the American Expeditionary Forces. It was found by experience, however, that for a 90-day reserve an allowance of 10 square feet per man was sufficient for supplies actually requiring cover. This allowance was later reduced to approximately 5 square feet per man, when a reserve of 45 days was determined upon. Considerable attention was given to the matter of placing in open storage those supplies which would not be damaged in the length of time that they would have to remain in the open. Experience demonstrated that hay, canned goods, small-arms ammunition, and projectiles could be placed in the open under paulin covers without material damage.

The location and construction of adequate storage depots in France constituted one of the first problems of the Engineers. With the designation of certain ports and railroads for the use of the American Expeditionary Forces, sites for the principal depots, at points which bore the proper relation to the transportation facilities, were selected. Following the approval of the projects by the commander in chief and consideration of the relative space requirements of the several services, plans for the depots were prepared by the transportation department. The task of actually building the structures was performed by the Engineers under the chief engineer, line of communications, and later the division of construction and forestry, under the chief engineer, American Expeditionary Forces. A diagramatic representation of the growth of depot covered storage space is shown herewith. The location of the several depots and their magnitude on February 1, 1919, is given below:

Base sections:	Square feet.
Montoir	[1] 3,446,740
St. Sulpice	2,627,000
St. Luce	199,200
Aigrefeuille	80,000
Miramas	401,948
St. Loubes (ammunition)	294,500
Total	[1] 7,049,388

[1] Includes 1,136,540 square feet, complete, except for flooring.

	Covered space.
Intermediate section:	
Gievres	3,838,848
Montierchaume	1,214,000
Mehun (ammunition)	409,823
Issoudun (ammunition)	446,600
Nevers (quartermaster)	150,909
Clichy (aviation)	100,000
Cosne (medical)[1]	48,133
Total	6,208,313
Advance section:	
Is-sur-Tille	1,355,000
Poincon (gas)	50,400
Liffol-le-Grand	407,904
Jonchery (ammunition)	306,400
Total	2,119,704
Total, Feb. 1, 1919	15,377,405

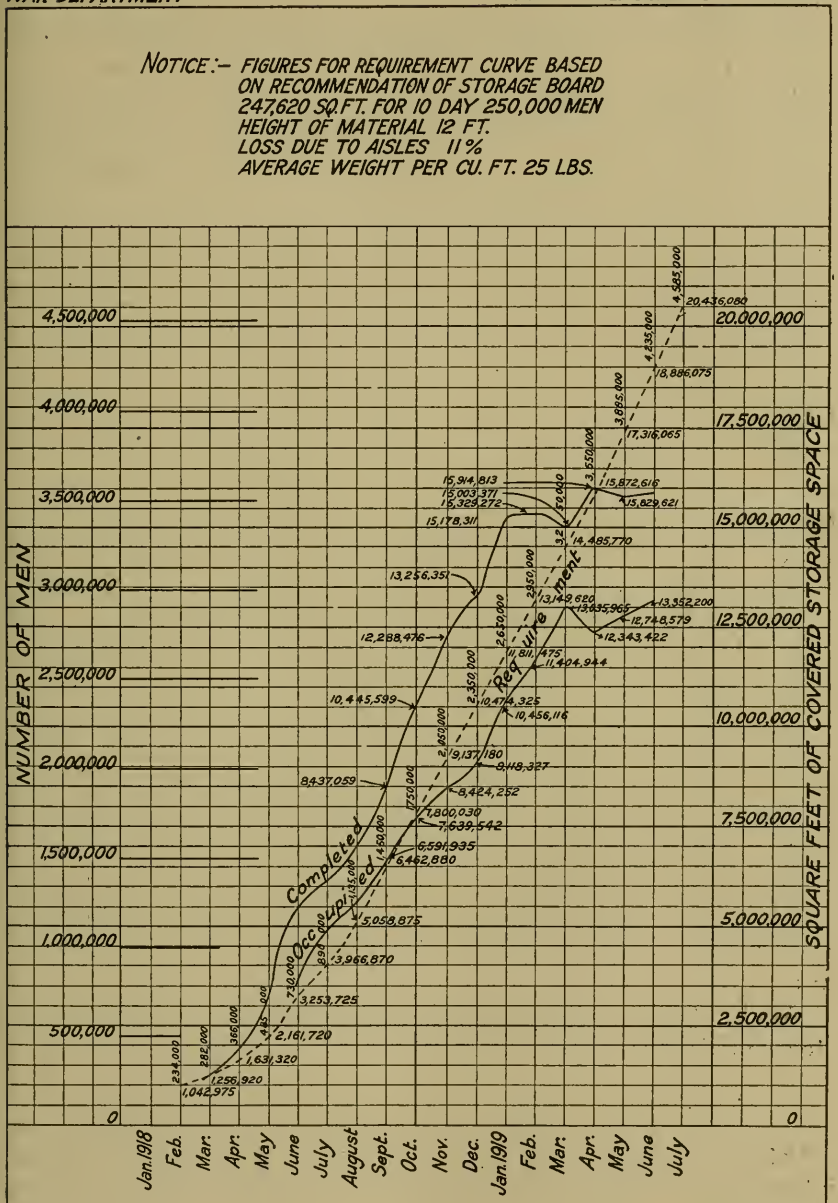
In accord with a policy of concentrating general supplies as far as possible in large centers, 83 per cent of the space was in six great depots—Montoir and St. Sulpice (serving the ports of St. Nazaire and Bordeaux, respectively) Gievres, Montierchaume, and the regulating stations at Is-sur-Tille and Liffol-le-Grand. Ammunition, not permitting of storage in common with other supplies, necessitated the construction of the large depots at St. Loubes, Mehun, Issoudun, and Jonchery. These depots, because of their magnitude and importance in the supply of the American Expeditionary Forces, are each considered at length in subsequent pages. Plan layouts indicating the size and arrangement of these depots are included.

The storage facilities at Nevers, Clichy, Cosne, and Miramas consisted largely of warehouses leased from the French. The construction at these points was relatively small, being principally the trackage necessary to make the warehouses available for American use and the barracks for the operating personnel. Miramas, near the port of Marseille, was subjected to considerable development of this character. The depots at St. Luce and Aigrefeuille were started to receive material from the ports of Nantes and La Pallice, respectively, but, as the figures indicate, did not attain any great size. For the Chemical Warfare Service's gas, which, like ammunition, could not be stored in proximity to other supplies, the small depot at Poincon was constructed.

The function of the depots was not one of the storage of the reserve alone, nor was the reserve stable. All depots, but more especially those in the advance and intermediate sections, acted as distributing points, and certain classes of supplies were continually being received and shipped. The early plans proposed provision for

[1] Medical storage turned back to French before Feb. 1.

WAR DEPARTMENT CORPS OF ENGINEERS U.S. ARMY



DEPOT COVERED STORAGE SPACE
INCLUDING AMMUNITION
45 DAYS STORAGE - ALL FRANCE
DIVISION OF CONSTRUCTION AND FORESTRY
O.C.E. - S.O.S. - A.E.F.
EDGAR JADWIN
BRIG. GEN. U.S.A.
DIR. OF CONST. AND FORESTRY

D.C.F. 9839-32

24

adequate stock at an advance depot. Any surplus was to be stored in the intermediate section and a proper stock assured there. Supplies in excess of the combined capacities of these two depots were to be retained at depots located as near as possible to each of the principal ports for American use. This program resulted in the commencement of construction of the advance and intermediate depots first, and of the base depots later.

The depots had many characteristics in common. Layouts largely similar were used and warehouses of standard types were constructed at all projects. The first warehouses were of lumber with rubberoid roofing. Owing to the difficulty in obtaining lumber a type was developed with a wood frame and corrugated iron roofing and sides, which had the added advantage of being easily and quickly erected. This type is illustrated in an accompanying plan. The standard warehouse was 50 by 490 feet, and 12 feet high at the eaves and required only 20,000 feet b. m. of lumber and 44,000 square feet of corrugated iron. Shorter lengths were built as necessity required. At Gievres, on one occasion, a warehouse 50 by 294 feet with roof and ends only covered with corrugated iron was erected by 60 men in eight and one-half hours. It was found practicable 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 placed on loose dunnage.

Ammunition constituted an important class of material for which storage was provided. The type of warehouses erected for ammunition differed but little from the type used for general storage, except that they were of an average length of 300 feet instead of 500 feet. An essential requirement, however, was that the buildings be separated by a minimum distance of 300 feet, which necessitated a layout with widely divergent tracks along which the warehouses were located.

For the Ordnance Department a group of steel frame shop and storage buildings was also constructed.

THE GENERAL INTERMEDIATE STORAGE DEPOT AT GIEVRES.

Between the base ports and the advance depots was the general intermediate storage depot at Gievres, originally designed to provide a center where a sufficient stock of supplies should be maintained to meet any demands made by the depots nearer the front as well as to relieve freight congestion at the ports. Eventually, it was further utilized to supply a large portion of the Service of Supply as well as to forward supplies directly to some parts of the front.

During the summer of 1917 Brig. Gen. (then Col.) Harry Taylor, chief engineer American Expeditionary Forces, sent Col. (now Brig.

Gen.) Edgar Jadwin and his two assistants, Capts. Somervell and Brooke, to examine eight possible sites for storage depots. They found at Gievres a broad, level, sandy plain, nearly 3 miles wide, between the Cher River and the Sauldre, and covered with grain fields, vineyards, and patches of timber with here and there a swamp. Near the Cher and through the village ran the Paris-Orleans Railroad, a main artery for American traffic, while along the Sauldre was National Highway No. 76 between Tours and Vierzon. A barge canal followed the course of the Cher and the Le Blanc and Argent narrow-gauge line crossed the plain from north to south. This site was recommended as the best of the eight, and on August 16, 1917, its adoption was approved by the chief of staff.

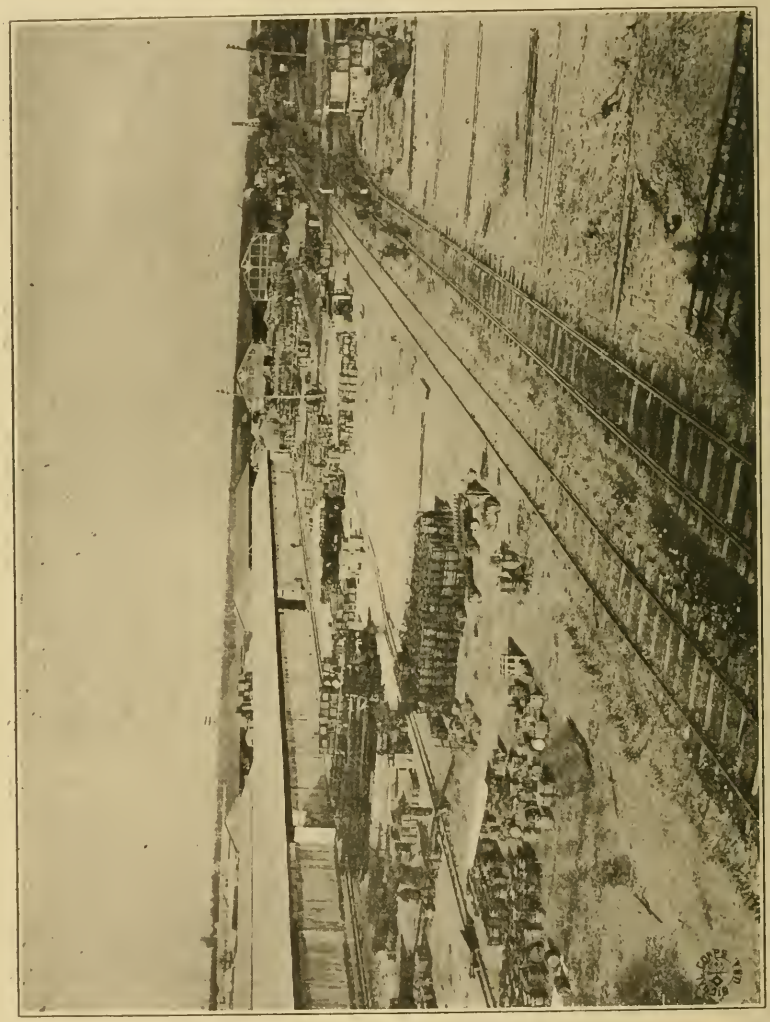
The authorization of August 16, 1917, called for a depot "capable of supplying 300,000 troops for 30 days and providing for expansion." The plans finally adopted, however, were on a much bolder scale and covered a depot capable of supplying 1,000,000 men for 30 days. This project designed to cover an area 2 miles wide and 6 miles long, was divided into 12 smaller ones which included, in addition to 213 warehouses and 260 miles of railway track, a large refrigeration and ice-making plant, two remount depots, a veterinary hospital, a camp hospital, a coffee roasting and grinding plant, and a gasoline distributing station. Moreover, the constructing and operating troops had to be housed and many auxiliaries, such as a water-supply system, shops, roundhouses, and motor parks, had to be provided. Active construction was begun by the 15th Engineers, who also supervised the work of the organizations which later arrived.

The plan adopted called for a ladder system of long, parallel, double tracks, between which were placed diagonally the rows of warehouses. These warehouses were spaced so as to reduce fire danger to a minimum and had a track on either side. This huge system formed the skeleton of the project. Along the southern and eastern edges the designs called for classification and departure yards, shops, roundhouses, and other railroad facilities. The refrigerating plant and most of the barracks were placed along the national road which formed the northern boundary, while the gasoline-storage facilities were located at the extreme eastern end. The other components of the project were similarly grouped about the central warehouse area.

On September 1, 1917, two companies began unloading French track material and laying a temporary line from which to unload future shipments. On December 1, 1917, the actual laying of the track was commenced simultaneously with the building of the warehouses, the 15th Engineers then being assisted by 200 American service troops and 500 Chinese laborers. From that time on the work went forward at an increasing pace. Labor troops began to

arrive from America; Spaniards, Portuguese, and Chinese were secured, and combatant troops were detained long enough to contribute a few weeks of labor.

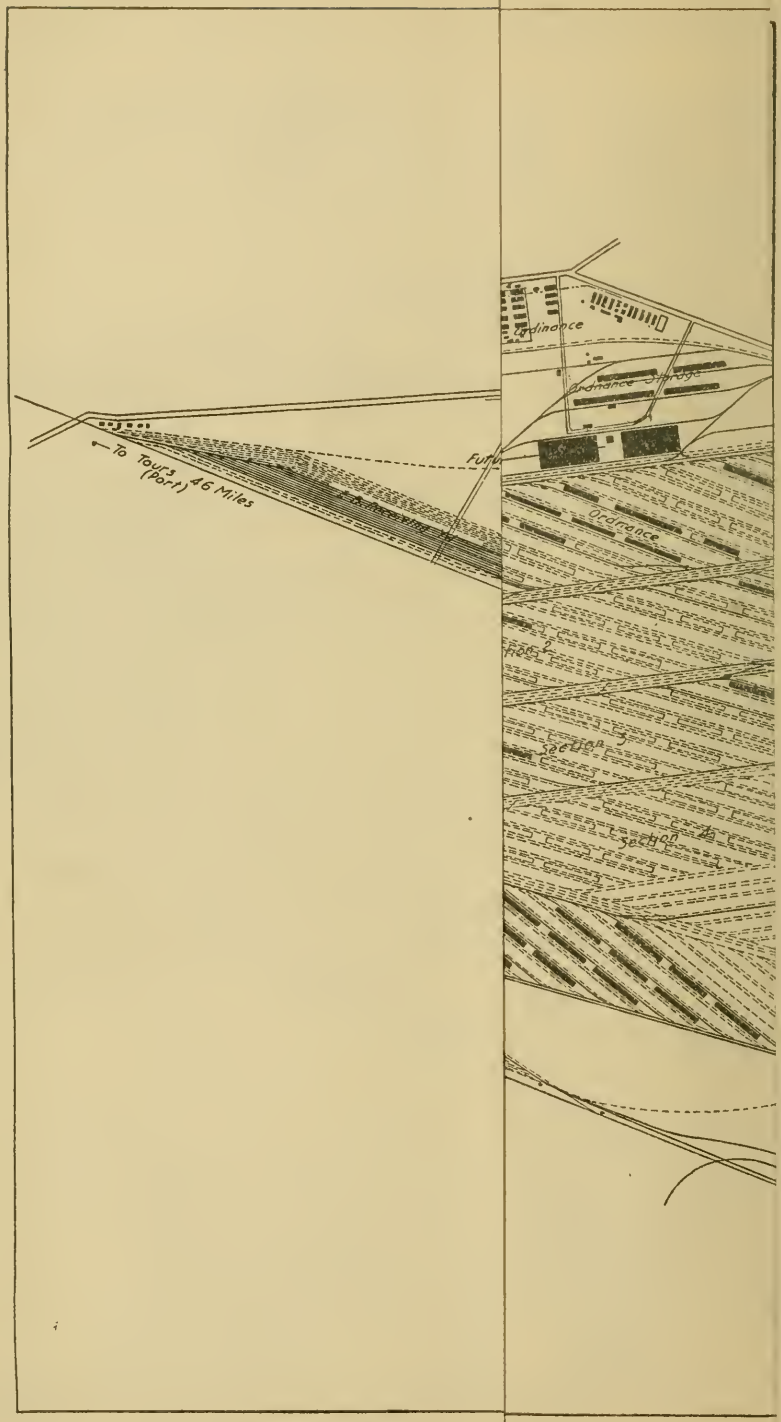
In spite of the constant shortage of labor, the work was pushed so energetically that another factor, the shortage of material, be-



(3166–D8) RAILWAY TRACK COVERED AND OPEN STORAGE AT THE GENERAL INTERMEDIATE STORAGE DEPOT, GIEVRES.

came a menace to the success of the project. To relieve this situation, various expedients were resorted to. Lack of rails made necessary a large reduction in the mileage, and for this reason it was decided to lay a track on one side only of each warehouse instead of on both sides, a change which, owing to the narrowness of the warehouses, did not materially affect their efficiency. It was also found necessary to dispense with the running tracks between grids.

WAR DEPARTMENT



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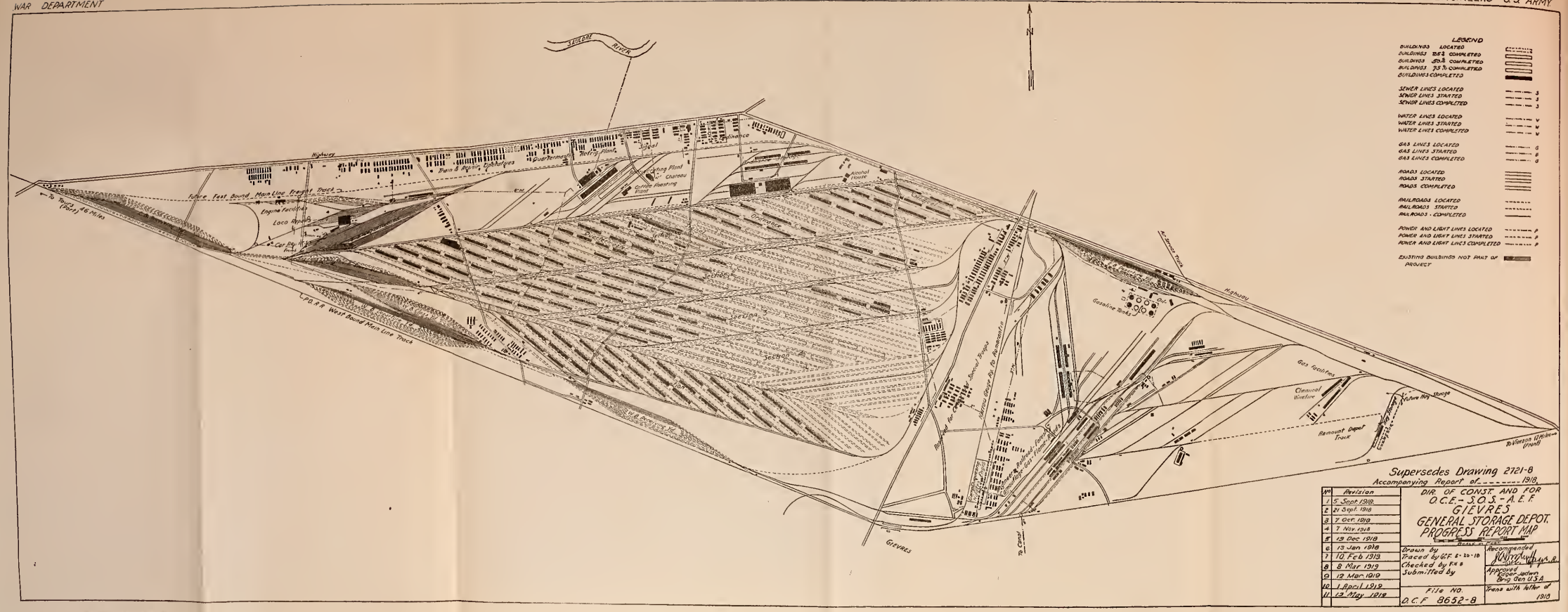
These were but the most sweeping of the shifts which had to be made in order to maintain a balance between labor and material. No sooner had the depot been put under construction than it commenced to operate, and the construction work had to be carefully regulated so as to keep transportation from interfering with construction and vice versa.

The Gievres site possessed two features which greatly facilitated the railroad work. One was the flatness of the terrain, which eliminated any extensive grading, and the other was an abundance of excellent ballast material on the site. The railroad work did not consist entirely of laying track. A constantly increasing complement of locomotives required shops and roundhouses, as well as water supply and storage facilities for large quantities of coal. The "roundhouse," which as a matter of fact was rectangular, was made up of identical sections so that additions could be built whenever the need arose. It consisted of seven of these sections, which were sufficient to house the assortment of Belgian, French, British, and American locomotives which were used in the yards and on the lines for which Gievres was the terminal. At one time 30,000 tons of coal were stored on the project, and plans had been made for a large increase.

The matter of water supply was in itself no small one. At a pumping station on the bank of the Sauldre were installed two electrically driven centrifugal pumps each having a capacity of 2,800 gallons per minute and two 1,800 gallons per minute pumps. A pipe line carried the water to a central tank of concrete, from which it was pumped to smaller wooden tanks, constructed of green lumber and bound with iron rods and ingenious iron lugs improvised out of pipe, or, in the case of the larger tanks, with a device fashioned from angle bars. Eight tanks of 25,000 and 50,000 gallons capacity were constructed.

Under shipping conditions as they existed in the first months of 1918, the American Expeditionary Forces could ill afford to lose any of the supplies which had been brought over with such difficulty and it was imperative that a warehouse-building program be carried out such as would keep pace with the increasing influx of supplies. If building materials had been readily procurable this would not have been difficult but structural steel had to be brought from America or England; the same was true of corrugated iron and sufficient lumber could neither be purchased nor imported. Various types of warehouses were designed. Six warehouses having hollow-tile walls and slate roofs were built by a French contractor. The Ordnance Department provided materials for two steel warehouses, 240 by 500 feet. These proved to be too large for efficiency in a case where so much material had to be handled, but this defect was reme-



Supersedes Drawing 2721-8
Accompanying Report of _____ 1918.

No	Revision
1	5 Sept 1918
2	21 Sept 1918
3	7 Oct 1918
4	7 Nov 1918
5	13 Dec 1918
6	13 Jan 1918
7	10 Feb 1919
8	8 Mar 1919
9	12 Mar 1919
10	1 April 1919
11	12 May 1918

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O.C.E.-S.O.S.-A.E.F.
GIEVRES
GENERAL STORAGE DEPOT.
PROGRESS REPORT MAP

Drawn by
Traced by U.C.F. 8-20-18
Checked by F.H.B.
Submitted by

Recommended
J. N. Wheeler Lt. Col. C.E.
Approved
Brig Gen U.S.A.

File No.
O.C.F. 8652-8

Trans with letter of 1918

died by running a track through the center of each building, thereby doubling the number of cars loaded and unloaded. Four types of smaller steel structures 50 feet wide and of varying length, designed for simplicity of erection and lightness, were ordered, three from American firms and one from Great Britain. In these the number of parts was reduced to a minimum, bolts were substituted for rivets, only two sizes of bolts were used throughout and corrugated iron was employed for the roofs and walls. These simple buildings could be erected by troops unfamiliar with structural work. On one occasion two detachments of 90 men each put up a steel warehouse in seven working days.

Most of the warehouses were of wood, were generally 50 by 504 feet, though the length was frequently varied, and were designed with a view to cutting down the material to the lowest possible amount. The posts supporting the roofs were cut from timber growing on the site; the rafters and purlins were cut in the vicinity by detachments of forestry troops. This saving in transportation resulting from the use of local material was an important item at a time when the car shortage was critical. Cleaning, grading, construction, and utilization followed one another rapidly. Often before the last workman had picked up his tools to leave a completed warehouse, the stevedores were piling up freight inside.

Yet there was a time during the spring and summer of 1918 when the building progress, hampered at all times by the shortage of labor and material, was unable to keep up with the increasing tonnage which was being received. The corrugated iron did not arrive in sufficient quantities. This situation was relieved by inclosing only the end walls with iron and hanging temporary curtains of canvas on the sides, thus postponing the need for thousands of square yards of metal. With the buildings going up at so fast a rate and being filled just as rapidly, there was neither time nor material for putting in the floors called for by the plans. However, short poles from 3 to 8 feet in length, collected locally were laid end to end about a foot apart over the floors and the supplies were thus elevated above the dampness of the soil. In some cases where the value or perishability of the supplies warranted, rough pine flooring was laid. When the armistice was signed the work was at its height, 174 of the 213 proposed warehouses had been completed, and 132 of the 260 miles of track had been laid.

In addition to the fundamental matters of trackage and storage, numerous less extensive yet indispensable projects formed a part of the scheme. The water of the Sauldre was unfit for drinking, and four wells—one of them over 500 feet in depth—were drilled and their output piped throughout the depot. Two remount depots, one

with a capacity of 400 horses, at the near-by village of Selles-sur-Cher, and another, having a capacity of 2,300 horses, the latter supplemented by a 2,000 animal veterinary hospital, were installed. A coffee roasting and grinding plant was under construction on November 11.

One of the branches of the project which was most vital to the success of the Army was the gasoline and oil depot from which the small stations in the forward areas were supplied. This was conveniently located with respect to track connections and to the main highway. The primary gasoline storage consisted of four tanks for two kinds of gasoline, with a total capacity of 2,000,000 gallons. These tanks were connected by 4-inch pipe to pumps having a capacity of 200 gallons per minute. Ten tanks to receive the gasoline from the cars were placed near the tracks and a secondary storage tank near the road. To insure protection against fire each tank was surrounded by earthen dike and provided with connections for smothering fire with live steam. Shops for assembling the 325 and 150 barrel steel tanks in use throughout the American Expeditionary Forces were put up and civilian steel workers brought to France for this work had completed all but one of their quota of tanks on the day the armistice was signed.

The American Army, coming as it did into a country whose food supply was already depleted, recognized that it could not depend upon European markets for meat, and that it would not only have to bring all its meat into the country but that, if the meat were to be served fresh, means of refrigeration would have to be provided. Refrigeration plants were therefore required at the ports, at the advance depot, and at Gievres, where the Engineers erected the largest refrigeration plant in France. For the design and operation of these plants, Maj. P. W. Evans, Quartermaster Corps, was in a large measure responsible.

In October, 1917, 103 carloads of material for the plant at Gievres arrived; on November 3, the first contingent of civilian constructors for the ice plant were on the ground; and on May 1, 1918, the plant commenced operation. The plant included the following buildings: Engine and boiler room, machine shop, laundry, storehouse, and the immense beef storage warehouse, 112 by 896 feet. The refrigeration was obtained by the expansion of ammonia circulating through 35 miles of 2-inch pipe, giving a temperature varying between minus 4 degrees and plus 5 degrees Fahr. In addition a fully equipped ice-making plant, with a capacity of 500 tons of ice per day, was installed. The beef-storage plant had a capacity of 15,000,000 pounds of meat and the average amount stored was but 544,856 pounds, yet in view of the promised increases in the American Expeditionary

Forces, work was commenced on another cold-storage building of the same size, which was, however, abandoned in November, before the foundations had been completed. While the mechanical equipment of the refrigeration plant required the services of more than 200 civilians, most of them skilled laborers and mechanics, the men who were responsible for the construction work were engineer officers and men.

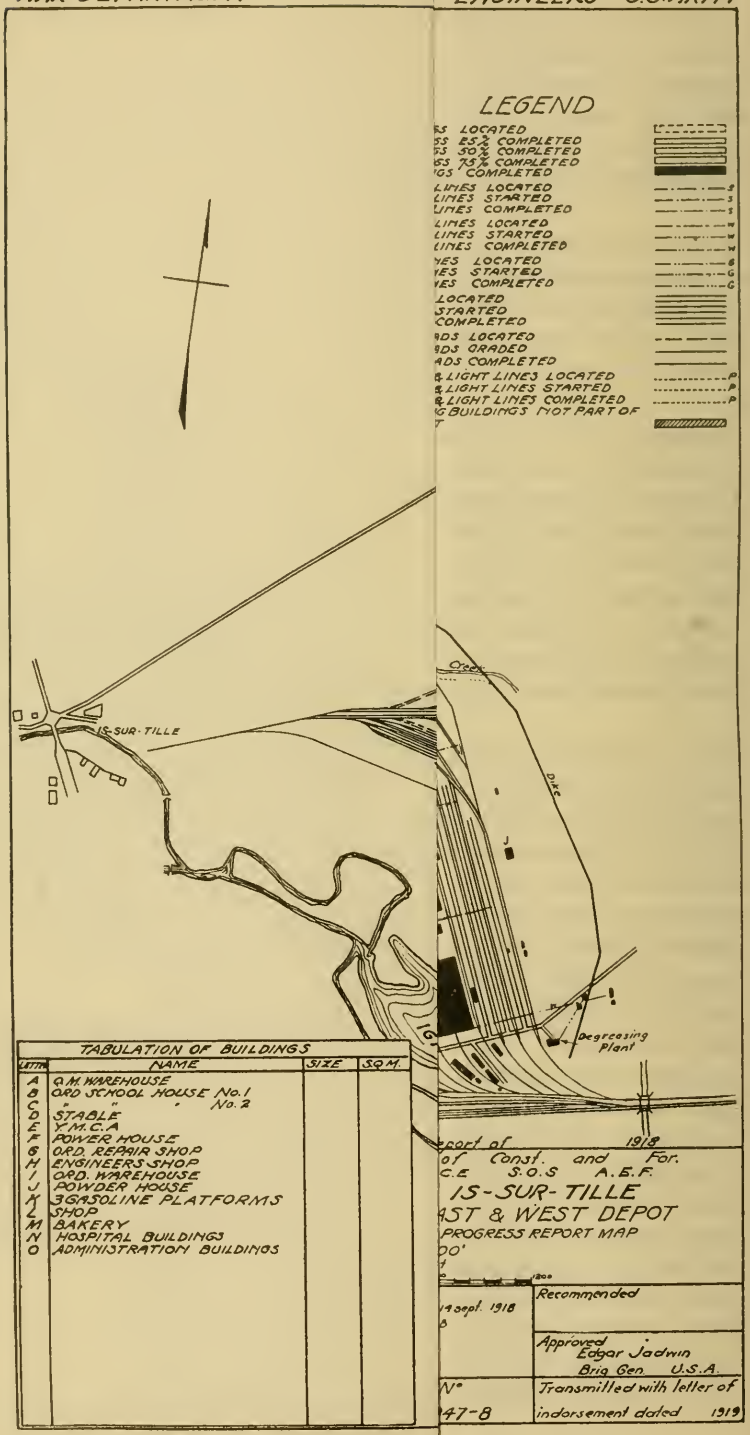
The history of the Gievres project is one long succession of difficulties overcome. The shortage of materials and the measures taken to counteract it have already been mentioned and the other big problem, that of labor, was no less troublesome. In addition to troop labor there were large numbers of French, Spanish, Chinese, and Portuguese civilians.

Fortunately these classes of labor did not have to be depended upon entirely. The construction troops, while never sufficient in numbers, were efficient and were used to best advantage in doing the more skilled work or in superintending the work of less skilled troops, and they fully justified the responsibility which was placed upon them. The work of the Negro service battalions has been commended again and again by their officers. Combatant troops were also employed whenever available, but, due to the necessarily frequent changes and transfers of units, did not constitute a really satisfactory source of labor.

The Gievres project was built under the general direction of the section engineer, intermediate section (west), reporting to the director of construction and forestry. Col. Ernest Graves served as section engineer until the fall of 1918, when he was relieved by Col. S. B. Williamson. The regiments which were in the main responsible for the construction were the 15th Engineers, which did practically all the work of organization during the earliest and hardest months, and the 55th Engineers, who relieved them in July, 1918. But many detachments, varying from platoons or less to battalions, which put strenuous effort into the work also deserve credit. The officers who at various times were in charge of the project under the section engineer were: Lieut. Col. C. W. Sturtevant, 15th Engineers; Maj. George H. Taylor, Engineers; Col. E. L. Daley, 55th Engineers; Maj. H. P. Warren, 55th Engineers; and Maj. B. R. Wood, Engineers.

When, in October, 1918, the talk of peace became most insistent, the work at Gievres was not permitted to slacken. The final day found the warehouses in all stages of construction, track being laid, foundations for a new beef storage plant being built and all the work going forward with energy. November 11 saw the Gievres project at its greatest, able to care for all the supplies needed for the armies, its departments in full operation and additional construction under way.

WAR DEPARTMENT — F ENGINEERS U.S. ARMY



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IS-SUR-TILLE ADVANCE DEPOT AND REGULATING STATION.

Is-sur-Tille was the principal advance depot and regulating station. The village of Is-sur-Tille is about 160 miles southeast of Paris and 95 miles south of St. Mihiel, at the northern terminus of the Paris-Lyons-Mediterranean Railway and the southern terminus of the Est Railway. Located within a short distance of all sections of the American front and upon the controlling railroad lines, advance depot No. 1 and regulating station "A," as these dual facilities were designated, distributed supplies to the advance section and the zone of the armies. Is-sur-Tille was the "neck of the bottle" through which, with few exceptions, supplies from the ports and base and intermediate depots had to pass.

When hostilities ceased 390 buildings, affording 2,110,800 square feet of floor space, had been erected. Forty-eight warehouses, with an area of 1,335,000 square feet, constituted the depot covered storage. Accommodations were provided for approximately 18,000 men, the construction and operating personnel. Within the area of the project were built 109 miles of railroad track. A mechanical bakery, with a daily capacity of 800,000 pounds of bread, was in operation. Complete electric light, power, and water-supply systems extended to all parts of the project, the latter consisting of a 110,000-gallon reservoir and 88,000 feet of pipe, supplying water purified by chlorination before entry into the mains.

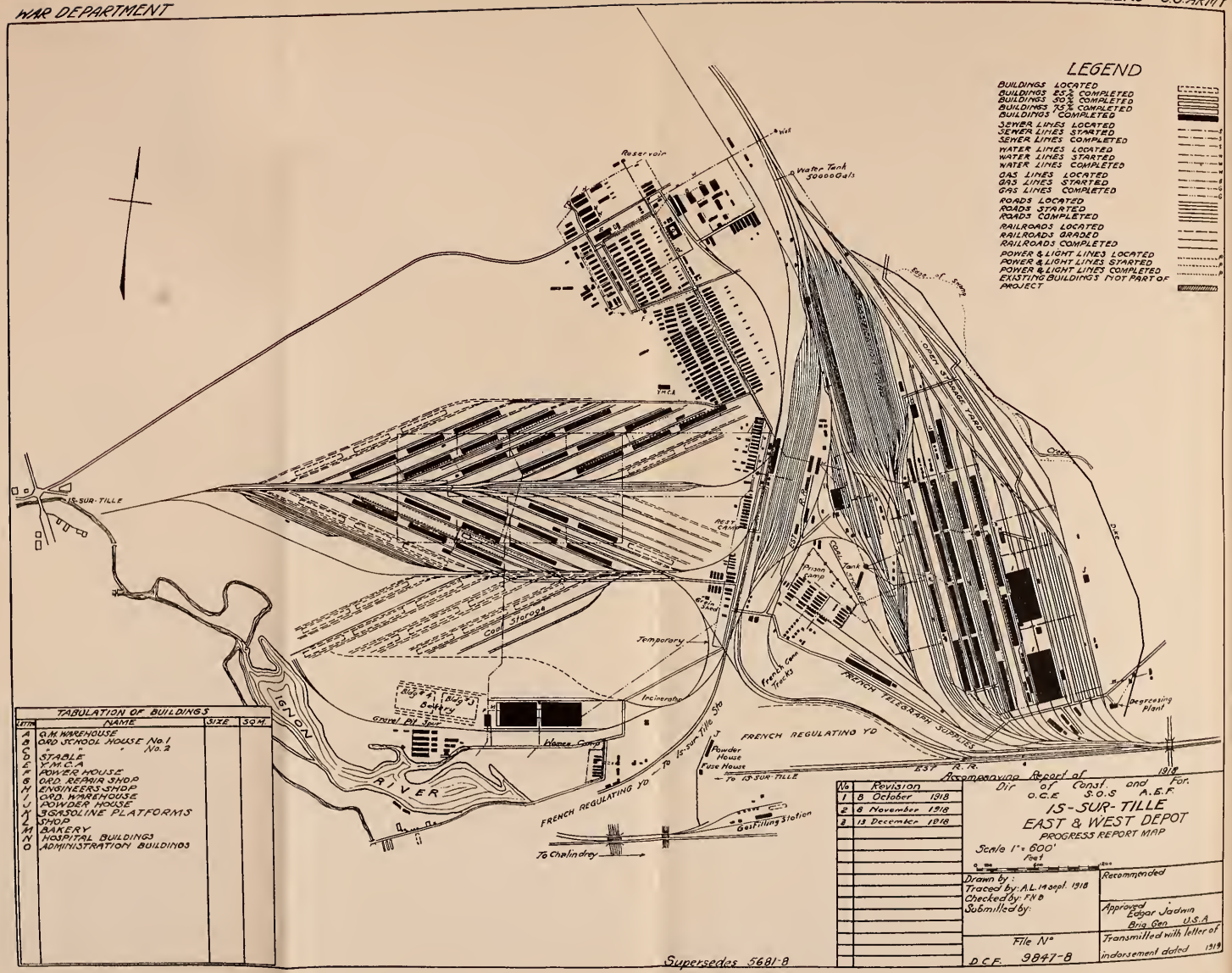
The decision to construct a large advance depot and regulating station at Is-sur-Tille was delayed until the French and American military authorities reached an agreement as to the exact location and plans for the work. On September 25, 1917, construction was authorized. The following day grading work was commenced by the 16th Engineers (railway), Col. Harry Burgess commanding, on what was decided to be the determining factor affecting the time of completion of the yard and depot, namely the removal of about 20,000 cubic yards of earth and 30,000 cubic yards of rock from two cuts required for the diversion of an existing main line of the Est Railway and for the tracks of the receiving yard.

To provide the facilities authorized on the initial plans required the removal of 30,000 cubic yards of rock and 90,000 cubic yards of earth, construction of 19 warehouses 50 by 500 feet, laying of 28 miles of track, provision of water-supply and electric-light systems, and numerous other auxiliaries. Under the general supervision of Lieut. Col. (later Col.) George H. Webb and Maj. (later Col.) Sam. A. Robertson, in charge of actual construction, a great transformation took place in a surprisingly short time.

The forces of the 16th Engineers were in November augmented by four companies of Infantry and one company of French railroad en-

WAR DEPARTMENT

CORPS OF ENGINEERS U.S. ARMY


LEGEND
BUILDINGS LOCATED
BUILDINGS 25% COMPLETED
BUILDINGS 50% COMPLETED
BUILDINGS 75% COMPLETED
BUILDINGS COMPLETED
SEWER LINES LOCATED
SEWER LINES STARTED
SEWER LINES COMPLETED
WATER LINES LOCATED
WATER LINES STARTED
WATER LINES COMPLETED
GAS LINES LOCATED
GAS LINES STARTED
GAS LINES COMPLETED
ROADS LOCATED
ROADS STARTED
ROADS COMPLETED
RAILROADS LOCATED
RAILROADS GRADED
RAILROADS COMPLETED
POWER & LIGHT LINES LOCATED
POWER & LIGHT LINES STARTED
POWER & LIGHT LINES COMPLETED
EXISTING BUILDINGS (NOT PART OF PROJECT)
Reservoir
Well
Water Tank 50000 Gals
YMCA
IS-SUR-TILLE
Rest Camp
Coal Storage
Temporary
Incinerator
Gravel Pit Spur
Hobos Camp
IGNON RIVER
FRENCH REGULATING YD
To IS-SUR-TILLE
Powder House
Fuse House
Gas Filling Station
To Chalindrey
FRENCH TELEGRAPH SUPPLIES
Crossing Plant
Coal Storage
Tank
Prison Camp
French Coal Tracks
Coal Storage
Ditch
Ditch
Ditch

gineers employing about 400 German prisoners, so that nearly 2,000 men were engaged on the work.

In succeeding months the work progressed rapidly. The two cuts were finished and the tracks were ready by the 1st of January, 1918. Two track-laying gangs were organized and laid as much as 1½ miles per day.

Standard warehouses 50 by 500 feet were built of light frame construction, sided and roofed with rough, irregularly sawed Swiss three-fourths inch lumber, and covered with tar paper. Later, when materials arrived in sufficient quantity, warehouses were sided and roofed with corrugated iron to reduce the fire risk.

On March 15, 1918, the yard and depot were completed and turned over to the transportation department for operation, and on April 5 the 16th Engineers departed for the British front, having completed, with the aid of the other troops assigned to the command, which at one time approximated 5,500 men, all the essential features originally contemplated. The construction work was then placed in charge of Maj. (later Lieut. Col.) Brehon Somervell.

Late in March it was determined to construct to the west of the original project additional warehouses and tracks. This project was designated as the "west depot" and the initial project as the "east depot." Construction of the former and additions to the latter were carried on independently. At about the same time, authorization of a mechanical bakery capable of an emergency production of 1,000,000 pounds of bread daily created a third distinct project, while the increasing personnel necessitated such extensive construction at Camp Williams as to require its separation as a fourth individual project.

In its final form the east depot embraced 20 warehouses, 50 by 500 feet; two steel warehouses, 240 by 500 feet; and 2,000,000 square feet of open storage space served by 8 miles of narrow-gauge and 59 miles of standard-gauge track. Advance quartermaster depot No. 1 occupied 19 warehouses with an area of 475,000 square feet and advance ordnance depot No. 1 occupied the two steel warehouses with an area of 240,000 square feet. Within the boundaries of the east depot were the receiving and classification yards, the former with 16 tracks and the latter with 25 classification tracks, 7 hospital train tracks, and 2 meat tracks. These yards, totaling approximately 20 miles, constituted the regulating facilities. In the construction of tracks, excavation of 300,000 cubic yards of earth and rock was required. An engine terminal was constructed with round house, machine shop, inspection and repair pits, and other necessary features.

The construction of the west depot was begun in April, 1918. Three months later this project, embracing 26 warehouses 50 feet wide and from 400 to 500 feet long, and 30 miles of track, was prac-

tically complete. A warehouse or two were yet unfinished, some track had yet to be ballasted, roads made, transmission lines built, and other features added, but the depot personnel for the Air Service, Engineer Corps, Medical Corps, and Signal Corps, to whom space was assigned, had been installed and had for some time received and issued supplies from the depot. All the warehouses built on this project were of the wood frame and corrugated iron side and roof construction. The initial program called for 33 warehouses with an area of approximately 750,000 square feet, but 26 only were constructed, and these proved sufficient up to the armistice. Future installation called for 16 more warehouses, increasing the covered storage area in the west depot alone to over 1,000,000 square feet.

The mechanical bakery at Is-sur-Tille had a rated capacity of 800,000 pounds of bread daily, but was capable of an emergency production of 1,000,000 pounds daily. On April 1, 1918, the site was bare. On September 1 the establishment was in operation. The plans, prepared by the Quartermaster Corps, provided two steel truss buildings, 240 by 280 feet, with sides and roof of corrugated iron, and a powerhouse of similar construction, 55 by 125 feet. All buildings had concrete floors throughout. The plant was equipped with electrically driven bakery machiney and with ovens built according to the standard British practice in groups of seven, so arranged as to lessen the chance of the plant being totally disabled. The powerhouse equipment, which was installed with a view to ultimately supplying all the light and power requirements of the camp and depot, as well as the bakery, consisted of two 330-horsepower vertical water-tube boilers, two turbo-alternators of 500 kilowatt capacity, together with condensers and other auxiliary machinery.

Camp Williams was located on higher ground to the north of the depots and yards. When the 16th Engineers departed in April the camp had been provided with accommodations for 7,000 men, including a well-equipped camp hospital. Additions were made almost continuously until, at the time of the cessation of hostilities, accommodations existed for 532 officers and 15,900 men, with a camp hospital of 500 beds.

Between the two depots were a rest camp, provost-guard camp, and prisoner-of-war inclosure, capable of housing in all more than 3,000 men. The rest camp was further enlarged after the signing of the armistice by the construction of numerous barracks and mess halls for troops passing through Is-sur-Tille en route to leave areas. A large theater, seating 1,800, was erected, supplementing the entertainment facilities of the Young Men's Christian Association and Red Cross, the buildings for which were also constructed by the Engineers. Light was furnished from two powerhouses equipped with 110-volt gasoline-electric generating sets.

Maj. Brehon Somervell was in charge of construction until November 10, 1918. Maj. W. F. Allison served in his stead until relieved by Capt. B. H. Liskow, on November 24.

POINCON GAS DEPOT.

Seventeen miles to the north of Is-sur-Tille, near the village of Poincon, was a gas depot, constructed by the Engineers for the Chemical Warfare Service. Although located at a distance because of the dangerous nature of its stores, it was considered as a part of advance depot No. 1 at Is-sur-Tille. Two warehouses, 50 by 594 feet, served by 1,000 feet of track, constituted the principal feature of the installation.

Four barracks, powerhouse, bathhouse, and recreation hut were provided for the operating personnel.

MONTOIR DEPOT.

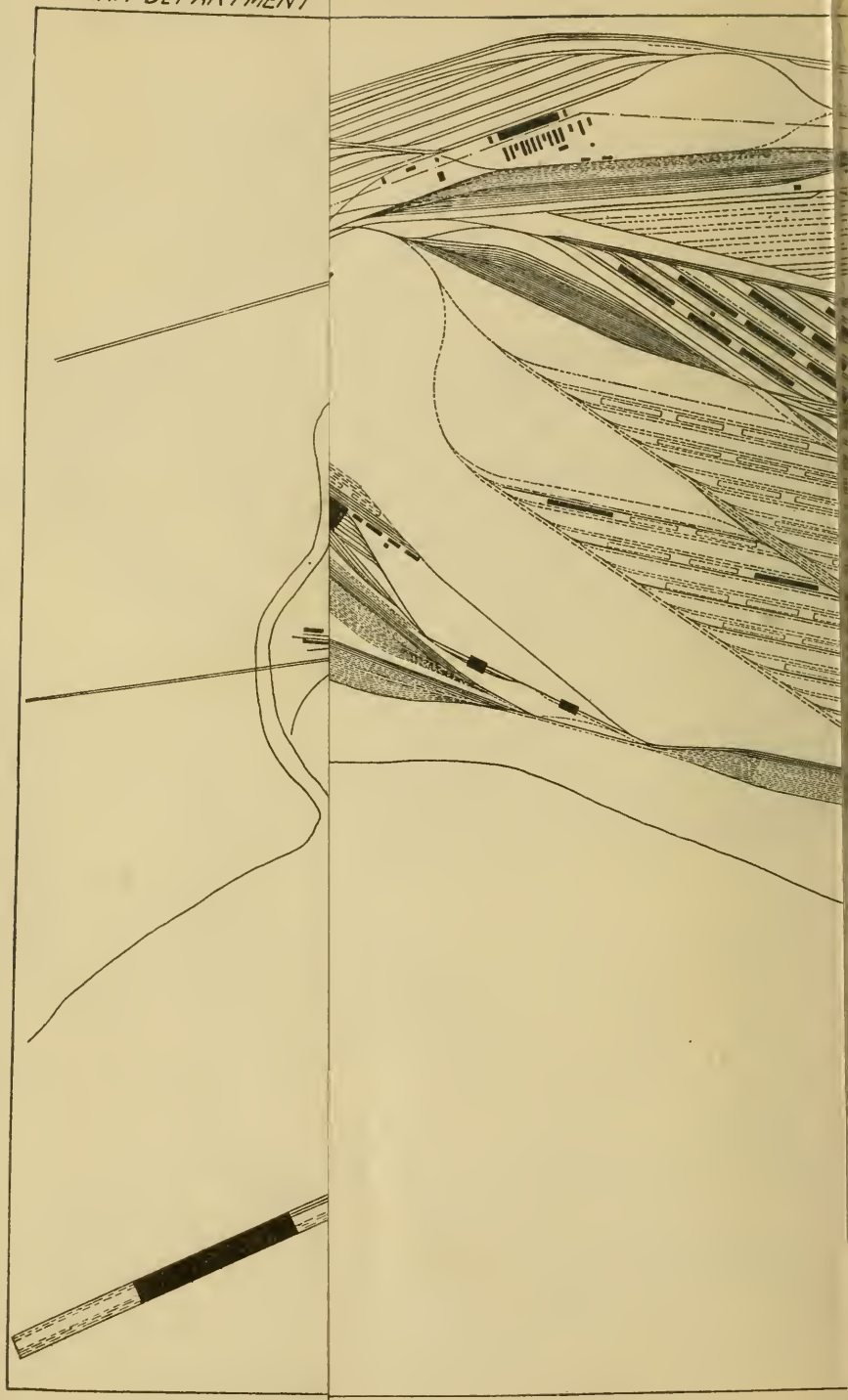
The depot at Montoir, near St. Nazaire, was second to Gievres among the great storage depots of the American Expeditionary Forces. On the cessation of hostilities 138 warehouses, with 134 miles of track, had been constructed on an area of about 4 square miles along the Loire.

As indicated by the progress chart of the Division of Construction and Forestry, dated February 1, 1919, the covered storage space then at Montoir totaled 3,446,740 square feet, including 1,136,540 square feet complete except for the flooring.

Nearly 14 per cent of the space was provided in four steel ordnance warehouses, 240 by 484 to 500 feet, built under contract. The remainder was the aggregate of both steel and wood frame, corrugated-iron covered warehouses of 50 feet width and from 400 to 786 feet in length, placed 3 in a row and 11 rows to a section, of which there were 4 completed. Each row of warehouses was separated by a clear distance of approximately 100 feet, and the intervening space was used for open storage, providing 6,926,400 square feet in the four sections. The layout provided for two additional sections. Three ammunition warehouses were constructed at isolated locations in the projected sixth section. The area was bounded and crossed by railroad tracks, forming a parallelogram approximately 1¼ by 1½ miles, terminating in receiving, classification, and departure yards that formed essential parts of the project.

Camp Montoir, practically an integral part of the depot, where the construction and operating personnel lived, occupied a site of about 50 acres overlooking the depot. Barracks were originally provided for 10,000 men and tents for 5,000 more. Following the armistice additions capable of housing 10,000 men were authorized for use in

WAR DEPARTMENT



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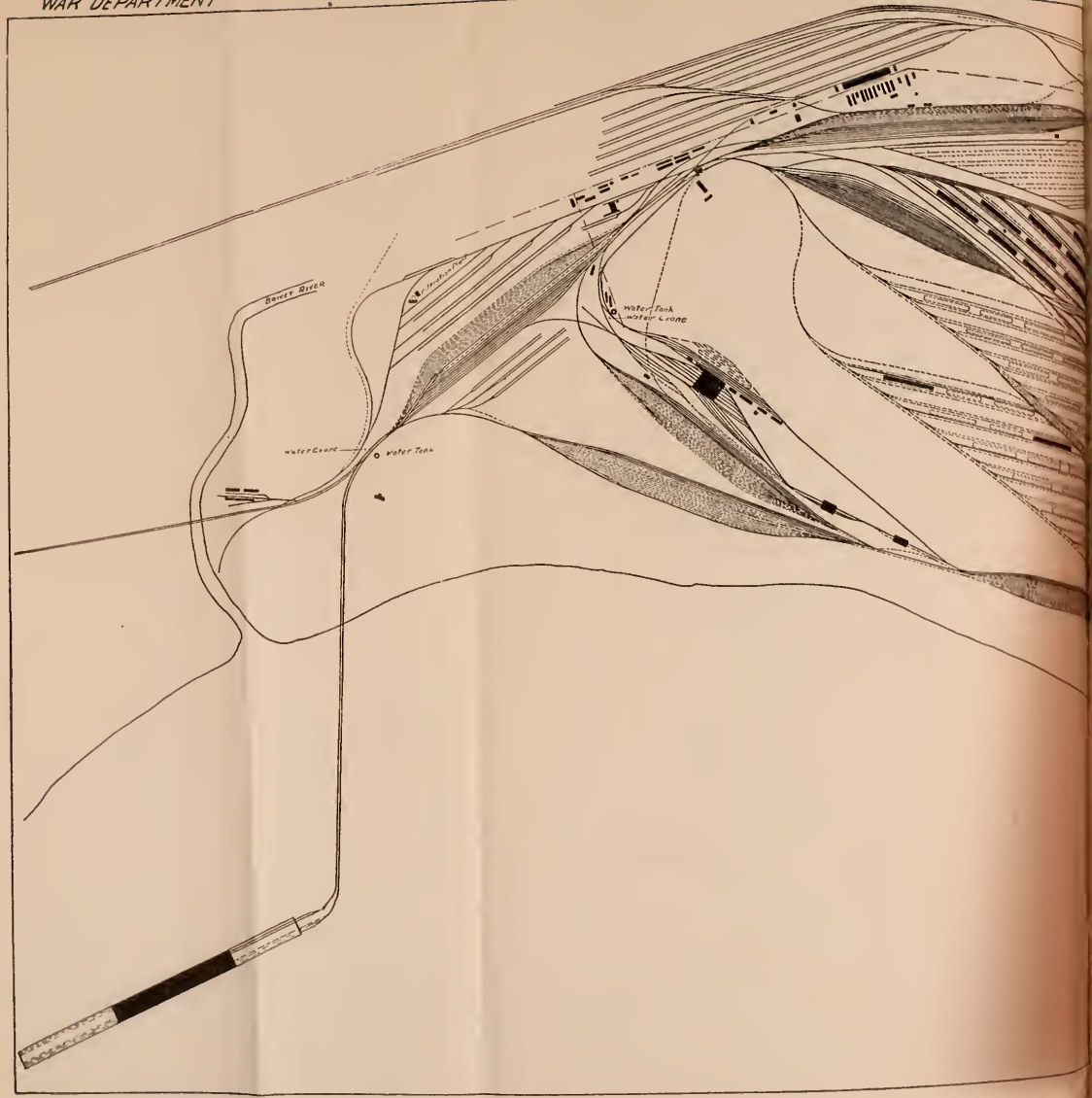
the embarkation of troops. The camp was complete with hospitals, storehouses, stables, and other auxiliaries, and was served, in common with the other parts of the project, by electric-light and water-supply systems, the latter involving the construction of a filtration plant with a capacity of 1,000,000 gallons daily. The camp alone possessed a sewer line and sewage-disposal plant with Imhoff tank.

The decision to construct at Montoir a base storage depot followed the selection of St. Nazaire as a port of entry, as did also the determination to construct the Montoir docks, as explained elsewhere under the head of "Ports and docks." Investigations of sites quickly led to the selection of the broad river lands as ideal for a depot of the magnitude planned. The land was practically flat, although, owing to its low elevation, it required a fill of from 18 inches to 2½ feet. A topographical survey was made, and the track laying was commenced by the 17th Engineers (railway) on December 1, 1917, under the command of Col. John Stephen Sewell.

In the early stages of construction the available forces were small and work proceeded slowly. By the end of January nearly 12 miles of track had been laid in the storage yards and one-half of the steel frame erected for a standard warehouse. The existing track facilities were not sufficient to carry the freight from the basins at St. Nazaire to the Montoir depot. A double-track connection, approximately 1½ miles in length, was therefore started between these two points, involving considerable grading and a double-track bridge over Brevet Creek. The bridge across this creek was completed and trains placed in operation over it on April 23. This was a pile bent bridge, with a central wooden truss, with a clear span of 33 feet. In the meantime the construction of warehouses had been rushed. In May the four ordnance warehouses were nearly completed and were partly filled with stores, and 27 other warehouses were ready for use except for the sand filling forming the floor. Concrete foundations for a dozen others were in place. Tracks were laid for an engine terminal and for the storage of coal. A single track was built to Donges, about 2 miles distant, where sand was obtained by dredging from the river bed into barges and pumping through a pipe line to a point where the sand was loaded into cars by cranes equipped with clamshell buckets.

The St. Nazaire connection was practically finished in June. By the 18th of that month 320,000 square feet of space was occupied by completed warehouses and an additional area of 880,000 square feet was roofed, but not floored. As a result of the increased Army program great quantities of supplies were being received at St. Nazaire and the Quartermaster Corps was placing all material unloaded into storage at Montoir. Construction barely kept ahead of the demand. In August the entire yard was 36 per cent complete. Camp Mon-


Bayou River
Water Crane
Water Tank
Water Tank
Water Crane

toir, including accommodations for 4,000 prisoners of war authorized only a month before, was practically finished. A water supply line was laid from St. Nazaire to serve the camp and engine facilities. During September a further big gain was made over the demand for space.

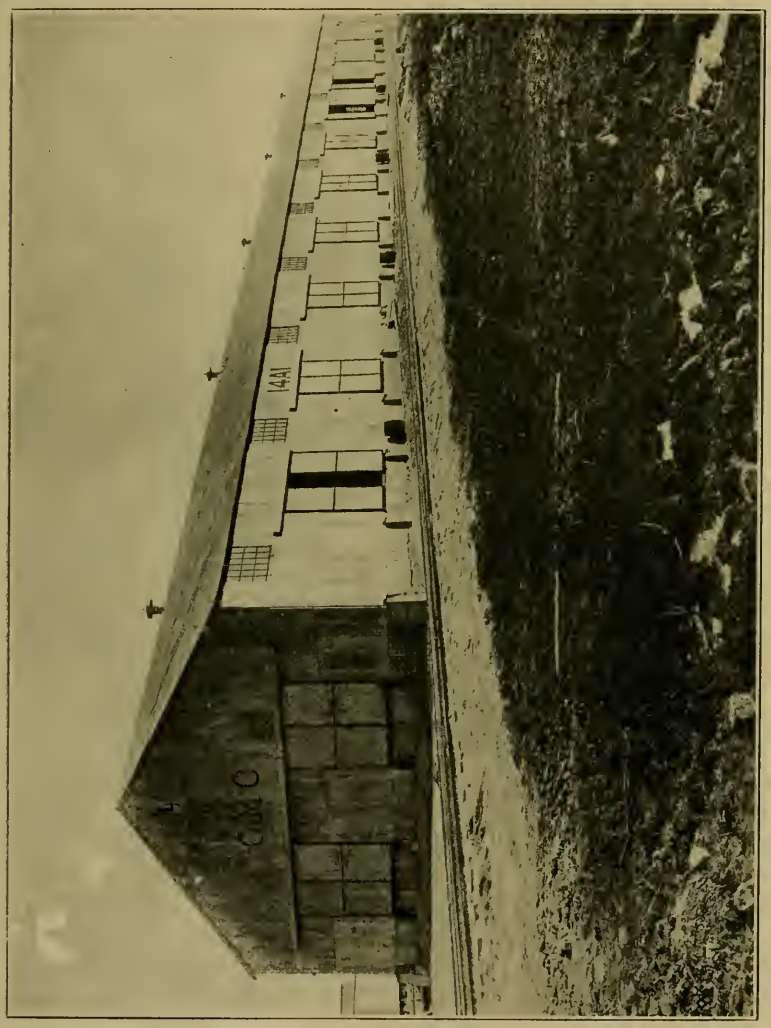
At the time of the armistice the construction forces were completing warehouses at the rate of two per day, and had erected the following structures:

	Square feet.
Complete:	
58 steel warehouses, 50 by 400 feet	1,160,000
12 wood warehouses, 50 by 504 feet	302,400
3 steel warehouses, 240 by 500 feet	360,000
1 steel warehouse, 240 by 484 feet	115,160
Complete except for flooring:	
9 steel warehouses, 50 by 400 feet	180,000
1 steel warehouse, 50 by 786 feet	39,300
54 wood warehouses, 50 by 504 feet	1,360,800
Total	3,517,660

Thus, by these structures 1,937,560 square feet of space was provided ready for use and the balance, 1,580,100 square feet, was being completed by the addition of floors as fast as required by the various services. The first warehouse built had a wooden floor, but lack of lumber caused delay, so floors were afterwards formed by unloading earth or sand within the warehouses and distributing it with wheel scrapers until the floor level was reached, necessitating an average fill of about 3 feet. Due to the great carrying capacity of this type of floor the amount of tonnage stored in the completed warehouses was greater than that which the entire six sections were designed to accommodate. Sections 1 and 2 were composed almost entirely of steel warehouses. When sections 3 and 4 were constructed the availability of timber for framing and corrugated iron for siding and roofing caused this form of construction to be substituted.

The extent and arrangement of the yards are shown on the accompanying general plan of the Montoir project. At the time work was stopped 125.8 miles of permanent track and 9.2 miles of temporary track had been laid, necessitating the placing of 602 permanent switches and 55 temporary switches. Wilgus Yard, located at the west of the project and used for the storage of Engineer supplies and for transferring and reloading, contained about 6 miles of track built of French rail. Elsewhere American 80-pound rail was used. Ties were bought from Portugal or produced in France by the Engineer forestry units. Sand ballast was used throughout the yards and proved very satisfactory. The entire layout was designed to secure a continuous movement of cars throughout.

Incoming empty cars were received over the Paris-Orleans Railway in the small westbound receiving yard to the south of the storage yards. The cars were pushed over a hump and classified in two yards. To one, the westbound departure yard, were shunted those cars destined for the Montoir docks and for the basins at St. Nazaire; to the other were sent the cars to be taken to the storage yards for loading.



(3599-F9) TYPE OF STEEL FRAME WAREHOUSE, WITH CORRUGATED IRON ROOFING AND SIDING, EMPLOYED AT MONTOIR YARDS.

Loaded cars coming from the docks and from St. Nazaire were placed in the eastbound receiving yard, which consisted of nine tracks, averaging 2,000 feet in length. At the extremity of this yard was a hump, which permitted cars to be distributed either to the large classification yard, composed of 20 tracks of 1,600 feet average length connecting with the storage tracks, or to the eastbound departure yard,

composed of 10 tracks, 2,800 feet long, which connected with the tracks of the Paris-Orleans Railway at a point about three-fourths mile beyond. At the east end of the storage was another small make-up and departure yard.

The engine facilities consisted of an engine house 100 feet by 201 feet, with six concrete pits, each with a capacity of three large locomotives, and housing a well-equipped machine and blacksmith shop capable of making all except the heaviest locomotive repairs; a modern power plant was installed, furnishing current for shop operation and the lighting of all buildings in the immediate vicinity. Car-repair yards were located just to the north of the engine house. There were also three water tanks, with a total of 115,000 gallons capacity; oil house; eight engine pits; and coal-storage yard with coal-handling cranes equipped with clamshell buckets.

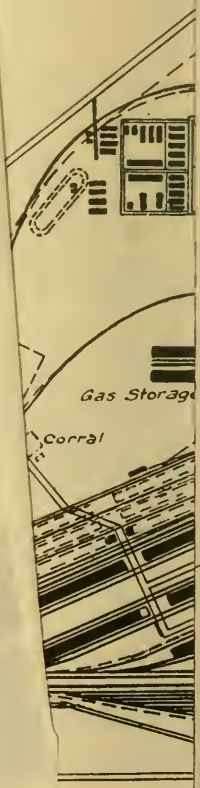
Apart from the storage and yard facilities, the Montoir project contained a sawmill and degreasing plant. The sawmill, completed at about the time of the armistice, was erected to remanufacture lumber received from Norway. It was equipped with three band saws, capable of sawing 50,000 feet per day, one ripsaw, of 12,000 feet daily capacity, and a planer, of 15,000 feet daily capacity. The degreasing plant, built for the Quartermaster Corps, was completed and placed in operation in February, 1919.

The facilities at Montoir would have been largely increased had hostilities continued. The entire project called for 180 warehouses, with 4,215,000 square feet of covered storage and 9,812,400 square feet of open storage space in the six sections. Three additional ordnance warehouses were projected, which, with other additions, increased the total projected to approximately 5,500,000 square feet of covered storage and 11,000,000 square feet of open storage space. The yard facilities contemplated 269.7 miles of track and 1,067 switches. Five more 50,000-gallon water tanks were to have been erected at the engine terminal.

The work was in charge, successively, of three section engineers, Col. J. S. Sewell, Lieut. Col. W. G. Atwood, and Lieut. Col. F. B. Maltby. Throughout the period of construction the 17th Engineers were assisted by various organizations, civilians, and prisoners of war assigned to the job from time to time. At all times the work was seriously handicapped by lack of skilled labor and a permanent personnel, as the exigencies of war constantly demanded removal of regiments to the advance areas.

ST. SULPICE DEPOT.

The base depot at St. Sulpice, 15 miles northeast of Bordeaux and 8 miles from Bassens, with which it is connected by double tracks of the main line of the Paris-Orleans Railway and an American-built


Gas Storage
Corral

third track, was created to store shipments received at Bordeaux and Bassens. It was designed to accommodate supplies for 1,000,000 men for 30 days. On a trapezoidal tract of land, approximately 3⅓ miles long and three-fourths mile wide, paralleling the tracks, the plans contemplated the erection of 144 warehouses 50 by 350 to 500 feet in size, aggregating 3,263,323 square feet of covered storage, with 7,200,000 square feet of open storage, and 152 miles of track.

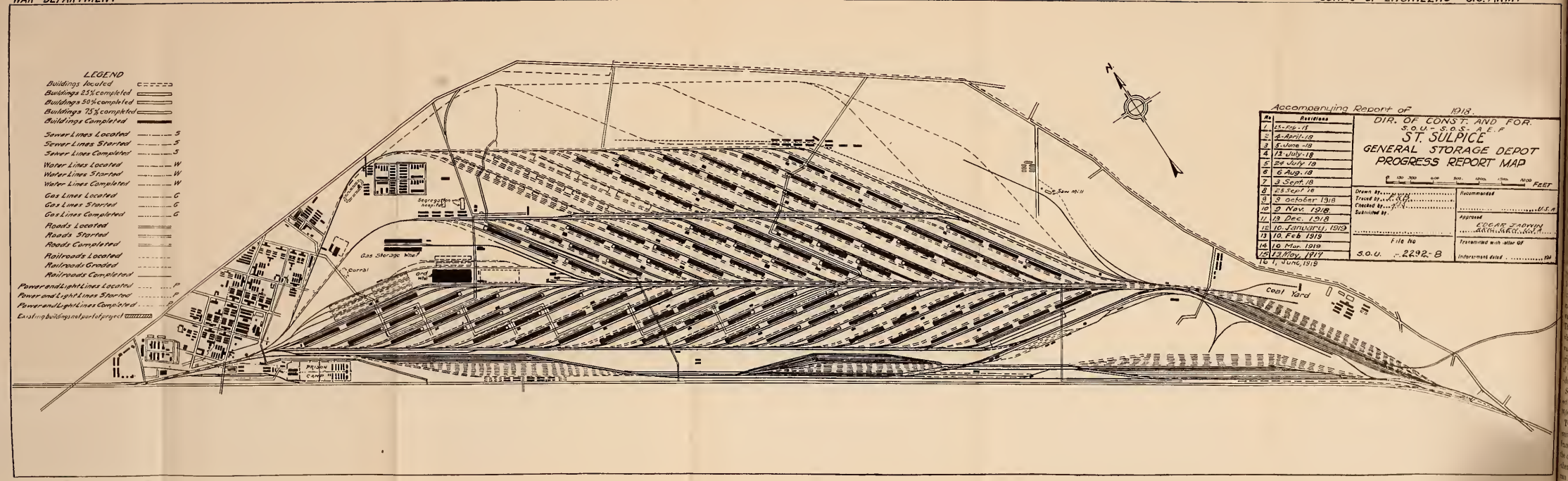
The completed facilities consisted of 110 warehouses, whose combined area was 2,637,350 square feet, 5,700,000 square feet of open storage; 92.6 miles of track, with 363 switches; barracks and mess halls for several thousand soldiers and prisoners of war; a camp hospital with a capacity of 400 beds; and numerous other structures, making a grand total of 630 buildings with a roofed area of 3,222,669 square feet. In the erection of these 630 buildings more than 18,000,000 feet b. m. of lumber were used.

The site at St. Sulpice was almost ideal for such a project, requiring comparatively little grading and possessing in general a sandy top soil that absorbed a good deal of water before becoming muddy and soft. On the site were a few buildings and two small settlements, Colas and Ferreyre. Some of these buildings were torn down and others were used for billeting troops and for offices and officers' quarters.

The project was divided into four sections, to be built as required; the need for the fourth section, however, never developed. The general plan consisted of three grids, as the sections were termed, side by side, each 800 feet wide. Section 1, the largest, was over 2 miles long. Each section was bounded by lead and running tracks and crossed by other tracks, along which the warehouses were built in rows of three each. The appearance of the layout of each section was that of a gridiron distorted into the form of a parallelogram. The warehouse rows were separated by a clear distance of 100 feet, which provided fire stops and the required open storage. This space was served by the same tracks as the adjacent warehouses. The original plan contemplated double tracks on either side of each row of warehouses, but in no case were these built, double tracks on one side, and in some cases single tracks, being sufficient.

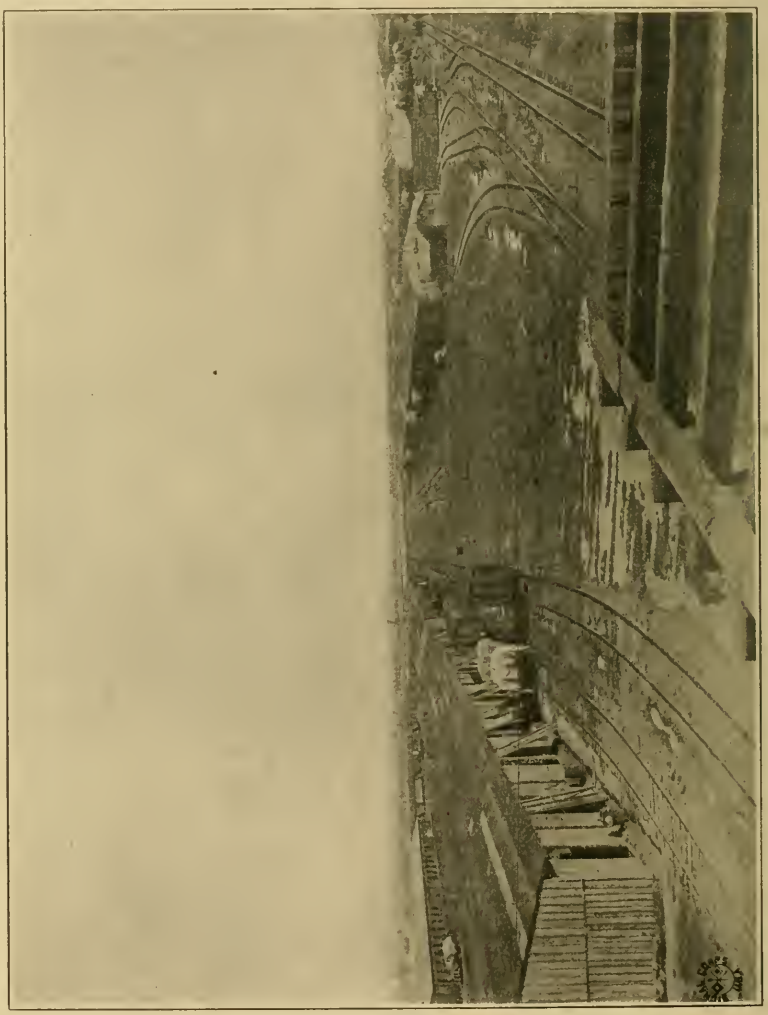
Section 1 contained 51 warehouses; section 2, 36 warehouses; and section 3, 18 warehouses. Coal-storage tracks for approximately 30,000 tons of coal were put in.

Two principal types of warehouse were employed—those of wood construction throughout, with tar-paper roof, and others with wood frame with sides and roof of corrugated iron. Floors were built if the character of the material to be stored therein demanded them; otherwise dirt floors were provided. A force consisting of 570 German prisoners with 30 American soldiers as foremen was so organ-


LEGEND
Buildings located
Buildings 25% completed
Buildings 50% completed
Buildings 75% completed
Buildings Completed
Sewer Lines Located S
Sewer Lines Started S
Sewer Lines Completed S
Water Lines Located W
Water Lines Started W
Water Lines Completed W
Gas Lines Located G
Gas Lines Started G
Gas Lines Completed G
Roads Located
Roads Started
Roads Completed
Railroads Located
Railroads Graded
Railroads Completed
Power and Light Lines Located P
Power and Light Lines Started P
Power and Light Lines Completed P
Existing buildings not part of project
Segregation hospital
Gas Storage Wher
Corral
Grd Whe
Saw Mill
Coal Yard
PRISON CAMP
N
Accompanying Report of 1918.
No. Revisions
1 25-Feb-18
2 4-April-18
3 5-June-18
4 12-July-18
5 24 July 18
6 6 Aug. 18
7 3 Sept. 18
8 25 Sept 18
9 9 October 1918
10 9 Nov. 1918
11 13 Dec. 1918
12 10. January, 1919
13 10. Feb 1919
14 10 Mar. 1919
15 13 May, 1919
16 1, June, 1919
DIR. OF CONST. AND FOR.
S.O.U. - S.O.S. - A.E.F.
ST. SULPICE
GENERAL STORAGE DEPOT
PROGRESS REPORT MAP
0 150 300 600 900 1200 1500 1800 FEET
Drawn by
Traced by
Checked by
Submitted by
File No
S.O.U. - 2292 - 8
Recommended
U.S.A.
Approved
EDGAR JADWIN
Transmitted with letter OF
Indorsement dated

ized that warehouses of the standard 50 feet width were erected at the rate of 732 linear feet per day.

The principal yard facilities, based on the use of standard American 40-foot cars, consisted of an eastbound receiving yard with 5 tracks of 50 cars capacity, a hump-combined eastbound and west-



(3565-F9) TRACK LAYOUT AND TYPE OF WOODEN WAREHOUSE BUILT AT ST. SULPICE DEPOT.

bound classification yards with a total of 13 tracks of 40 cars capacity for both movements, a westbound receiving yard, and an eastbound departure yard, each with 10 tracks of 60 cars capacity, and a single track, constituting the westbound departure yard, with capacity for 55 cars. The facilities named extended in succession from west to east between section 1 and the Paris-Orleans tracks,

with the exception of the two last-named yards, which were placed at the east and west ends of section 1, respectively.

The track facilities were so laid out that they could be increased to maximum without the necessity of tearing out or remodeling work already done.

Trains between Bassens and St. Sulpice, operating on the American track, ran on a regular schedule, and as many as 25 locomotives were used in handling the traffic at times. Engine facilities were therefore required at St. Sulpice, although extensive construction of this character was not necessary because of a similar installation at Bassens. There were constructed a machine shop, with 3,000 square feet of space; an engine and boiler house, 2,800 square feet in area; car repair shop; two 50,000-gallon water tanks; tool house, oil house; R. T. O. offices; coaling platform; inspection and ash pits.

The housing needs at St. Sulpice were diverse. Barracks and mess halls for several units and a well-equipped camp hospital were constructed. The tabulation below indicates the character and extent of these provisions:

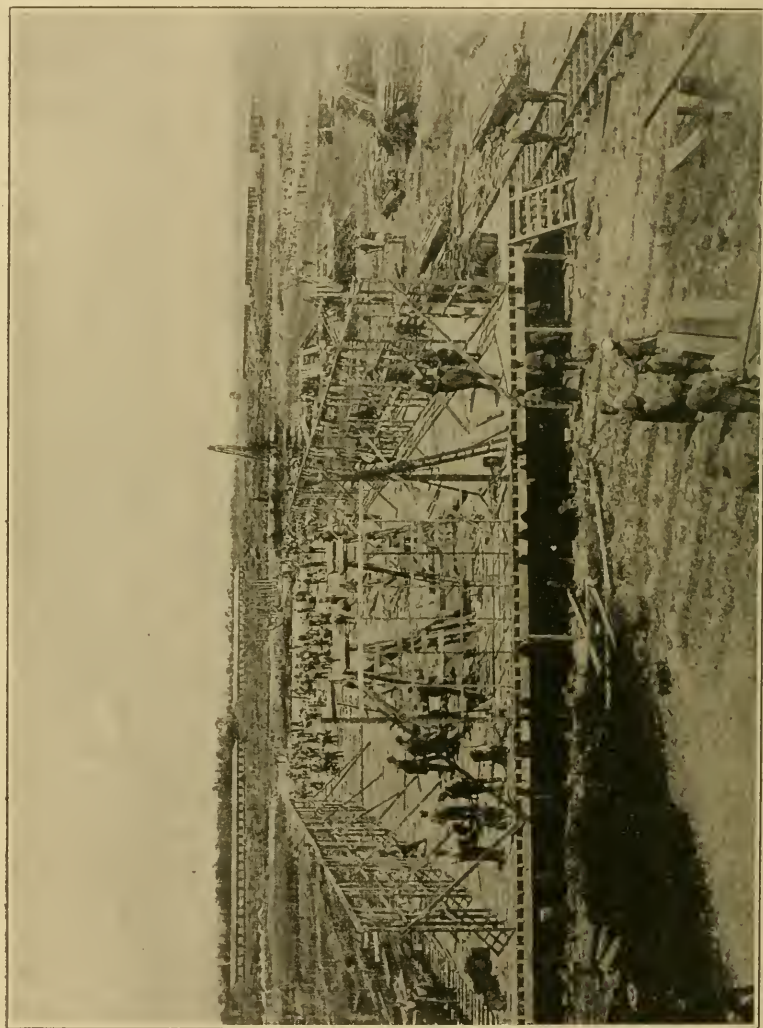
	Square feet.
Camp for construction and operating personnel, 195 barracks and mess halls	319,788
Prisoner-of-war camp for 6 companies of prisoners and 4 escort companies	118,778
American military prison camp No. 1	22,441
Camp hospital, 400 beds	50,713.
	532,686

Owing to the level character of the land and the network of tracks drainage was difficult. The difference in elevation between the highest and lowest points of the project was but 14 feet, and the average level of the warehouse district was 4 feet above the lowest point. Following closely the natural drainage lines, a main drainage canal 85 square feet in cross section and 6,020 feet long was dug which carried the bulk of the run-off. Tributary to this canal were small ditches which drained all parts of the warehouse district and the camp. Independent ditches carried off water from areas which it was not possible to drain to the main canal. The aggregate length of these secondary ditches was over 60 miles. Over one-half of the secondary system made use of old ditches which were cleaned and enlarged. The remainder represented new construction.

Two principal wells were drilled, one having a depth of 810 feet and the other a depth of 310 feet.

For the disposal of garbage and excreta from the camp a small dock was built on the Dordogne River, a distance of about 1½ miles from the camp.

The project was designed to be served mainly by rail, but it became necessary to construct roads to an extent not originally contemplated. The area was surrounded by good roads and several crossed it. A total of 3.55 miles of existing roads were widened, repaired, and improved and 3.89 miles were newly constructed. With few exceptions, gravel was used as the road metal. A turning space, 3,020 square feet in area, and a road, 12 feet wide and 255 feet long, both of concrete, were constructed at the garbage dock. A motor reception park, containing 9,000 square feet of space, with car wash stand and other accessories, was completed. In connection with the construction of roads, 101 grade crossings and 8 bridges, one of which



(669-U8) WOODEN WAREHOUSE CONSTRUCTION AT ST. SULPICE DEPOT.

was a masonry arch, were built. The roads serving the project were built under traffic and rolled with simple concrete rollers made on the job.

Engineer troops, Negro service battalions, Infantry, Indo-Chinese, civilians, and prisoners of war were represented in the labor employed, which, for a period in October, 1918, at the time of greatest activity, numbered more than 5,000 men. Engineer troops were used generally for supervision and for skilled labor, such as steam shovel operation and pile driving. Track gangs were also formed from Engineer personnel and labor battalions, due to their previous experience. Line troops were found to do very good work under experienced direction. Negro service troops were used on practically all types of construction and were valuable.

Indo-Chinese on simple tasks were fairly satisfactory. They were not fitted for heavy work, but their cost to the United States was no greater in proportion to the work done than line troops. German prisoners of war, when properly organized and placed on work where they were not too crowded, turned out as much, if not more, work than the ordinary soldier. On buildings they were found to be excellent when employed under their own noncommissioned officers. The employment of civilians, who were used largely on contract construction, was not a success. The working of civilian laborers and soldiers together engendered bad feeling.

When the final inventory was taken it was found that to complete the project as originally designed—warehouses, tracks, camps, roads, everything, in fact, necessary to provide storage for a 30-day supply for 1,000,000 men—required roughly 1,000,000 man-days of labor. Twenty complete steel warehouses required about one man-day for 6½ square feet, whereas warehouses 50 by 500 feet, with dirt floors, wooden frame, corrugated iron sides and roof, required for erection one man-day for about 30 square feet.

Experience proved that an ideal force to construct a project of like magnitude under similar conditions would be three Engineer companies, 12 Negro labor companies, and a grading outfit of about 100 teams, supplemented by the necessary Infantry for guard duty. Prisoners of war might be substituted for labor troops in part, but not entirely, since they are not so mobile, due to the necessity of guarding them. With such a force the work could have been done faster than it actually was, at the same time using fewer troops.

The first plan for the project was dater October 1, 1917. The layout was substantially changed, however, by a plan issued December 12, 1917. Construction was started soon thereafter by details from Company B, 18th Engineers (railway), under Capt. B. J. Simmons, who remained as engineer in charge of construction, under Col. J. B. Cavanaugh, section engineer, base section No. 2, until

June 16, 1918. The usual difficulties incident to the shortage of materials and labor were encountered and work proceeded slowly until March, 1918.

On March 8 the director of construction and forestry directed that the buildings at St. Sulpice be completed with the least possible delay, regardless of other work. At that time, while considerable yard and camp construction had been done, no warehouses were erected. Assignment of Infantry troops to the job was made by the commanding general, base section No. 2, increasing the labor to 800 men. On April 1, three weeks later, 8 warehouses, whose aggregate length exceeded 1 mile, were complete except for doors and battens, 14 were roofed and usable, and 18 in all were under construction. Lumber was being used at the rate of 135,000 feet b. m. a day. At no time were any of the essential operations of the war held up by the lack of facilities at St. Sulpice.

The 18th Engineers were relieved by the 32d Engineers on July 15, 1918. Maj. C. C. Fitzgerald, of the latter regiment, became officer in charge of construction on August 24 and pushed the project through to completion.

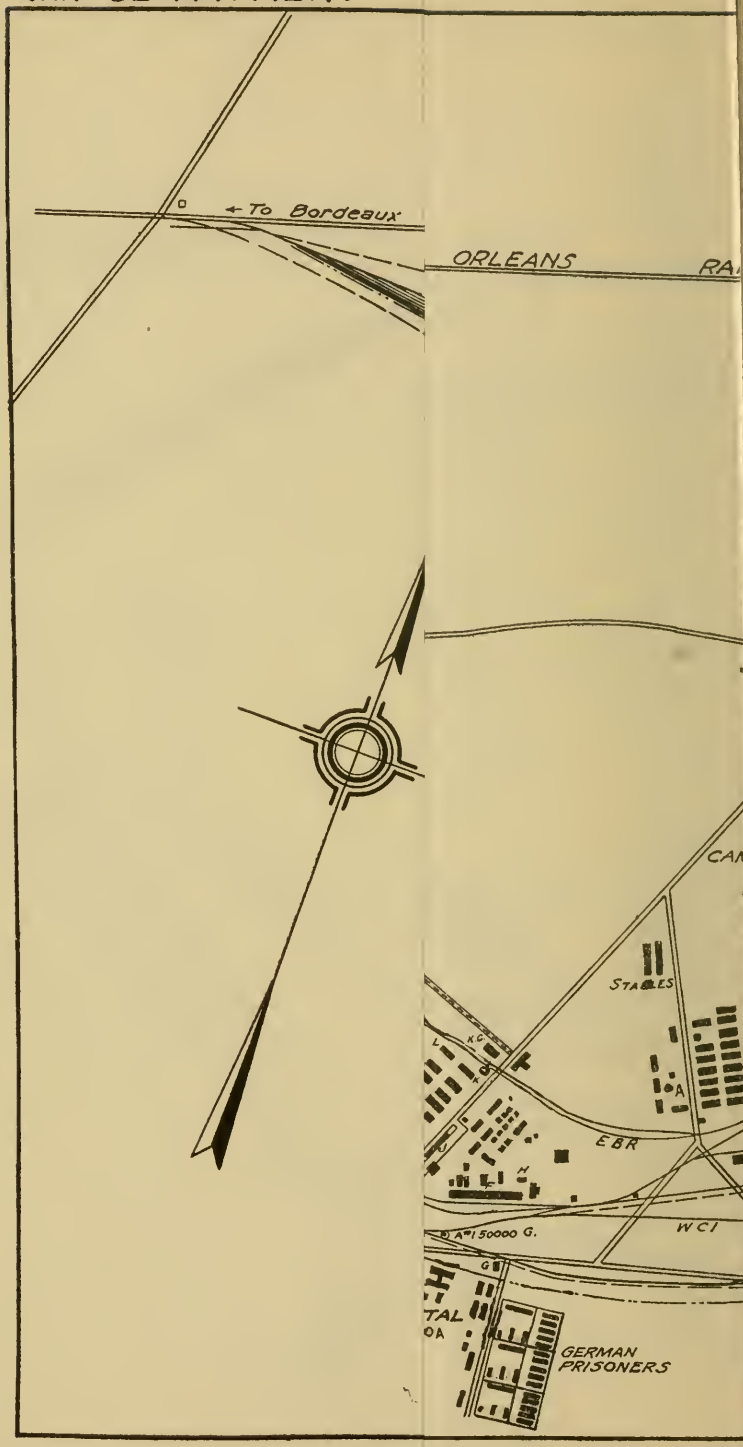
MONTIERCHAUME DEPOT.

Montierchaume was selected in September, 1917, as a site for the erection of a depot to provide space for a part of the 30 days' reserve to be held in the intermediate section and to which supplies landed at Bassens and St. Nazaire and Marseille could conveniently be evacuated, since it was apparent that the ground available at Gievres would not permit of the extension of facilities to the degree required. Located near the end of the division run from Bassens to Issoudun, it also afforded an excellent location for an engine terminal and car repair facilities. Authorization to commence construction was given on April 15, 1918. Five months later, on September 26, construction had progressed so that the depot was ready to receive incoming shipments, and the chief quartermaster began operations.

Originally designed to store 30 days' supplies for 1,000,000 men and to provide extensive track and engine facilities, the storage depot project at this point in the intermediate section (west) was 30 per cent complete and had begun operating when hostilities ceased.

The project extended for about 5 miles along the double-tracked main line of the Paris-Orleans Railway from Bordeaux to Bourges. Trains from the ports entered by the eastbound receiving yard. Beyond the receiving yard were the eastbound classification and departure yards. These terminated at an acute angle of an elongated parallelogram of tracks nearly 1½ miles on a side which inclosed the

WAR DEPARTMENT



storage area. Down either side of the parallelogram and thence by lateral tracks the cars passed to the warehouses and open storage areas. The plans provided for four sections, each with 14 rows of three warehouses each. As constructed, however, no section was complete, but each possessed a number of rows of from one to three warehouses each. The apex of the tracks forming the opposite acute angle of the parallelogram in the village of Neuvy-Pailloux, where the trains, eastward-bound with supplies for the front, emerged from the depot upon the main line.

The construction authorized included 216 miles of track, 4,000,000 square feet of covered storage, and 200 acres of open storage space. There were constructed 49½ miles of track and 55 standard warehouses, providing 1,214,000 square feet of covered storage. Scattered over the area were eight camps, including one inclosure for 450 prisoners of war, aggregating 500,000 square feet of barracks.

Engine house, oil house, inspection pits, ash pits, and the necessary tracks were built for the engine terminal. Pumps and approximately 5 miles of pipe were installed for delivering water from the River Indre to the engines. About 1 mile of track was laid and the adjacent ground graded to provide storage for 50,000 tons of coal.

Work had also been started on the construction of gasoline storage tanks for the Motor Transport Corps. One large building, 90 by 270 feet, nine barracks and one small building were erected for the Gas Service gas-mask repair factory. Two and one-half miles of track had been laid and 30,244 square feet of barracks built at Neuvy-Pailloux at the site of the projected Anglo-American Tank Division factory.

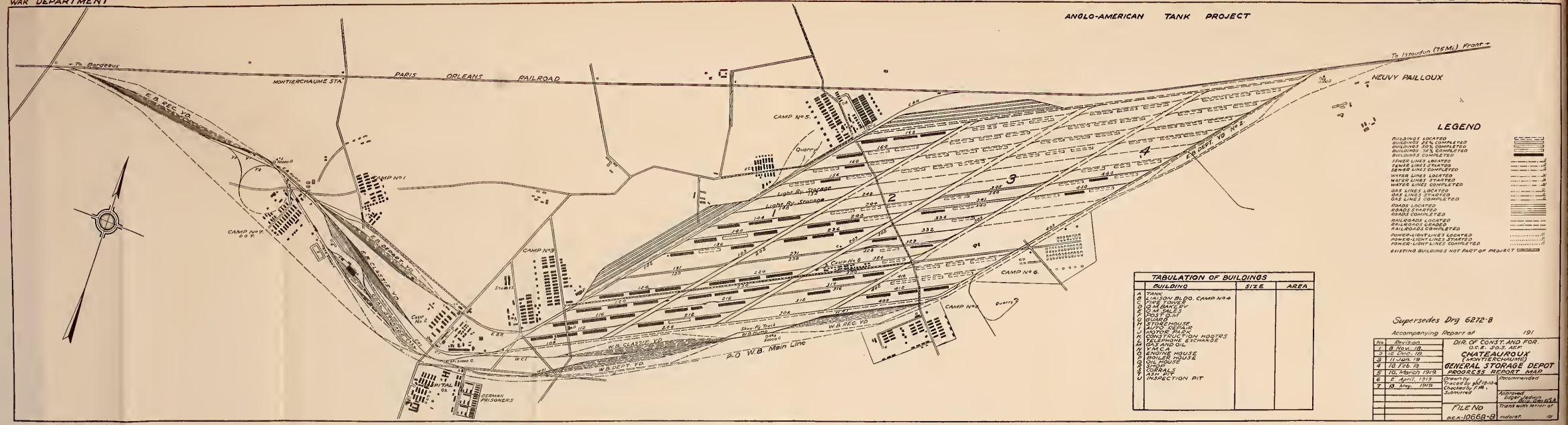
The depot was effectively utilized after the armistice for receiving and classifying great quantities of surplus supplies and salvage from the construction projects and from the zone of the armies. This necessitated the construction of a considerable mileage of track after the armistice.

The project was constructed under the direction of Col. Ernest Graves and Col. S. B. Williamson, who, in turn, occupied the post of section engineer, intermediate section (west) and was in immediate charge of Maj. George E. A. Fairley, of the 511th Engineers, from April 5 to June 5. Lieut. Col. Frederick B. Kerr, 23d Engineers, was in charge from June 5 to October 18, and Maj. Fairley again from October 18 until construction was terminated.

Various Engineer regiments, Italian laborers, and German prisoners were employed on the work from time to time. Of the regiments, the 511th, 23d, 25th, and 11th Engineers deserve mention for their share in the accomplishment, especially the first named, which served throughout the construction period.

WAR DEPARTMENT

CORPS OF ENGINEERS U.S. ARMY



TABULATION OF BUILDINGS

	BUILDING	SIZE	AREA
A	TANK		
B	LIAISON BLDG. CAMP No 4		
C	FIRE TOWER		
D	O.M. BAKERY		
E	O.M. SALES		
F	POST O.M.		
G	GUARD		
H	STOREHOUSE		
I	AUTO REPAIR		
J	MOTOR PARK		
K	CONSTRUCTION HOOTRS		
L	TELEPHONE EXCHANGE		
M	GAS AND OIL		
N	Y.M.C.A.		
O	ENGINE HOUSE		
P	BOILER HOUSE		
Q	OIL HOUSE		
R	SHOP		
S	CORRALS		
T	ASH PIT		
U	INSPECTION PIT		

127071—19. (To face page 313.)

LIFFOL-LE-GRAND REGULATING STATION.

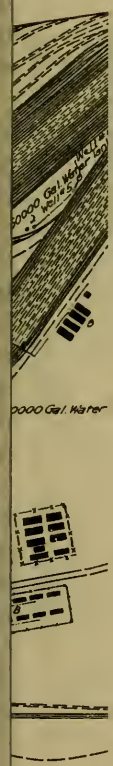
Liffol-le-Grand in the Department of Vosges, in the advance section, Service of Supply, was 30 miles from the American front. Here to supplement the facilities at Is-sur-Tille, was constructed a regulating station with 45 miles of track, a storage depot with 18 standard warehouses, engine terminal, bakery buildings, and accommodations for the shelter of 4,000 men, thus placing it among the more important of the supply distribution centers created for the American Expeditionary Forces.

The construction at Liffol-le-Grand was approved by the commander in chief on December 10, 1917, but the necessity of securing the consent of the French to various features of the layout and other reasons, delayed the beginning of construction until April 16, 1918, when a detachment of the 15th Engineers (railway) under charge of Lieut. Col. C. W. Sturtevant began work. The plans adopted in conformity with the wishes of the French placed the yard on waste land, much of which was swampy, thus complicating construction. Shortage of cars and equipment also imposed restrictions. Under these difficulties, work proceeded until the middle of June.

On June 17 the head of the French mission at general headquarters advised that since the beginning of the enemy offensive French regulating stations near the front had been bombed from the air and that it had been necessary to transfer supplies further to the rear. He questioned, therefore, the advisability of building storehouses or making important installations at Liffol-le-Grand. Accordingly, on June 20, it was decided that no warehouses were to be constructed at that time and track work was to be reduced to a minimum.

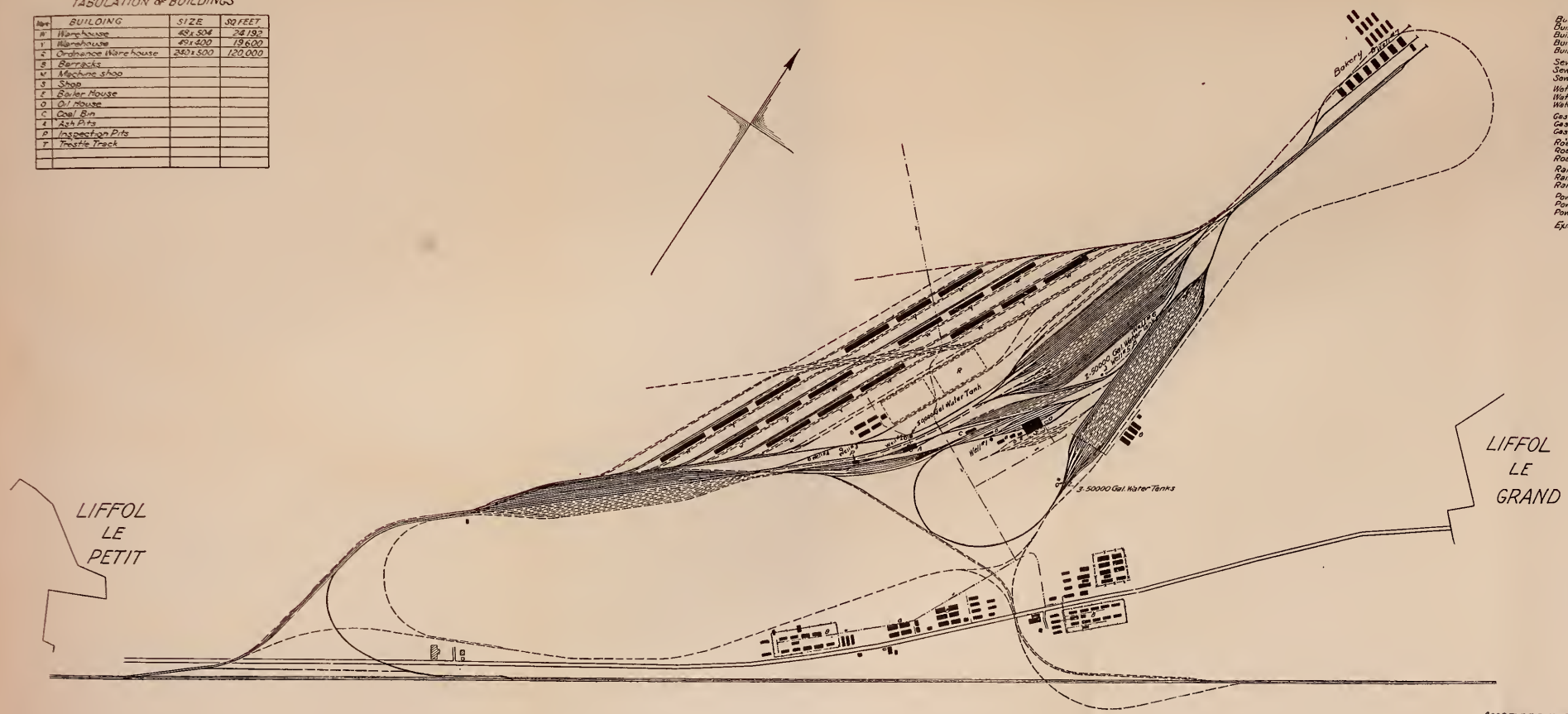
By August 10 the danger which had caused the reduction of the construction was considerably lessened and work on the original project was resumed. Offensive operations by the American Army were impending and the facilities at Liffol-le-Grand were urgently needed. Instructions were received that the work "be given special attention and everything possible be done to make this project ready to function." As a result, on October 12 the yards, with accommodations for 1,800 cars, were opened for service. During October many of the main features were practically completed and the station gave valuable assistance to the major operations in which the Army engaged.

Fifty-seven miles of track were authorized in the yards, engine terminal, and storage depot. The 45 miles laid, therefore, represented 79 per cent completion. The facilities for the regulating station proper consisted of receiving, classification, and departure yards with a total of 26 miles of track. The project was situated adjacent to the double track Neufchateau-Chaumont line of Est Railway, con-


0000 Gal. Water

TABULATION of BUILDINGS

Ref.	BUILDING	SIZE	SQ FEET
W	Warehouse	48 x 504	24,192
Y	Warehouse	49 x 400	19,600
Z	Ordnance Warehouse	240 x 500	120,000
B	Barracks		
M	Machine shop		
S	Shop		
E	Boiler House		
O	Oil House		
C	Coal Bin		
A	Ash Pits		
P	Inspection Pits		
T	Trestle Track		



LEGEND

Buildings located
Buildings 25% completed
Buildings 50% completed
Buildings 75% completed
Buildings completed

Sewer lines located — S
Sewer lines started — S
Sewer lines completed — S

Water lines located — W
Water lines started — W
Water lines completed — W

Gas lines located — G
Gas lines started — G
Gas lines completed — G

Roads located
Roads started
Roads completed

Railroads located
Railroads graded
Railroads completed

Power and light lines located — P
Power and light lines started — P
Power and light lines completed — P

Existing buildings not part of project

Accompanying Report of 1918

No.	Revision
1	9th July, 1918
2	5 Aug 1918
3	4 Sept 1918
4	24 Sept. 1918
5	8 Oct. 1918.
6	4 Nov. 1918
7	13 Dec 1918
8	10 Feb. 1919

DIR OF CONST. AND FOR
S.O.U. - S.O.S. - A.E.F.
LIFFOL LE GRAND
REGULATING STATION
PROGRESS REPORT MAP

Drawn by
Traced by N.C.M. 5-13-18
Checked by [illegible] 5-13-18
Submitted

Recommended
USR

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

File No. S.O.U. 5722-8

Transmitted with letter of Indorsement 191

nection with which was effected by a double track lead at the south end of the yard. A small amount of track construction was done after the armistice to facilitate the dispatch of supplies to the Army of Occupation and to the troops in the forward areas.

The project embraced 208 buildings, whose area was 525,000 square feet. The bulk of this space was in 18 warehouses, 48 by 400 and 500 feet, with an area of 407,904 square feet, comprising the storage depot. All the warehouses authorized were erected. About 12 miles of tracks were laid in the depot, serving all the warehouses and 584,000 square feet of open storage space. Sixty-five barracks, 25 by 100 feet, were erected to house the construction and operation personnel. The bakery called for 8 buildings, 75 by 125 feet, for field bakeries with an output of 275,000 pounds of bread daily, 15 barracks for the personnel, and 5,000 feet of track. All these facilities were completed.

Necessarily the engine facilities at Liffol-le-Grand were large. A building, 75 by 300 feet, capable of accommodating 12 locomotives and a well-equipped machine shop, was constructed. All machines were driven by individual electric motors from power furnished by two 50-kilowatt direct-current 220-volt generators, direct connected to steam engines. Current was supplied from the same source for lighting purposes. Two 50,000-gallon water tanks were erected, which largely supplied the engine terminal. Into these tanks water was pumped from six wells, varying in depth from 230 feet to 758 feet. The yard had 6 tracks for engine storage, 2 ash pits, and 2 inspection pits. Approximately 7 miles of track were laid for all purposes within the terminal.

Lieut. Col. C. W. Sturtevant was in charge of construction on March 21, 1918, and remained until November 17, 1918. In addition to companies D and E and Headquarters Detachment, 15th Engineers (railway), various labor battalions, numbers of French, Portugese, and Chinese laborers and prisoners of war were employed for varying periods in the construction of the depot. Maj. George Taylor relieved Col. Sturtevant and was in charge until January 20, 1919, when he was succeeded by Capt. Starr Thayer.

MIRAMAS DEPOT.

The depot at Miramas, near Marseille, in base section No. 6, involved no warehouse construction, since it was possible to lease from the French 401,948 square feet of covered storage space, which proved sufficient for the needs of the American Expeditionary Forces at that point. Some incidental construction was necessary, however, to enable this depot to function. Approximately 5.8 miles of track was laid in the form of yards, involving the construction of

four bridges. For the operating personnel 15 barracks were erected and a prisoner-of-war inclosure completed.

ST. LUCE DEPOT.

At St. Luce, on the outskirts of Nantes, in base section No. 1, a small depot to store supplies received at the port of Nantes was constructed under the direction of the section engineer. The authorized construction involved 102,935 feet of track, 89 switches, 265,000 cubic yards of grading, engine facilities, 12 warehouses with a floored area of 244,000 square feet, a camp of 17 barracks, and 1 prisoner-of-war inclosure for 450 men.

Grading was commenced by a French contractor in December, 1917. In April, 1918, American troops were assigned to the job and work progressed more rapidly. When construction was stopped by the cessation of hostilities 45,925 feet of track had been laid, 57 switches installed, 11 warehouses giving 199,200 square feet of covered storage space erected, and the camp and prisoner-of-war inclosure completed.

AIGREFEUILLE DEPOT.

The project at Aigrefeuille, in base section No. 7, was authorized for the purpose of creating a storage and railroad yard at a convenient point where all classes of material received at the ports of La Pallice, La Rochelle, and Rochefort could be stored or prepared for shipment to the front. In addition to the storage provisions, included in the construction program were an engine terminal capable of repair and storage as well as the usual roundhouse work, camp, and prisoner-of-war inclosure.

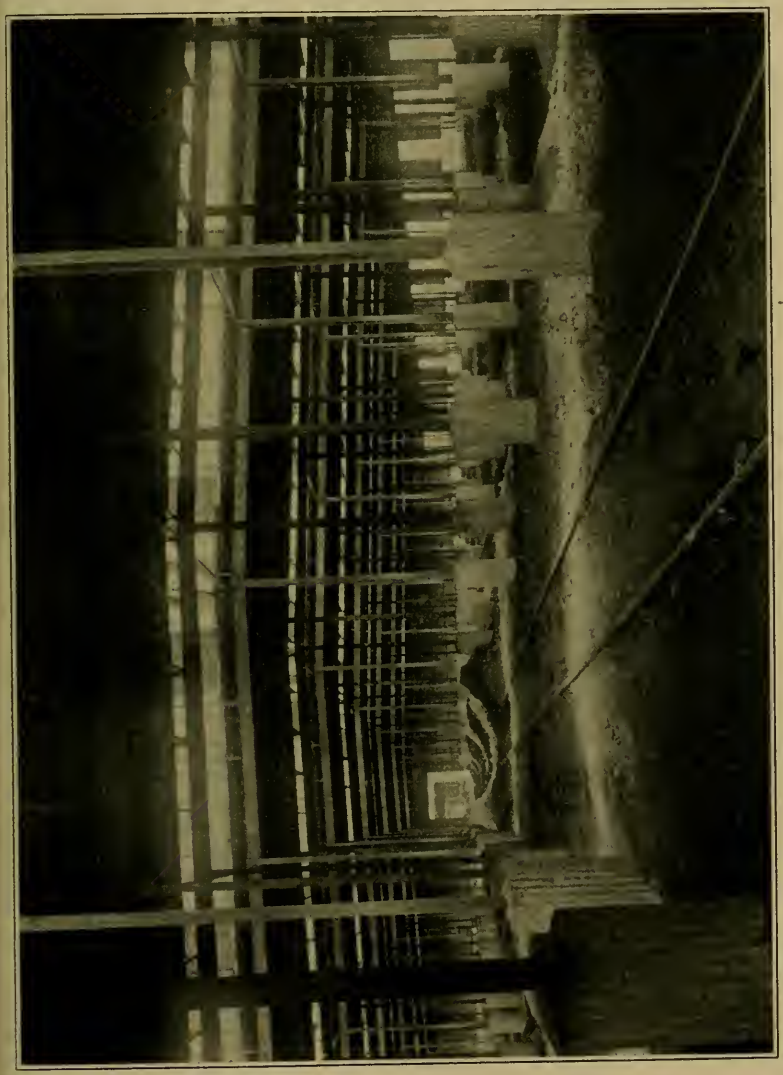
When construction ceased 3 large warehouses and 1 small one were completed, giving 80,000 square feet of space. Camp facilities, including a camp hospital, for 2,000 men were provided. Seven miles of track was laid. It is of interest to note that of 112 buildings, large and small, in the project 104 were constructed mainly from salvaged lumber obtained from packing boxes and crates at the car erecting plant at La Rochelle.

ORDNANCE DEPOT AND SHOPS AT MEHUN.

Two projects were constructed by the Engineers at Mehun-sur-Yevre. Between Mehun and Foecy was located intermediate ordnance ammunition depot No. 4, while south of the city were the ordnance machine shops.

The ammunition depot consisted of 8 warehouses, 7 of wood and 1 of steel, each 50 by 1,008 feet, with corrugated iron and sides, and the facilities necessary for their operation, including 13 fuse houses, 38 barracks, a guardhouse, blacksmith shop, carpenter shop, garage,

13 bathhouses, stable hospital barrack, and an ample water-supply system. The total covered storage amounted to 409,823 square feet, and to serve the warehouses 54,530 feet of track were laid. This project was completed and in operation for some time before the armistice.



(843-J8) STEEL FRAME ORDNANCE BUILDING AT MEHUN.

The ordnance machine shops were all of steel. Owing to scarcity of materials in France not only the structural steel, amounting to 50,000 tons, but the cranes, power equipment, lighting fixtures, and window glass were shipped from America, and this necessitated an accurate and minute estimate of the supplies needed.

Designs for the steel-frame buildings, some of them 500 or 600 feet long and about 250 feet wide, were prepared by the firm of Stone

& Webster, and such a degree of standardization was effected that only 148 different pieces, inclusive of the smallest parts, were required. Throughout the project all the columns were of one length, the roof slope of the warehouses being obtained by varying the height of the concrete footings and that of the shops by setting at the proper elevations light extensions of the main columns. Construction was so simplified that it afforded no serious difficulties to the unskilled troops who did the work.

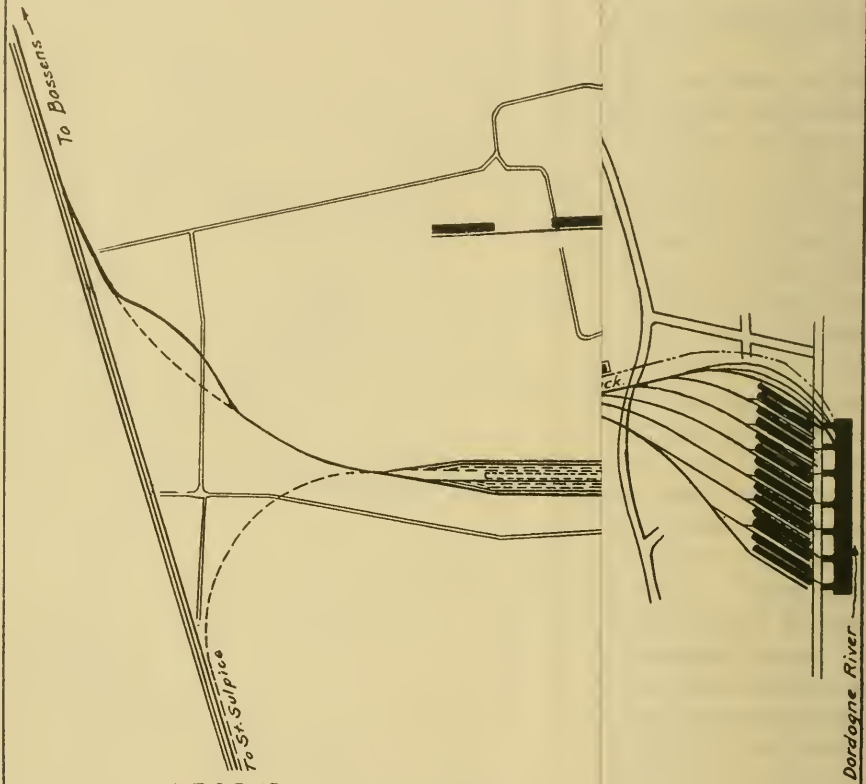
In January, 1918, the 501st Engineers, under command of Maj. Woolsey Finnell, was assigned to the work and began preliminary operations, such as surveys and grading. Thereafter, in spite of difficulties due to absence of switch engines, to lack of cranes and other equipment, and to unfavorable weather, as well as to actual shortage of building materials, the work was pressed vigorously, so that when the cessation of hostilities intervened, more than a million square feet of floor space had been covered. The buildings which had been completed included a forge and foundry shop, carriage shop, machine shop, carriage assembly shop, reamer shop, transformer building, gun shop, paint shop, administration building, and two warehouses. An additional gun shop, an acetylene plant, a compressor building, and one more warehouse were under construction. Moreover, the completed buildings were equipped with cranes, lathes, drills, and every sort of machinery for the construction and repair of ordnance and provided with sufficient electric power. Water was piped from a pumping station at the Canal du Berry. Trackage to the extent of 36,750 feet had been laid and surfaced and barracks had been put up to house the constructing and operating troops. As a result the project was complete enough to be in efficient operation.

Included in the auxiliary construction was the building of a 30,000-volt, high-tension power line from the city of Bourges, 8 miles away. The power required far exceeded the amount which could be furnished by an existing French plant and to make up the deficiency, five 250-horsepower boilers and three steam turbines were installed. The power line was put up by practically inexperienced men, but to Company B of the 38th Engineers is due the credit for the more difficult technical work at the plant, including the setting up of hundreds of motors, the installation of a lighting system, and the erection of six transformer plants.

ST. LOUBES AMMUNITION DEPOT.

The St. Loubes ammunition depot in base section No. 2 was located on the Dordogne River about 2 miles from St. Sulpice, with which it was connected by the American-built third track from Bassens to St. Sulpice, paralleling the double tracks of the Paris-Orleans Railway. This depot was constructed for the receipt, classification, stor-

WAR DEPARTMENT. U.S. ARMY.



LEGEND

BUILDINGS LOCATED
BUILDINGS 25% COMPLETED
BUILDINGS 50% COMPLETED
BUILDINGS 75% COMPLETED
BUILDINGS COMPLETED
SEWER LINES LOCATED — S
SEWER LINES STARTED — S
SEWER LINES COMPLETED — S
WATER LINES LOCATED — W
WATER LINES STARTED — W
WATER LINES COMPLETED — W
GAS LINES LOCATED — G
GAS LINES STARTED — G
GAS LINES COMPLETED — G
ROADS LOCATED
ROADS STARTED
ROADS COMPLETED
RAILROADS LOCATED
RAILROADS GRADED
RAILROADS COMPLETED
POWER AND LIGHT LINES LOCATED — P
POWER AND LIGHT LINES STARTED — P
POWER AND LIGHT LINES COMPLETED — P
EXISTING BUILDINGS NOT PART OF PROJECT

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C.E.- S.O.S.-A.E.F.
ST. LOUBES,
AMMUNITION DEPOT
RESS REPORT MAP.
0 500 1000 1500
SCALE IN FEET
7/5/18 Recommended
27/18 R.C.
Approved.
Edgar Jadwin
Brig. Gen. U.S.A.
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age, and shipment of ammunition and high explosives. The facilities consisted of a lighterage dock 750 feet long, 14 sorting sheds, and storage warehouses with an area of 294,500 square feet, with the necessary trackage. The lighterage dock is considered in detail elsewhere under the head of "Ports and docks," and therefore the storage facilities alone are described.

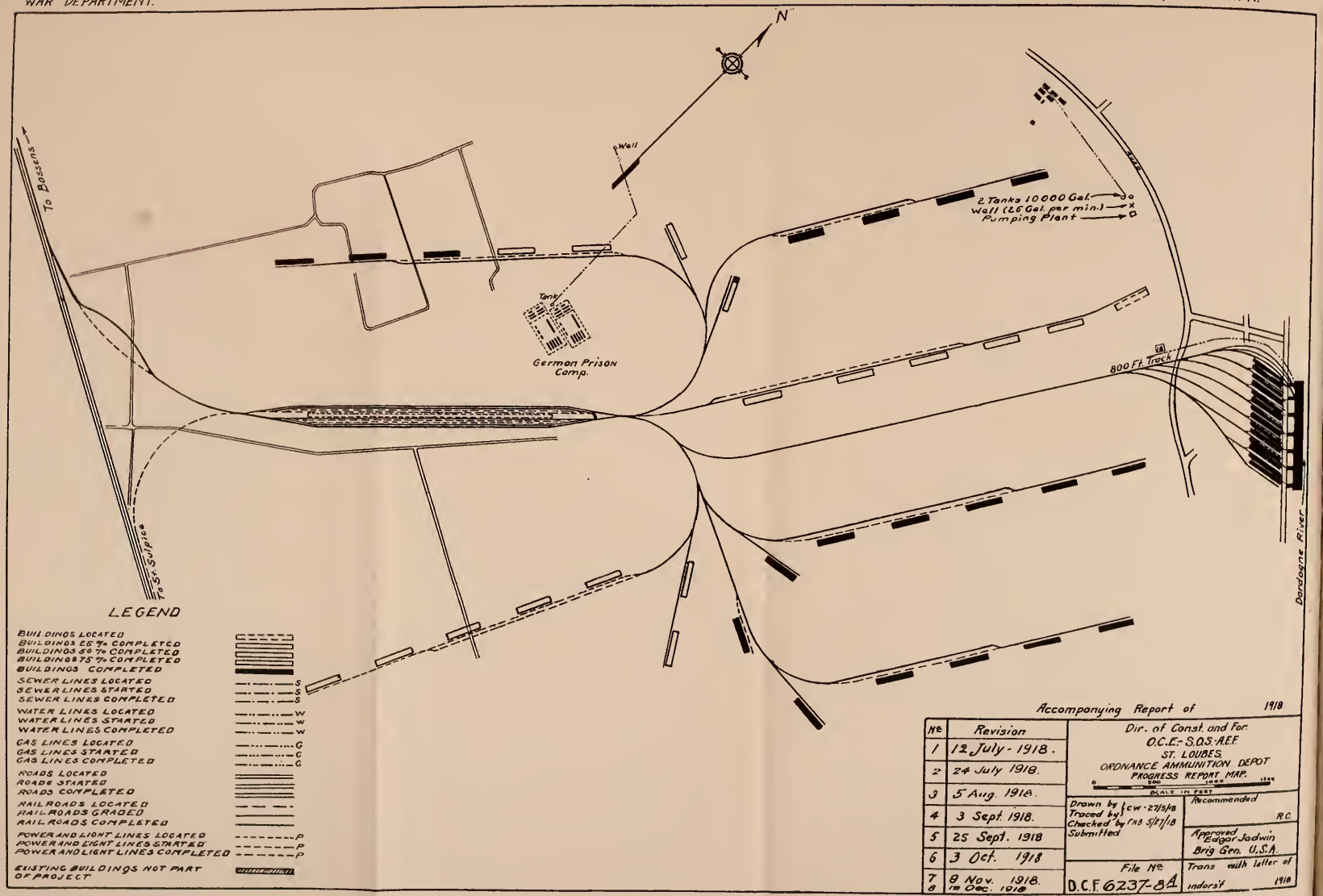
The depot was constructed on a flat area between the Dordogne River and the Paris-Orleans Railway, approximately 1½ by 1 mile, containing 1,304 acres, almost equally divided between meadows and vineyards and traversed in all directions by drainage ditches. The area lay for the most part at an elevation of about 5 feet below high tide in the river. Dikes along the river bank prevented inundation, while tide gates in the drainage ditches enabled these to function properly.

Fourteen sorting or classifiction platforms were built at an angle of 39 degrees with the dock and a short distance therefrom. These platforms were supported on posts. Each was 18 feet wide and 300 feet long and depressed 3 inches at mid-width. A roof of corrugated iron 13 feet wide and 7 feet high at the eaves was placed centrally over each platform, providing approximately 75,000 square feet of covered storage. On one side of each platform was a line of meter-gauge track, while on the opposite side was standard-gauge stub track which communicated with a single track leading to the storage area.

The plans for the storage depot proper provided for 36 warehouses, 50 by 300 feet, with wood frame and corrugated-iron sides and roof, founded on earth fills, and spaced at a minimum distance of 300 feet. They were to be placed on spur tracks, turning out practically in the center of the project from the central track running from the classification platforms to the Bassens-St. Sulpice third track. Reverse curves, turning out on a curvature of 9 degrees 30 minutes, were utilized on four of the spurs which extended toward the river in parallel lines spaced 1,200 feet apart. Two other spurs, turning out on the same curvature, curved through approximately 180 degrees, making the project practically symmetrical with respect to the central track. Between these two spurs a nine-track classification yard, with capacity for 450 standard American cars, was contemplated, of which five tracks were actually built. The accompanying plan indicates the type of layout. The project called for 17 miles of track, of which 14 miles were built.

Nineteen warehouses were completed, giving an area of 294,500 square feet.

The first unit of a system of barracks to accommodate 1,000 men of the operating personnel was started. Barrack buildings and mess halls were of standard design and construction.


N
Well
To Bassens
To St. Sulpice
Tank
German Prison Camp.
2 Tanks 10000 Gal.
Well (26 Gal. per min.)
Pumping Plant
800 Ft. Track
Dordogne River
LEGEND
BUILDINGS LOCATED
BUILDINGS 50% COMPLETED
BUILDINGS 75% COMPLETED
BUILDINGS COMPLETED
SEWER LINES LOCATED
SEWER LINES STARTED
SEWER LINES COMPLETED
WATER LINES LOCATED
WATER LINES STARTED
WATER LINES COMPLETED
GAS LINES LOCATED
GAS LINES STARTED
GAS LINES COMPLETED
ROADS LOCATED
ROADS STARTED
ROADS COMPLETED
RAILROADS LOCATED
RAILROADS GRADED
RAILROADS COMPLETED
POWER AND LIGHT LINES LOCATED
POWER AND LIGHT LINES STARTED
POWER AND LIGHT LINES COMPLETED
EXISTING BUILDINGS NOT PART OF PROJECT
Accompanying Report of 1918
Nº
Revision
1 12 July - 1918.
2 24 July 1918.
3 5 Aug. 1918.
4 3 Sept. 1918.
5 25 Sept. 1918
6 3 Oct. 1918
7 8 Nov. 1918.
8 12 Dec. 1918
Dir. of Const. and For.
O.C.E.- S.O.S.-A.E.F.
ST. LOUBES.
ORDNANCE AMMUNITION DEPOT
PROGRESS REPORT MAP.
SCALE IN FEET
Drawn by
Traced by
Checked by
Submitted
Recommended
R.C.
Approved
Edgar Jadwin
Brig. Gen. U.S.A.
File Nº
D.C.F. 6237-8A
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The project was begun in June, 1918, and was about 90 per cent complete when further construction ceased on November 15. The completed portions had been in successful operation for the preceding two months.

ISSOUDUN AMMUNITION DEPOT.

For the storage of small-arms ammunition a depot with 446,600 square feet of covered storage space was constructed at a point 4.8 miles east of Issoudun, in the intermediate section, west, connecting with the Bourges branch of the Paris-Orleans Railway. The project, begun in June, 1918, was practically completed by November 11, and ammunition had for some time been received and stored. Except for demountable barracks housing the personnel, little material obtained directly from the French entered into the construction of the depot. American track material and fittings were used and the corrugated iron covering the warehouses was brought from the United States. The ties, poles, and lumber used were produced by the Engineer forestry troops.

The approved plan called for 31 warehouses, 50 by 308 feet, of which 29 were completed before construction was halted. These were of the standard wood-frame and corrugated-iron construction and similar to those erected at St. Loubes for ammunition storage, except that the roof and but one bay at each end were covered with corrugated iron. The material stored was further protected by canvas coverings. The buildings were located with sufficient space between them to reduce the fire hazard and danger from possible explosions to a minimum.

The railroad tracks were located to conform to the contour of the ground as far as possible, thus reducing grading to a minimum. A total of 56,200 linear feet or 10.6 miles of track were laid and ballasted with dirt, no cinders or gravel being obtainable. Except four of the nine storage tracks, practically all the trackage authorized was constructed. A locomotive coaling platform and water-supply facilities, furnishing 28,800 gallons of water every 24 hours, for both locomotive and camp use, were constructed. Nearly a mile of road was graded and surfaced.

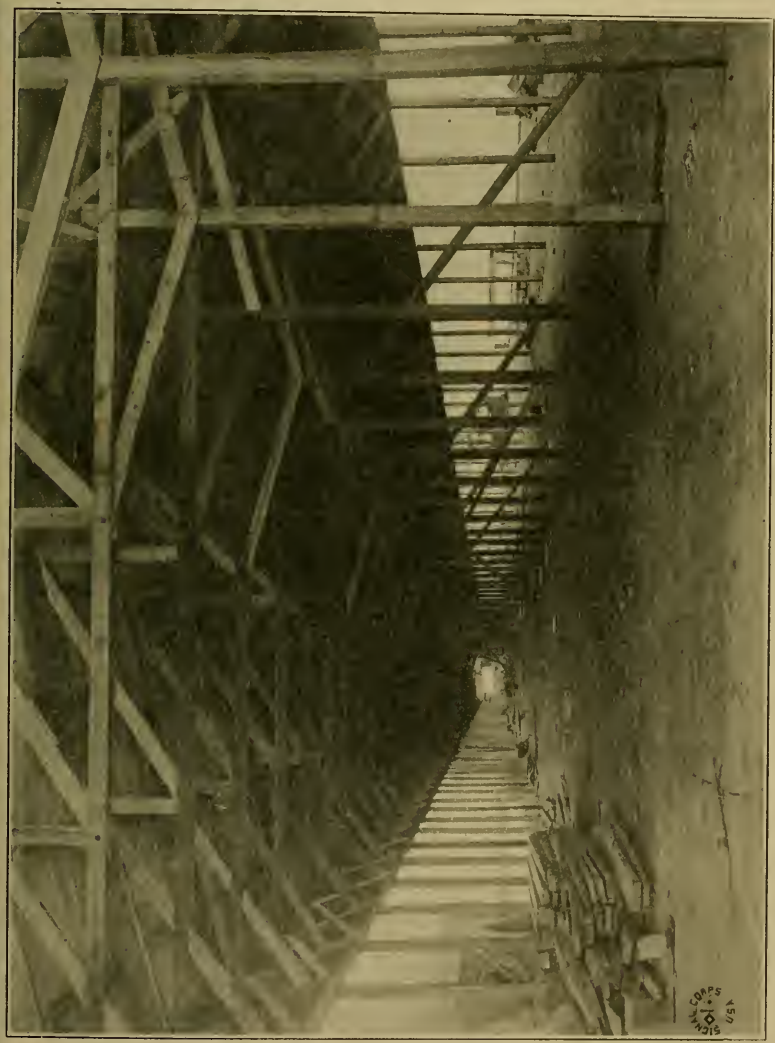
JONCHERY AMMUNITION DEPOT.

Advance ordnance depot No. 4, as the depot at Jonchery was designated, supplied all munitions of certain types for the First and Second Armies.

The original plans provided for 10 large munition warehouses, 3 large pyrotechnic houses, 20 grenade huts, and 3 fuse houses. Construction was begun in October, 1917, by detachments from the 15th Engineers, railway, and in July, 1918, the facilities named were largely completed. To meet the constantly increasing demands, ex-

tensions were authorized and partially completed before the cessation of hostilities, so that the total covered storage space provided was 306,400 square feet. The open storage space occupied was 325,000 square feet.

The project was served by 28.8 miles of track, involving 120 switches and 6 crossings. Barracks with 112,000 square feet of space



(3595-F9) TYPE OF COVERED DOCK STORAGE BUILT AT MONTOIR PIER.

were erected and the whole served with extensive water supply, telephone, and electric light facilities, all of these installations being made by the Engineers.

DOCK STORAGE.

At practically all ports used by the American Expeditionary Forces it was essential to have on the docks sheds or warehouses in which

the supplies unloaded from the adjacent vessels could be classified and, if necessary, stored until they could be dispatched to depots or to the front. At several ports it was possible to lease from the French suitable warehouses with sufficient space, but at the principal ports the required space was secured wholly or in part by new construction.

All the storage at American Bassens was newly constructed, being built as an integral part of the docks, which are described elsewhere under the section "Ports and docks." The classification sheds at St. Loubes were, as has already been indicated, of new construction. Over two-thirds of the dock storage at St. Nazaire, Brest, and Rochefort and one-half of that at Nantes was constructed by United States forces. At the other ports leased space was largely used. The tabulation below indicates the space ready for occupancy and occupied on February 1, 1919, on which date the storage facilities throughout France were approximately at a maximum. The construction of three berths of the Montoir dock, however, resulted in the completion of 65,000 square feet of dock storage at that point after February 1, 1919.

Dock covered storage space.

Base section.	Ready for occupancy (square feet).	Occupied (square feet).
No. 1:		
St. Nazaire	350,163	350,163
Nantes	305,938	190,388
Total	656,101	540,551
No. 2:		
Bassens	519,499	383,699
Bordeaux	501,692	501,692
St. Loubes	75,852	21,785
Total	1,097,043	907,176
No. 4:		
Le Havre	199,800	199,800
Rouen	20,000	20,000
Total	219,800	219,800
No. 5: Brest	178,971	78,271
No. 6: Marseille	674,295	674,295
No. 7:		
La Pallice	31,300	31,300
Rochefort	170,928	170,928
Total	202,228	202,228
Total, all France	3,028,438	2,622,321

At those ports where it was necessary to erect warehouses, structures of the usual wood frame, corrugated-iron type were generally constructed, varying in dimensions, however, according to conditions. At Bassens, for example, eight classification sheds were commenced in January, 1918. These consisted of six sheds 66 by 204 feet, one

66 by 312 feet, and one of two stories, 66 by 312 feet, built on concrete floors and alternating with an equal area of open storage. Beside them were depressed tracks, on the inshore side of which four additional warehouses, begun in May and finished in October, 1918, were constructed. One was 100 by 1,358 feet, one was 100 by 602 feet, and two were 100 by 294 feet. All were provided with a 6-inch concrete floor on a sand fill, with a timber and pile bulkhead on both sides.

MISCELLANEOUS STORAGE.

Under the head of miscellaneous storage were classified those facilities provided at dozens of camps, hospitals, schools, and other points scattered over France where concentrations of troops necessitated the provision of storage space to meet local needs. While much of this space was in buildings leased from the French, at some camps and hospital centers warehouses of the same type and as large as those in storage depots were constructed. The subject presents no new features and, for the purpose of this report, it is sufficient to include only the tabulation below, the figures for which are taken from the progress report of the director of construction and forestry, dated February 1, 1919, covering 80 projects then in use:

	Ready for occupancy (square feet).
Base sections	1,528,915
Intermediate section	1,717,318
Advance section	611,459
Total	3,857,692

PLANS HALTED BY ARMISTICE.

Had hostilities continued the depot covered storage space approved for construction under existing plans, together with that already constructed, would have sufficed to store 45 days' supplies for over 5,000,000 men. Dock and miscellaneous storage would have been increased on a proportionate scale.

Provision had been made for extensions at all the large depots. These extensions represented the bulk of the proposed increase. Small ammunition depots were also proposed at Donges, in base section No. 1, and at Le Cors, in the intermediate section.

On November 14, 1918, immediately after the signing of the armistice, General Orders, No. 54, issued from headquarters, Service of Supply, made sweeping reductions in the construction program of the division of construction and forestry, eliminating those features for which the need no longer existed. The effect of this order and of supplementary cancellations was to reduce the covered storage space authorized for construction by the amounts quoted below. These

figures show the magnitude of the extensions that had been contemplated: Depot storage, 12,050,640 square feet; dock storage, 1,245,345 square feet; and miscellaneous storage, 716,285 square feet.

REFERENCE DATA, STORAGE DEPOTS.

	Appendix number or file reference.
Report, D. C. & F. to C. G., S. O. S. (through C. E.), March 12, 1919	Appendix No. 40.
Project Reports of section engineers	Appendix No. 43–52, incl.
Monthly reports and histories:	
15th Engineers (railway)	Appendix No. R–15.
16th Engineers (railway)	Appendix No. R–16.
17th Engineers (railway)	Appendix No. R–17.
18th Engineers (railway)	Appendix No. R–18.
Monthly progress charts, D. C. & F	D. C. & F. Files.
Descriptive tabulation, warehouses (drawing)	D. C. & F. (9188–44.)

Hospital Construction.

By the construction of 7,700 hospital barracks, equivalent to 127 miles of ward buildings, and the acquisition and alteration of existing French buildings, bed space for 280,000 patients, or 14.2 per cent of the total strength of the American Expeditionary Forces, had been provided at the time of the armistice; 139,000 beds were in French buildings, while 141,000 beds, more than half of the total, represented new construction. Reference to the accompanying tabulation shows that the maximum number of beds occupied by the sick, wounded, and convalescent, never exceeded 10 per cent of the American Expeditionary Forces, and that the available bed space, since the first week in July, was always 50,000 beds in excess of the number of beds occupied, although tentage for crisis expansion and operating personnel were not provided in sufficient numbers to match the bed space provided by construction.

For single barracks at camps serving as infirmaries, capable of caring for only a small number of patients, hospital projects were developed ranging in magnitude to those at Mars, Mesves, Savenay, and Beau Desert, hospital centers of 20,000 beds capacity, subject to 100 per cent crisis expansion, together with quarters for an operating personnel of 700 officers, 2,000 nurses, 5,000 enlisted men, and a convalescent camp for 4,000. Hospital construction extended over the whole of France and across the Channel to England, as shown by the accompanying chart.

In August, 1917, instructions were issued to provide for hospitalization on the line of communications for 300,000 men. During the following month nine French hospitals were taken over and each formed the nucleus of a hospital center, the original 6,000-bed capacity of these buildings being developed to 34,800 beds. It was found impossible to obtain many existing hospitals from the French,

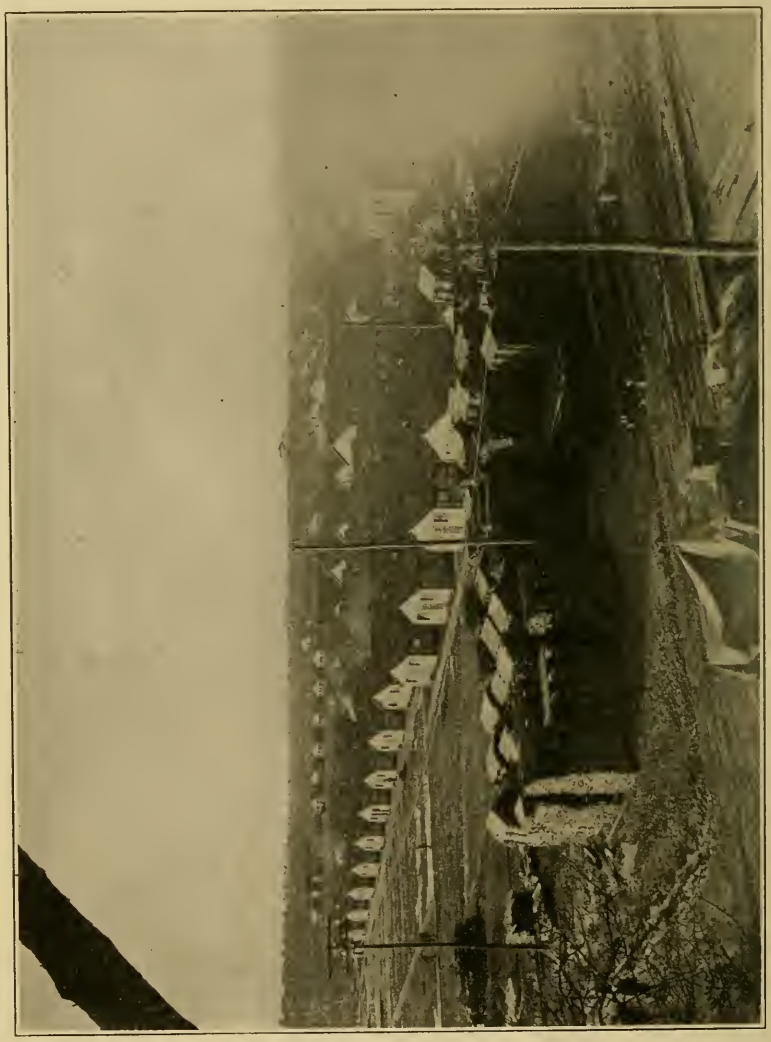
so that preparations were made to construct a large number of barrack hospitals. Authorization had been given, tentatively, to provide hospitalization for 10 per cent of the strength of the American Expeditionary Forces. In its main aspects, the problem was one of quantity production—of establishing at widely separated points hospitals of capacities varying from 300 to 20,000. The time element was all important and the only solution lay in standardization, the result being the production of "type" plans. The experiences of both the French and British were freely consulted, and much attention was given in the preparation of the plans to economy of materials and personnel. For further economy in personnel, administration, and supply, hospitals were grouped, so far as local conditions would permit, into centers of hospitalization.

The principal set of type plans was for a 1,000-bed hospital unit known as type "A," and embodied the general arrangement and structural details necessary to enable the men in the field to proceed with the work without further extensive directions. The large hospital centers were developed in multiples of the 1,000-bed type "A" unit. A second set of plans for a 300-bed camp hospital or type "B" unit was based on the use of standard demountable barracks 20 by 100 feet. In the type "A" units, however, the ward buildings were usually 20 by 160 feet. When it was discovered that demountable buildings could not be obtained in sufficient quantity to keep pace with the hospital program, hospital wards 36 by 156 feet, accommodating 100 patients, were developed and extensively used. In the type "A" units there was, in addition to the barrack wards, provision for tentage for 1,000 beds in case of emergency.

FIRST WORK BY CONTRACT.

French contractors were at first in a better position to secure materials and labor than the American Expeditionary Forces and contracts for construction were accordingly made where possible. This advantage, however, steadily decreased until the summer of 1918, when American forces obtained access to all markets for material, while at the same time it became correspondingly difficult for contractors to get labor and material and to obtain transportation. Most of the hospital buildings were constructed of lumber, but in some cases light masonry walls and concrete floors were used. Practically all the labor in the advance section, due to its location in the French Zone des Armees, was done by troops. Among the hospitals built by troops alone in the advance section were Bazoilles, 6,000 beds, authorized in September, 1917; Rimaucourt, 5,000 beds, and Langres, 2,000 beds, authorized in November, 1917. All the above hospitals were built according to type "A" plans, using demount-

able hospital barracks. When it is considered that for each of the above hospital units of 1,000 beds, 65 hospital barracks were required, together with the necessary materials for heating, lighting, water supply, and railroad connection, and that most of the work was done by unskilled labor, some idea may be gained of the amount



(3476-F9) UNIT NO. 6 OF BASE HOSPITAL 114, BEAU DESERT.

of supervision required in having material delivered and erected, especially during the period of the extra heavy troop movements.

The problem of hospitalization by the American Expeditionary Forces was different from that of the great Allied Armies whose convalescents could be evacuated to their homes. This was impossible for the American Expeditionary Forces. Many patients evacu-

ated from the front, it was found, after having received medical dressing, a good warm bed, and proper food for a few days, did not really need to occupy active hospital beds. In order to dehospitalize rapidly, it was decided to provide 20 per cent of the hospitalization in convalescent hospitals. In these camps, convalescent patients received such medical attention as was required, were comfortably housed, exercised, and kept under disciplinary control sometimes impossible at the larger hospitals.

Until May, 1918, hospitalization had been on a 10 per cent basis—that is, 10 beds for every 100 men in the American Expeditionary Forces. At that time, however, 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 capacity of 15 per cent of the American Expeditionary Forces strength in Europe. The immediate effect was to more than triple the necessary rate of hospitalization. This increased rate was more than met by the steady increase in the percentage of bed space provided, indicated in the tabulation given herewith.

In five months, from May until October, the percentage of hospitalization, in the face of the unforeseen increased rate of troop arrivals, was increased from 6.8 to 14.2 per cent.

Hospitalization data to April 1, 1919.

Date.	French buildings.	Additions.	New construction.	Available space.		Additional authorization.	Total authorization.	Strength.	Beds occupied.	Per cent of strength.
				Beds.	Per cent of strength.					
1917.										
Nov. 30	6,250	.....	.....	6,250	4.6	18,750	25,000	137,140	.....	.....
Dec. 31	6,500	500	.....	7,000	3.8	64,000	71,000	183,489	5,500	3.0
1918.										
Jan. 31	13,322	1,331	695	15,348	6.8	79,488	94,836	224,521	8,000	3.5
Feb. 28	17,381	2,859	840	21,080	8.3	95,155	116,235	253,463	9,000	3.5
Mar. 31	20,234	5,800	895	26,929	8.2	96,666	123,595	327,382	10,800	3.3
Apr. 30	23,317	7,871	2,040	33,228	7.7	88,285	116,113	432,021	11,500	2.6
May 31	30,762	10,151	3,910	44,823	6.8	87,245	132,068	661,204	15,336	2.3
June 30	36,891	13,353	20,430	70,674	8.0	112,181	182,855	880,143	22,905	2.6
July 31	46,008	17,966	35,539	96,513	8.3	162,779	261,292	1,177,426	47,519	4.0
Aug. 31	61,014	17,877	52,180	131,071	9.1	158,508	289,579	1,432,739	58,300	4.1
Sept. 30	94,728	21,872	78,406	195,006	11.4	157,707	352,713	1,711,202	111,964	6.5
Oct. 31	123,383	23,242	106,155	252,780	13.4	178,668	431,448	1,880,628	182,814	9.7
Nov. 14	139,000	25,000	116,000	280,000	14.2	187,558	467,558	1,971,277	190,356	9.7
Nov. 30	105,633	20,895	115,987	242,515	12.3	17,522	260,237	1,942,495	179,247	9.1
Dec. 31	69,896	20,481	125,432	215,809	11.8	1,000	216,809	1,832,604	138,470	7.5
1919.										
Jan. 31	42,814	13,203	104,524	160,541	9.2	.....	160,541	1,739,051	84,732	4.9
Feb. 28	36,792	12,704	95,295	144,791	9.2	.....	144,791	1,572,669	80,807	5.1
Mar. 31	32,759	12,991	80,311	126,059	9.3	.....	127,559	1,350,560	57,026	4.2

TYPICAL PROJECTS.

Of the proposed 20,000-bed hospital centers, all of which were reduced in size by the cancellation of uncompleted projects after the signing of the armistice, the principal ones were located at Mars,

Mesves, Savenay, and Beau Desert, near Bordeaux. Savenay and Beau Desert were the two large hospital centers for the evacuation of troops to the United States. Among the projects involving 10,000 beds or more were those at Beaune, Allery, and Rimaucourt. To indicate the necessity and the urgency of this hospitalization, it may be noted that on November 11, 1918, there were 16,624 patients in Allery Hospital, and 19,596 in Mesves Hospital. Hospitals of slightly smaller capacities than the foregoing were provided at a number of other places. At the French summer resort at Vichy, hospitalization was provided, not by construction of wooden barracks such as were built at other hospital centers but by taking over and altering about 90 hotels and other buildings, thus providing beds for over 16,000 patients. Similar procedure was followed at other large resort centers, such as Vittel Contrexeville, and also in the Pyrenees and in the Riviera. All of the foregoing work was for the so-called base hospitals—the large projects. In addition there were scores of smaller camp hospitals and convalescent camp hospitals. On November 1, 1918, there were 87 base hospitals and 86 camp hospitals in operation. After the armistice, when the need for hospital capacity was lessened, certain large centers, such as those at Beaune and Allery, were converted into American Expeditionary Forces schools.

Large scale hospital construction is typified by the 20,000-bed, type "A" base hospital centers at Mars and Mesves in the intermediate section (east). Both projects consisted essentially of the grouping of 20 of the 1,000-bed type "A" hospital units to form 20,000-bed cities, with 4,000-bed convalescent camps, the completion of which was halted by the armistice after the work at each project was more than 60 per cent completed.

THE MARS HOSPITAL PROJECT.

Ground for the Mars Hospital project was broken February 23, 1918, after a cost-plus-percentage contract for its construction had been awarded to a French contractor. In the early days the work of the Engineers was largely supervisory, but later on troops arrived and were employed to great advantage in speeding the erection of barracks, construction of roads, installation of water, sewerage, and the various other facilities demanded in order that the project might function.

The contractor's forces consisted of French, Spanish, and Indo-Chinese labor, reaching a maximum strength of 3,180 men on September 10, 1918. The troops employed on the project included detachments from the 26th, 528th, and 521st Engineers. The contractor's organization was at all times an important factor in the supply of carpenters, concrete finishers, bricklayers, and special mechanics for

machine-shop and repair work. The American forces handled all pipe laying, pumping installations, and electrical wiring, and was efficiently supplemented by convalescent patients. Frequent changes in the Army personnel, however, made the contractor's force a most valuable framework for the organization.

Original authorization called for the construction of 10 type "A" hospitals, having a normal capacity of 1,000 beds, each with a crisis expansion of 1,000 beds in tents. These units were entirely self-contained, providing for the housing and functioning of a completely equipped hospital in addition to buildings for housing personnel. Each unit contained 20 wards for patients, kitchens, dining rooms, quartermaster and medical storerooms, an operating building, a lab-

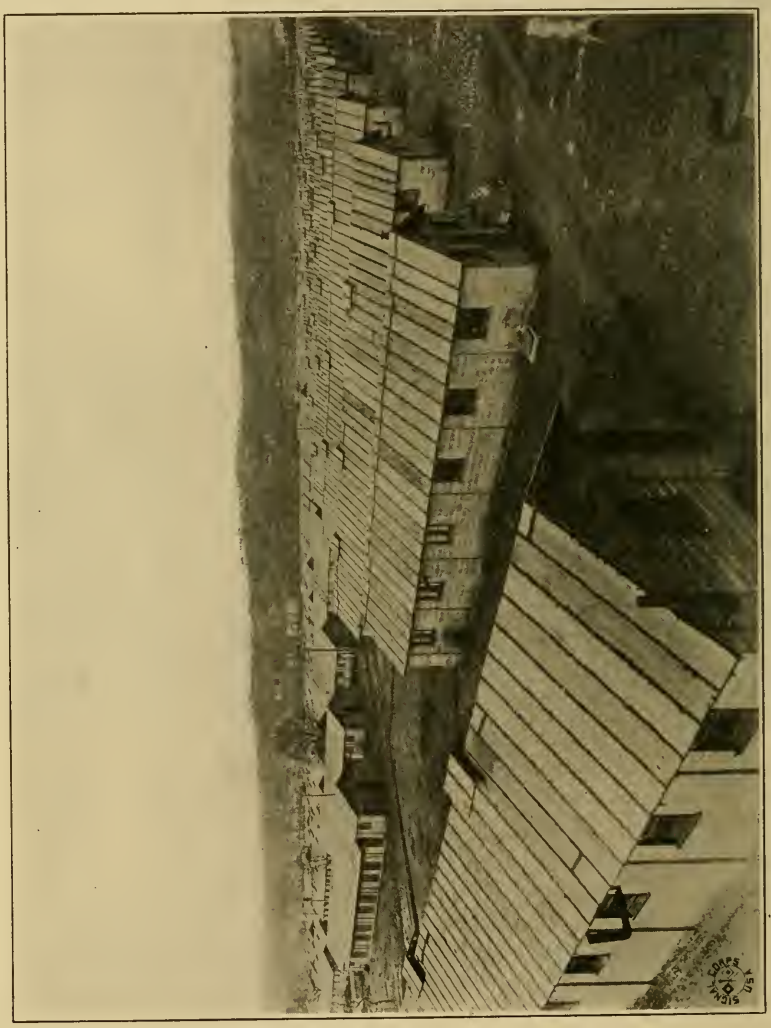
(729–G8) THE 20,000-BED HOSPITAL AT MARS.

oratory, morgue, patients' bath, etc., making a total of 58 buildings per unit.

The first buildings were of brick and concrete with cement floors. A framework of trusses with purlins and wood panels was first built up and concrete walls poured to a height of 4 feet. The remainder of the wall was then laid up with hollow brick 11 by 11 by 22 centimeters. To expedite construction a quantity of demountable barracks arrived from Switzerland, and the wards of approximately four units were built of these exclusively. Two types were received, one 5-meter in width and the other 6 meters. The narrower type was used exclusively for nurses' and officers' quarters, and the 6-meter type for wards.

Still later a new type of building was standardized by the division of construction and forestry. This construction provided for a simple rugged frame structure sheathed with 1-inch lumber and

covered on the sides with single-ply roofing paper. Concrete floors were used, and the buildings were constructed rapidly. At about the same time plans were issued for wards 36 feet wide, halving the number used per unit. These buildings were a distinct success, both from a standpoint of hospital operation and that of construction.



(3521-F9) BASE HOSPITAL AT PERIGUEUX, SHOWING TYPE OF BUILDING WITH MASONRY SIDES.

A combination of a number of the smaller and special buildings in the type "A" units also greatly simplified the general construction.

Authority to double the capacity of Mars Hospital was issued June 12, and shortly thereafter two convalescent camps of 2,000 beds each were authorized. Both convalescent camps were finished and in operation before construction was stopped; all buildings in these

camps were built entirely with convalescent labor with one Engineer sergeant on the ground to direct and superintend. Concrete finishing was handled by Spanish laborers from the contractor's force.

A railroad was built from the hospital site to the Paris-Lyon-Mediterranean station at Mars; the first train used this track on June 6. Other features were the construction plant during the period of maximum progress, including a 60-centimeter gauge railway with 5¼ miles of track for hauling rock and sand, a sawmill, a machine shop, and a temporary electric-power plant. A canteen supplied restaurant service for the workmen. Fifteen different nationalities were taken care of, and the kitchen was divided into three sections to permit the food to be prepared in accordance with the preference of the nationalities concerned. The canteen was handled exclusively by French and Spanish labor, but was operated under the direction of an American officer. When the construction force was greatest, it served 3,000 men twice per day.

The permanent standard-gauge railroad, 5 miles in length, was built from the Mars station to the hospital site. A passing track, 2,000 feet in length, was constructed at Mars station for handling freight and hospital trains. Trains reached the hospital group by a switchback, which was a stretch of tangent track along the entire length of the hospital area; there was one siding for car storage and another track arranged to bring freight to the quartermaster warehouse with the car floors on the same level as the warehouse floor. In addition, there was a track from the switchback which made a complete Y, and which was added as a convenience for the return of trains to Mars station.

Water was first available in the main reservoir on July 5, and on that date the hospital was ready for operation. The first wounded arrived on August 2. The main reservoir of stone and concrete, with a capacity of 220,000 gallons, was located on the high ground back of unit No. 6 and was originally intended to take care of the water supply of the first 10 units. When an additional 10 units were authorized, an additional 100,000-gallon reinforced concrete reservoir was designated and constructed.

A permanent 10-inch water-supply line from the Allier River approximately 5 miles in length was completed on August 24, or a little more than 30 days after the ground was broken. Three pipe-laying gangs of 10 men each, working in competition, laid 2,000 feet of pipe in a single day. In anticipation of an emergency, late in August a temporary pumping installation was commenced, and the first water was pumped from the river on September 15. Four rotary pumps raised water 200 feet to the reservoir at the hospital. The station had a capacity of 25,000 gallons per hour. For the distribution in the hospital groups 12-inch, 6-inch, and 4-inch pipe was

used, the total length of all water pipe at the Mars installation being approximately 200,000 feet.

In the construction of the sewerage system there was used 400,000 feet of 4-inch pipe, 35,000 feet of 6-inch, 30,000 feet of 8-inch, 6,000 feet of 10 and 12 inch, and 3,000 feet of 16 and 18 inch.

Electrical power was supplied over a 3-phase 15,000-volt transmission line which had been constructed from a line near Nevers. This line was 11 miles in length and of standard European construction. One of its special features was a 1,000-foot span across the Loire River near Nevers. There was a 300 K. V. A. step-down substation on the hospital site, where voltage was changed to 5,000 for distribution. Small 3-phase transformers, suitably arranged, again changed the voltage from 5,000 volts down to 115–230, 3 phase.

More than 6½ miles of roads were built in the hospital area and the entire 9½ miles originally planned was graded. Approximately 18,000 yards of rock were used for road construction.

On November 18, when preparations were made to close down construction, there had been built a hospital city for approximately 40,000 inhabitants, comprising 700 buildings with a floor space of 33 acres. The maximum number of patients at the hospital was approximately 14,400, on November 14. At all times space was available sooner than the corresponding hospital equipment, but hospital equipment was provided in excess of the number of patients actually received.

MESVES HOSPITAL.

In its scope and general layout the hospital project at Mesves was practically a duplication of the 20,000-bed base center at Mars. The construction work was done under a cost-plus-percentage contract with a French firm, whose efforts were reinforced by American Engineer troops. Access to the site was provided by constructing 3 miles of standard-gauge railroad, and on April 23, 1918, the first trainload of material arrived on the hospital site. By December 1, 1918, there had been delivered more than 4,000 carloads of construction material.

The story of the Mesves project is one of progress made with a continuous shortage of materials, labor, and transportation. For the control of the construction the project was subdivided into classes of work, such as installation of water system, sewers, electric lights, plumbing, and building construction, the latter, in turn, being subdivided into units. The men in charge of each class of work were under the supervision of a field superintendent, who, in turn, received his instructions from the Engineer officer in charge. Each day there was a meeting of all the officers, at which matters pertaining to the

work were discussed and arranged for the following day. In this way cooperation was maintained.

In July many of the United States troops and many of the motor trucks were withdrawn from the work. At this time materials were

(3512–F9) WOODEN BARRACK WARDS AT LIMOGES BASE HOSPITAL.

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 19,600.

At the time of the armistice more than 4,000 carloads of construction material had been delivered and quarters had been provided for

more than 20,000 patients. The magnitude of the project is indicated by the fact that the water supply and the sewerage systems each necessitated the laying of 28 miles of pipe. In November, when operations were curtailed, a total of 45 acres of concrete floors for barracks had been laid and 23,000 windows, containing 270,000 panes of glass, were in place. The maximum amount of labor employed was 5,184 men.

SAVENAY HOSPITAL CENTER.

The history of the hospital center at Savenay is one of a rapid growth from the original plans. This work was started with the

(3338–F9) WARD BARRACKS, BASE HOSPITAL 106, BEAU DESERT.

remodeling of the school building at Savenay in September, 1917. It was originally planned to have a hospital of 2,500 beds, but the project was enlarged to 5,000, then to 10,000 beds, and finally, at the signing of the armistice, materials and men were on hand for the building of a 20,000-bed hospital with a 5,000-bed convalescent camp. This work was held up in the early stages by difficulty in securing material and skilled labor. It was being pushed rapidly at the conclusion of hostilities, and the final plan called for a 10,000-bed hospital with a 2,000-bed convalescent camp. The project involved the building of 265 barracks with a floor area of 736,845 square feet, 65

masonry buildings with a floor area of 176,656 square feet, and 81 miscellaneous buildings with 67,416 square feet.

TRANSPORTATION AT ALLEREY DIFFICULT.

At the 10,000-bed hospital project at Allerey, where about 600 demountable Swiss barracks were used, the big construction problem, because of limited track facilities, proved to be the unloading of cars and the delivery of the barrack material to the site. The Engineers employed French trucks, horses, and even oxen—in fact, anything in the form of vehicle in order to permit the release of cars within the required 24 hours.

The contract was awarded to a French firm on a cost-plus-percentage basis. It was expected that this firm's knowledge and familiarity with French markets and labor would prove valuable. Although material assistance was rendered by this firm, it soon developed that to expedite construction, materials from Army depots and other Army sources would have to be provided and the services of the contractor strengthened. Direction of all parts of the work was taken over by the Engineer personnel. Additional officers were ordered to the project April 1, and soon an efficient organization was perfected.

At the 7,000-bed project at Bazoilles, Negro service battalion labor was used to good advantage. It was soon found that colored troops could be organized for concrete work, barrack construction, and, in fact, all work to be done. Excellent results were obtained by working white and colored details on neighboring jobs where rivalry had the effect of speeding progress.

While much of the hospital work was done far behind the front lines some of it was close enough up to receive enemy shelling. On the construction of an evacuation hospital at Baccarat the work was frequently interrupted by German artillery fire. On the morning of September 2, 1918, a group of men were caught in a gas-shell attack and 30, themselves hospital builders, had to be sent to hospitals.

Immediately after the armistice, work on the big hospitalization program was practically halted. Until hostilities ceased, the provision of bed space for 15 per cent of the total American Expeditionary Forces strength was required. On November 14, however, the authorized rate of hospitalization was reduced to 7½ per cent, and at the same time a wholesale cancellation of uncompleted construction was made by General Orders, No. 54, Headquarters, Service of Supply, although considerable additional work remained to be done at such centers as embarkation camps.

REFERENCE DATA, HOSPITAL CONSTRUCTION.

	Appendix number or file reference.
Report, D. C. & F. to C. G., S. O. S. (through C. E.), Mar. 12, 1919	Appendix No. 40
Project report of section engineers	Appendix No. 43 to 52, incl.
Report of engineer valuation board, Mar. 11, 1919	Appendix No. 42
Type plans for hospitals	Appendices 53, 53*a*, 53*b*, and 54.
Memorandum D. C. & F. to E. P. O., Mar. 28, 1919, giving square feet of troop and hospital barracks constructed	File, D. C. & F. 200.30/452
Descriptive tabulation, types of hospital barracks (drawing)	D. C. F. 9186–44

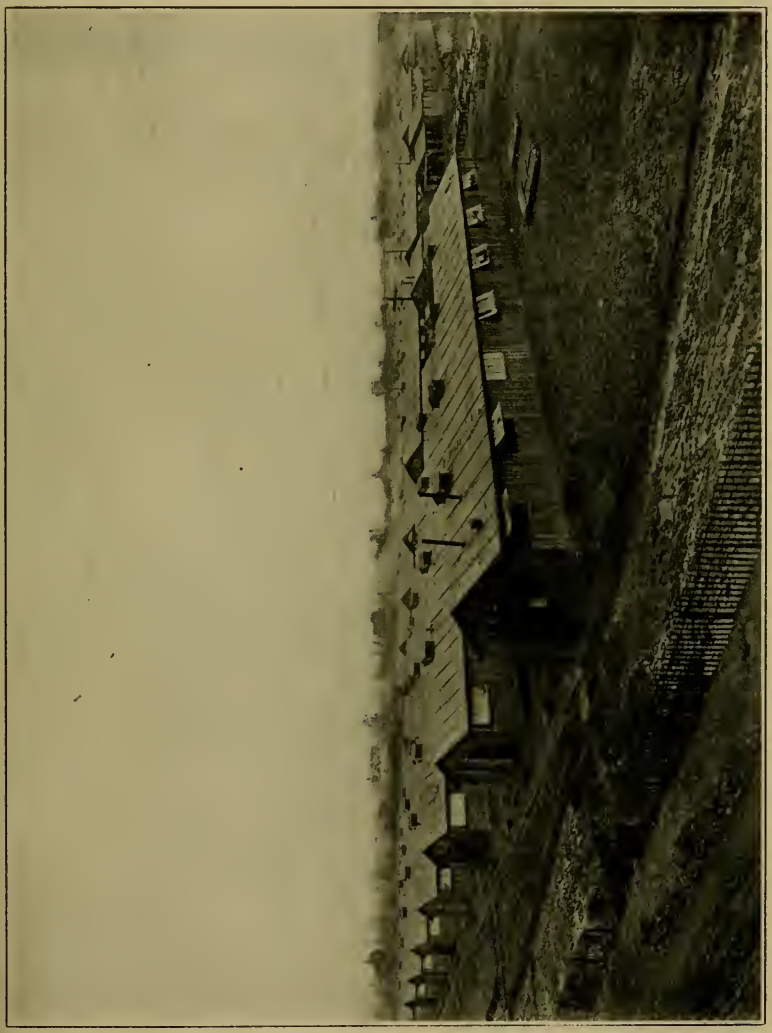
Troop Shelter.

Both in scope and general character of construction the problem of providing shelter for troops had many features in common with that of building hospitals. In fact, it was generally the erection of demountable wooden barracks that constituted the first construction work of Engineer troops, newly arrived in France. After the American troop movement gained headway, towns were taxed beyond their billeting capacity, so that additional accommodations on a large scale had to be furnished.

The basis of the troop-shelter program was the provision, by new construction, of barracks for one-third of the strength of the American force, the assumption being that the remaining two-thirds would be billeted. Up to March 1, 1919, there had been constructed or erected 16,444 barracks covering a total area of 32,894,059 square feet. In carrying out the barracks-construction program, the chief difficulties were not of a technical nature, inasmuch as the wooden structures were simple to erect. The main task was not to build barracks, but to get the materials with which to build.

According to General Orders, No. 46, General Headquarters, American Expeditionary Forces, 1917, prescribing the space allowance in troop barracks 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 with the French and British Governments and with civilian contractors in France and Switzerland for approximately 23,000 barracks, of which 15,000, including 4,500 hospital barracks, were delivered. Most of these were of the demountable type, either Adrian or Bryant, plans of which are attached hereto. Deliveries were slow except during August, September, and October, 1918, when more than 1,000 barracks per month were received, and, therefore, it was necessary to construct barracks in place from lumber furnished by forestry troops. Two types of barracks shown in the accompanying plans were developed to utilize a mini-

mum quantity of lumber. Type "B" barracks required 6,100 feet b. m. of lumber, while type "C," with corrugated-iron roof and sides and frame of wood, required only 1,600 feet board measure of lumber. These barracks were furnished with 4-man bunks of the type shown, and accommodated about 100 men.



(3540-F9) WOODEN BARRACKS BUILDINGS AT CAMP NO. 4 NEAR BORDEAUX.

The main demands for barracks construction for the American Expeditionary Forces came from such centers as rest camps, replacement and supply depots, divisional areas, training schools, and prisoner of war camps. Thousands of stevedores at the base ports were provided with shelter and camps were created for the personnel at practically all of the big construction projects in the Service of

Supply. In the divisional areas in the advance section, barracks construction was undertaken on a large scale, as is indicated by the figures in the following tabulation:

Troop accommodations (barracks and huts, etc.) constructed to March 1, 1919.

Section.	Square feet of barracks.	Equivalent to standard barracks with 2,000 square feet each.
Advance section	11,632,887	5,816
Intermediate section (east)	1,141,882	570
Intermediate section (west)	6,847,618	3,423
District of Paris	161,000	80
Base section No. 1	4,602,329	2,301
Base section No. 2	4,168,388	2,084
Base section No. 3	744,249	372
Base section No. 4	108,484	54
Base section No. 5	2,611,519	1,306
Base section No. 6	349,117	175
Base section No. 7	526,586	263
Total	32,894,059	16,444

Among the big centers of Army population, created by the construction of wooden barracks in the base and intermediate sections, were the Pontanezen Barracks at Brest, and camps at St. Nazaire, Bordeaux, St. Aignan, St. Amand, and Le Mans. Shortage of transportation added its usual burden to practically all of the jobs. At Marcy, for example, the men of one company of an Engineer regiment wheeled by hand over a distance of two miles all barrack material necessary to house 400 men engaged on railroad and engine terminal construction.

PONTANEZEN CAMP LARGEST PROJECT.

The largest single project for barracks construction was at Brest, where Pontanezen Barracks, a rest camp to accomodate 80,000 men —55,000 in barracks and 25,000 in tents—involved the construction of about 850 buildings for officers and men. There were also constructed for this camp a large number of mess halls and kitchens, each with a feeding capacity of 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 was toward large kitchens operated by permanent personnel. Several types of these kitchens were developed, the largest of which were those at Pontanezen. A plan of one of the troop kitchens is attached.

At Pontanezen, a barrack building consisting of a wood frame sheathed with corrugated iron was largely used. On this project the 397th Engineers adopted a form of construction organization where-

by successive gangs specially trained in one type of work were sent over the job. First came the detail which graded the site, then one which laid sills, a third which framed the timber, and so on up to the roofing detail, which finished the building. By repeating the same operations day after day, each gang acquired a high degree of

(3532-F9) TYPE OF TROOP SHELTER EMPLOYED AT CAMP GENICOURT.

skill in its special task, with the result that the construction proceeded rapidly. With this method of distributing the labor, several buildings were always in course of construction at one time, and quantity production was realized.

The great area of the camp site—about 5,000 acres—made the problem of distributing material to work in progress one of im-

portance. Not only did road conditions make it necessary to have a central distributing point to which supplies could be furnished by means of motor trucks and from which further distribution could be made by wagons or by hand, but scarcity of materials during certain periods, accompanied as it was by demands from the various construction units, made it imperative that all material should pass through a central distributing point in order to prevent units from obtaining more than their share.

For purposes of controlling construction, the camp area was divided into sections and subsections. Sections were numbered consecutively, 1, 2, 3, etc., and subsections were lettered a, b, c, etc. Upon a map of the area were shown these subdivisions, so that material for any given section, as 5b, for instance, was quickly routed to its proper destination. Signboards further facilitated the delivery.

Narrow-gauge railroads were laid in the area, and material was delivered over these lines by cars, pushed by hand. Points not accessible from the light railway were reached by wagons, drawn either by horses or by hand. Casual labor was used for this purpose. In many other cases, due to lack of cars and wagons, material was delivered direct from the yards to the job on the backs of casuals.

Although at first Engineers were used as labor troops, they were replaced as rapidly as possible by transient casuals, leaving a skeleton organization of Engineer troops to act only as office men, yardmasters and foremen. The actual labor itself was done by unskilled casuals. By this method of "dilution" a maximum of skilled labor was rendered available for construction purposes.

10,000-MAN CAMP AT MONTOIR.

At Montoir, 5 miles up the Loire from St. Nazaire, a wooden-barracks camp for 10,000 men was created. Here Engineers formed the backbone of a construction force comprising French and Spanish civilian carpenters and a detachment of German prisoners of war. Due to the influx of troops at St. Nazaire, there was a constant demand for more barracks. One week after ground was broken for the new camp the construction organization had grown to about 400 men. Barracks, washhouses with hot and cold water showers, and standard sanitary latrines were erected. At the end of two months 10,000 men were living in the camp, 3 miles of macadam road had been built, running water was in all the kitchens, electric lights had been installed, and sewers laid.

At most of the camps the one-story barrack building was the standard. At the Barankuine stevedore camp near the Bassens docks, however, where it became necessary to house 8,000 men on a

plot of only 25 acres, double-story construction was employed. There were built at this site 32 two-story frame buildings, 31 by

(4078–D8) WOODEN BARRACKS AT LE MANS EMBARKATION CENTER.

92 feet in plan, each for 250 men. There were also constructed at this camp five mess halls, four of them 32 by 115 feet each, with a

(417–S8) FOR STEVEDORE CAMP AT BARANQUINE TWO-STORY WOODEN BUILDINGS WERE ERECTED TO ECONOMIZE ON GROUND SPACE.

capacity of 500 men. The fifth was 60 by 312 feet in plan, all with concrete floors.

BARRACK CONSTRUCTION IN DIVISIONAL AREAS.

In the divisional areas in the advance section, in addition to the quarters for troops, there were erected mess halls, bathhouses, stables, and other miscellaneous buildings to supplement the existing billets. Twenty-three divisional areas were projected. In some of them the French had erected buildings which were taken over by the American Army. New construction in the divisional areas began early in 1918, under the section engineer, advance section, and continued after the armistice until the divisions began to move from the advance section toward the base ports. On November 11 work was stopped in the second, twentieth, sixth, twenty-second, and twenty-third divisional areas, and all of the available labor and material was concentrated in areas still unfinished.

On January 1, 1919, there had been constructed in divisional areas about 2,700 barracks and mess halls and 540 bathhouses. Demountable barracks of various types, generally 20 by 100 feet in plan, were used where available; otherwise barracks were constructed of rough lumber.

More barracks had been erected in the advance section on March 1, 1919, than in any of the other sections. On that date the total square feet of barracks in the advance section amounted to 11,632,887, or the equivalent of 5,816 standard barracks, 20 by 100 feet. By far the larger percentage of this construction was in the divisional areas. At Bourmont, third divisional area headquarters, for example, there had been provided 900,000 square feet of barracks, or the equivalent of 450 standard buildings, while at Chateauvillain, ninth divisional area headquarters, 608,800 square feet, equivalent to 304 barrack buildings, had been provided.

After the armistice the work of barracks construction outside of the divisional area limits was concentrated at such points as the embarkation center at Le Mans and other places in the immediate vicinity of the base ports.

REFERENCE DATA, TROOP SHELTER.

	Appendix number or file reference.
Report, D. C. & F. to C. G., S. O. S. (through C. E.), Mar. 12, 1919	Appendix No. 40.
Project reports of section engineers	Appendix Nos. 43 to 52, incl.
Report of engineer valuation board, Mar. 11, 1919	Appendix No. 42.
Type plans for barracks	Files, Drafting Room, D. C. & F.
Memorandum D. C. & F. to E. P. O., Mar. 28, 1919, giving square feet of troop and hospital barracks constructed	Files D. C. & F. 200.30/452.
Descriptive tabulation, barracks (drawings)	D. C. & F. 9184–44, 9185–44, 9187–44

Remount Depots and Veterinary Hospitals.

Acquisition from the French in July, 1917, of stables at St. Nazaire with a capacity of 2,400 animals, and an order placed with the French barrack bureau for 500 horse shelters, each with a capacity of 50 horses, were the first steps taken by the American Army to provide housing and medical attention for the animals in the American Expeditionary Forces. The stables thus acquired served as shelter for the first Cavalry regiment to arrive in France, though before many months had passed authorization had been given for further acquisition from the French, as well as for the construction of remount and veterinary hospital facilities.

Before all of the 500 horse shelters had been requisitioned from the French, steps had been taken to install remount depots and veterinary hospitals near several of the base ports, as well as in many parts of the advance section. When hostilities ceased and a large percentage of all construction was discontinued, space had been acquired, constructed or authorized in remount depots to accommodate 61,200 animals. The total authorized facilities in veterinary hospitals were for 39,100 animals. The total space for animals, available February 1, 1919, was: In remount depots, 39,700, of which 27,700 represented new construction; and in veterinary hospitals, 27,600, of which 16,500 was new construction.

At La Rochelle, St. Nazaire, and Bordeaux large remount depots and hospitals were constructed for the animals arriving from overseas and the facilities acquired and constructed at Bayonne served as a clearing station for animals purchased in Spain. Facilities were provided at Gievres, Selles-sur-Cher, and Sougy in the intermediate sections, and numerous small stations in addition to a large depot at Lux, were scattered throughout the advance section, through which animals passed on to combat units and through which they returned from near the front lines.

In the selection of sites for remount depots and veterinary hospitals the main considerations were proximity to standard-gauge railroads, with possibilities for construction of spurs or sidings; facilities for watering animals, sandy soil if possible, and good drainage. During May, 1918, a program of depot and hospital construction was formulated. A board, composed of Col. E. A. Gibbs, of the division of construction and forestry, and Maj. S. W. Bell, of the remount service of the Quartermaster Corps, recommended sites for installations, and visited the British areas to study methods of construction developed there during four years of war.

Standard horse shelters, accommodating 100 animals, were 216 feet long and 23 feet wide. They were sheathed with either lumber or corrugated iron and roofed with tar paper. In the center of each

stable provision was made for the storage of grain. The erection of these shelters constituted the main item of construction, though complementary construction included dressing rooms, operating rooms, dipping vats, sulphurizing chambers, blacksmith shops, and storehouses for forage and equipment. For shelter alone, each animal

(3535-F9) REMOUNT DEPOT AT CARBON BLANC, SHOWING TYPE OF HORSE SHELTER.

required from 80 to 140 feet b. m. of lumber, depending upon the ability to secure corrugated-iron sheathing, and 200 square feet of tar paper.

In general, remount depots were built for from 2,000 to 5,000 animals and near them were veterinary hospitals with provision for from 1,000 to 2,000 animals.

In addition to the construction necessary for the proper housing, feeding, and doctoring of the animals, there were required at all depots and hospitals, barracks, mess halls, buildings for office space and storage, for officers and enlisted men. Such construction was based on a personnel of 75 officers and approximately 2,000 men for every depot of 5,000 animals capacity.

The facilities provided involved the construction of 2,210,000 square feet of stabling and quarters for 650 officers and 17,000 enlisted men.

REFERENCE DATA, REMOUNT DEPOTS AND VETERINARY HOSPITALS.

	Appendix number or file reference.
Report, D. C. & F. to C. G., S. O. S. (through C. E.), Mar. 12, 1919	Appendix No. 40.
Files of D. C. & F. on individual projects	D. C. & F. Files
Report of section engineer officers	Appendix No. 43–52, incl.

Water Supply in the Service of Supply.

In many French municipalities and at hundreds of other places throughout the Service of Supply, which served as sites for hospitals, camps, depots, and shops—in fact wherever there was a concentration of American troops—it became necessary for the Engineer Department to supply water. This obligation resulted in the creation of a water-supply section, under the direction of Capt. (later Lieut. Col.) Thomas H. Wiggin, as a part of the organization of the office of the chief engineer, line of communications, and later of the director of construction and forestry. When the armistice was signed water-supply installations had been made, ranging from simple wells to city projects, including dams, pumping plants, pipe lines, reservoirs, filtration plants, and other accessories demanded by the best engineering practice. On all of the chief projects in the Service of Supply, water supply was one of the prime requisitions.

The necessity for special attention to the water-supply problems had been recognized by the Chief of Engineers, at Washington, and by the chief engineer, American Expeditionary Forces. During the summer of 1917 there were sent to France certain special water-supply personnel. Based on French and British experience, a requisition for a large quantity of pipes, pumps, valves, tanks, well-drilling outfits, and other special equipment was prepared and was translated into terms of American water-works practice by the office of the Chief of Engineers, at Washington.

During the latter part of August, 1917, the water-supply section, line of communications, in France, began its work with an inspection and listing of materials required for the Bazoilles Hospital which

had just been taken over from the French in an unfinished condition. This work was followed by a general investigation of the supplies for American troops in the vicinity of Bordeaux, La Rochelle, and St. Nazaire, and the Artillery camps at Souge, Meucon, and Coetquidan. In these inspections the officer in charge of the water-supply section, line of communications, was accompanied by the officer in charge of the water-supply section of the chief engineer's office. As the work developed there was a division of water-supply duties, the Service of Supply projects being handled by the division of construction and forestry, and the Army work by the division of military engineering and engineer supplies. (See p. 56.)

In October, 1917, a water-supply section was more definitely established under the chief engineer, line of communications. Its personnel was gradually increased until in June, 1918, there were 14 officers and 7 men. The system up to that time was a centralized one, so far as making the investigations, drawings, and requisitions were concerned. Plans were sent to Engineer officers in charge of construction for execution. There were, however, many smaller waterworks which were planned by the construction forces in the field. Beginning about June 1 the water-supply work was largely decentralized, the personnel of the central office being distributed to the various section Engineers for the purpose of planning as well as executing the works. The central office still maintained a supervising and advisory function and also occupied itself with following up the purchase and shipment of the necessary material and in listing and requisitioning material to maintain depot stock. This activity included also the preparation of tonnage priority statements which were cabled to the United States to govern the shipment of water-supply material needed.

GENERAL STANDARDS.

The first problems concerning the water supply and sewerage section in the Service of Supply were the determination of standards for the quantity of water to be supplied and for methods of disposing of sewage. These problems were linked, because the choice of water-borne sewage methods would have involved a comparatively large use of water. The question of sewage disposal was first brought to a definite point in a discussion with the Medical Department of methods to be used for the six 1,000-bed units to be added to the hospital at Bazoilles. For some of the masonry buildings which had been secured from the French for hospitals an inadequate water-borne sewerage system generally existed, and this was made a reason for continuing that style of installation in so far as

the masonry buildings were concerned. The quantity of plumbing material required for these installations was comparatively small, but when the installation of water-flushed closets for hospitals for the total American Expeditionary Forces was studied it became evident that material would be difficult, if not impossible, to obtain.

The scarcity of material, together with the extra amount of labor involved in installation, the extra quantity of water required for flushing, and the facilities required to purify the sewage before discharging it into French streams, caused the water-supply and sewerage section to recommend the use of incinerators for human excreta. This decision was accepted by the Medical Department for hospitals and was also put into effect for the other American Expeditionary Forces works, exception being made in a few cases as above, and also in some cases near the ocean where mixed sewage could be discharged into tidewater without purification.

DECISION AS TO QUANTITY OF WATER.

The water-supply section, office of chief engineer, American Expeditionary Forces, aided by the data furnished by the water-supply and sewerage section, chief engineer, line of communication, obtained at this time a decision of the general staff allowing 25 gallons per capita in hospitals and 10 gallons per capita in other places. These figures were understood to be a maximum which could not in all cases be supplied. In the summer of 1918, after investigation in a number of British hospitals operated by American units, it was recommended by the water-supply section, Service of Supply, and approved by the general staff, Service of Supply, to cut the allowance for hospitals to 12 gallons per capita where there were no central laundries and 14 gallons per capita where laundries were to be installed.

The decision generally to eliminate water-borne sewage made the problem of purification one of treating sink and shower-bath waste water containing considerable quantities of soap to the extent necessary to permit its discharge into streams. Considerable study had been given without success to this problem by the French engineers, and investigations of the subject in general and of the existing French and British plants showed the impossibility of complete purification. The treatment chosen was that of sedimentation for several hours and straining through straw screens. In some cases the effluent is sterilized by liquid chlorine.

FILTER PLANTS.

In general, water was supplied from tube wells, shallow dug wells, or streams, with or without filtration. At St. Nazaire it was necessary to build a rapid-sand filter plant of 3,000,000 gallons daily capacity and another of 1,000,000 gallons daily capacity to supply the ports and the various camps. At Mesves and Mars hospitals rapid-sand filter plants, each of about 500,000 gallons daily capacity, were installed, and at Savenay Hospital two plants, each of 330,000 gallons per day. At the Romorantin air-service plant two filters, each of about 200,000 gallons daily capacity, were placed, the first of their type to be built in France. Another rapid-filter plant was at Langres Hospital, and a slow-sand filter plant was built at the hospital at Chateauroux.

At Brest a supply to provide a maximum of 3,000,000 gallons daily was taken from the Penfield River and sterilized but not filtered, since this river is very clear throughout almost the entire year, and a reservoir of about a week's supply, with a by-pass channel, enabled the worst of the turbid water to be sent by without using.

DEEP WELLS.

At Bassens two unusually successful tube wells were sunk, having a capacity respectively of 550 and 580 gallons per minute, delivered water under a 40-foot artesian pressure. These wells had a depth of about 700 feet. At Beau Desert Hospital, near Bordeaux, a well 1,520 feet deep was sunk, from which 500 gallons per minute were obtained by pumping. Other wells of smaller capacity, the deepest 1,020 feet, were used in this vicinity and tube wells were also used successfully at Gievres, Montierchaume, Liffol-le-Grand, Bazoilles Hospital, Brest, and a number of other localities. The tube well was used wherever possible because it yielded clear water, thus doing away with a filter plant. Geological studies aided the location of wells. It was found, however, that generalizations as to underground water were only of limited value as the wells at Montierchaume, for example, proved successful in a country which appeared to be very unpromising.

STERILIZATION OF WATER.

A section of the water supply office was organized to have charge of the receiving, storing, erection, and repair of automatic sterilizing machines used for the armies. The largest work of sterilization undertaken by the American Expeditionary Forces was that of the city

of Tours, where about 1 part per million of chlorine was applied to from 4,000,000 to 5,000,000 gallons daily requiring the use of about 40 pounds of chlorine per day. This application was made under a contract with the city of Tours by which the city agreed to pay the estimated cost of the chlorine while the United States gave the use of the machines and supervised the operations.

LABORATORY SUPERVISION OF WATER SUPPLY.

Water analyses laboratories for the examination of possible supplies and for the periodic examination of supplies in use were also provided. In general, there was a water analysis laboratory in each section, there being nine in the Service of Supply. In most cases these laboratories were established as branches of a medical laboratory, but were technically responsible to the Engineer Department. In this manner the chlorination of the supplies was controlled. The laboratories were inaugurated by the joint efforts of the water supply section of the office of the chief engineer American Expeditionary Forces and that of the chief engineer line of communication, afterwards division of construction and forestry.

RAILROAD WATER SUPPLIES.

A special water problem was occasioned by the railroads, not only in connection with new yards and depots, but in augmenting the water supplies along the French railroads which were used by the American Expeditionary Forces. In some cases water could be supplied in connection with that furnished for other purposes, but in many cases there were needed separate installations, pumping from a river or well to existing French tanks or to new 50,000-gallon American railroad tanks, from which the water was distributed either through the existing French mains and railroad standpipe or through new 1-inch steel mains and American standpipes. A large program requiring hundreds of tanks, pumps and standpipes was under way at the time of the armistice. Only about 30 new tanks and 75 new standpipes were actually put into use, although a number of additional roadside water stations belonging to the French railroads were reinforced by the addition of pumps or force mains, or both. This work was handled through the office of the water supply section in conjunction with the water supply engineer of the transportation corps who determined the quantities of water required and the places at which tanks and standpipes were needed.

ST. NAZAIRE WATER SUPPLY.

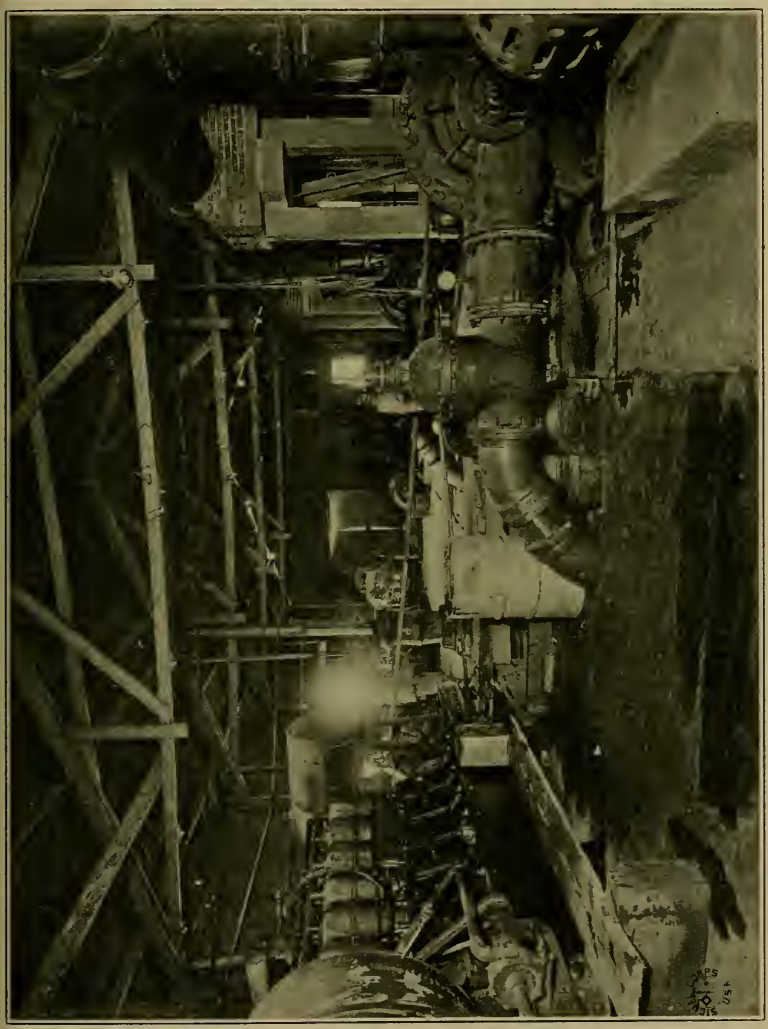
The water supply for the city of St. Nazaire offered so many difficulties that it constituted by far the biggest single problem. The city obtained its supply of about 1,000,000 gallons a day from two watersheds, having a combined area of about 4 square miles, with storage of about 160,000,000 gallons. In dry seasons this supply was reinforced by water brought in boats from a point about 15 miles up the Loire River. This country does not yield deep well water, as it is underlaid with granitic rock. The nearest additional surface water free from salinity is at a distance of about 15 miles.

(3425–F9) LAYING CAST-IRON PIPE LINE FEBRUARY 10, 1919, TO INCREASE WATER SUPPLY OF ST. NAZAIRE.

The combined French and American uses were estimated at 3,000,000 gallons per day. In the absence of the necessary large pipe and pumps an attempt was made to supply water for the first season by an additional reservoir of about 400,000,000 gallons. French records showed that normal rainfall was sufficient to fill this reservoir in addition to those owned by the city. It was intended ultimately to secure a more distant source and to assure the filling of this reservoir by pumping.

The winter of 1917–1918 proved to be exceptionally dry throughout France and not only did the new reservoir remain unfilled, but even the small existing reservoirs received no run-off. In this emergency, in the spring of 1918, recourse was had to the source at Pontchateau,

about 15 miles away, from which water was brought by 5 miles of force main supplemented by existing canals and a part of the tidal estuary from which the salt water was excluded by a dam. This makeshift tided over the summer of 1918. Early in 1919 the new reservoir at St. Nazaire was about three-quarters full, showing that



(3589-F9) INTERIOR OF TRIGNAC PUMPING STATION FOR ST. NAZAIRE WATER SUPPLY.

the assumptions upon which the previous year's plans were based were normally justified.

The St. Nazaire work involved the installation of 15 pumps, with a total capacity of 30,000,000 gallons daily. About 48,000 feet of 24 to 12 inch pipe, 60,000 feet of 8 to 4 inch pipe, and elevated tanks of 200,000-gallon capacity were used in the supply and main distribution systems alone.

WATER SUPPLY AT BREST.

The water supply of the docks and camps at Brest and vicinity offered another large problem. The original French systems which supplied Port du Commerce, Foutras Barracks, Bougen Fortress, and Pontanezen Barracks were insufficient and it was necessary immediately to 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 pipe line were laid. In order to supply all portions of the projects at 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 the constantly increasing needs at other points this original addition to the French supply became inadequate and further provision had to be made. It was estimated that for a full supply and to permit the use of the French system, particularly at Port du Commerce, to be dispensed with, 3,000,000 gallons per day would be necessary. 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 six pumps and with a total capacity of 4,700,000 gallons daily, were constructed. Forty-one thousand feet of 14 to 10 inch pipe and 10,000 feet of 6-inch and 4 inch pipe were used in the main supply and distribution system.

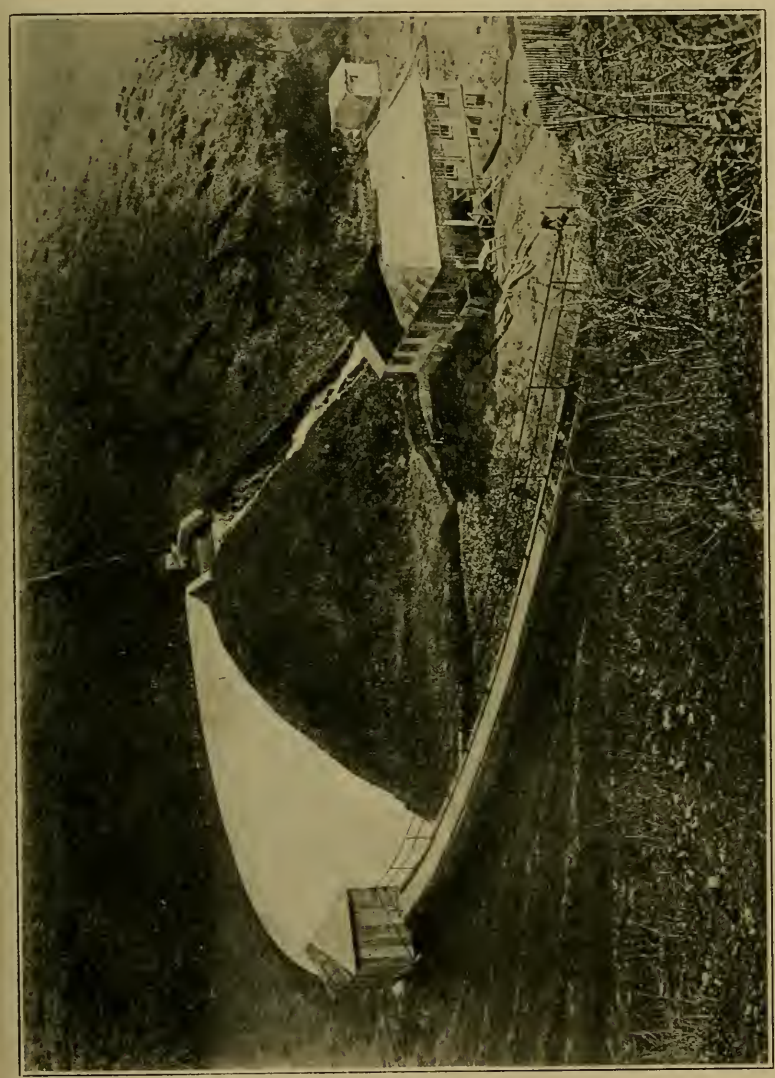
MISCELLANEOUS WATER-SUPPLY WORK.

Practically all the other large projects required water-supply installations of considerable magnitude, a few of which may be mentioned as of interest. For the Savenay 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 100,000,000 gallons, was constructed in addition to two 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 per day, were erected.

For the Mesves Hospital an installation practically duplication of 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.

The installations at the Montierchaume storage depot involved the aying of some 30,000 feet of 4-inch, 6-inch, and 8-inch pipe; pumpng 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



(3574-F9) THE CURVED CONCRETE DAM AT SAVENAY FORMED A RESERVOIR OF 100,000,000 GALLONS CAPACITY.

of a total capacity of 150,000 gallons. The general intermediate storage depot at Gievres called for even a larger installation than that at Montierchaume. The deep wells at Bassens, Beau Desert, and elsewhere have already been mentioned.

PURCHASE OF MATERIAL IN FRANCE.

Much of the activity of the water-supply section was in connection with the location, requisitioning, and following up of deliveries of pipe, fittings, pumps, engines, motors, and other special material found in France and required on account of the slow deliveries from the United States. In this way practically the whole of the material for the St. Nazaire water supply was secured, as well as more than half of all the pumping machinery of any considerable size for the whole work of the Service of Supply.

FIRE PROTECTION.

The desirability of fire protection was recognized at the beginning of the water-supply section's work, and estimates were presented periodically as to tonnage required for hydrants and piping. The extent to which this work was justified under the limitations of tonnage and labor, and the generally temporary nature of war installations, was a question requiring the decision of the highest authority, as the desired tonnage ran into tens of thousands. The water-supply section took advantage of the possibility of securing 200 miles of 4-inch cast-iron pipe and fittings on prompt delivery from England to establish the policy for the large hospitals of providing piping capable of carrying fire streams. Hydrants were also provided as fast as they could be obtained. The general question of fire protection was covered by the appointment by the commanding general, Service of Supply, of a bureau of fire prevention. Plans were made by the bureau for the installation of fire piping, reservoirs, and pumps in connection with many of the water-supply systems. However, lack of tonnage and the armistice prevented most of these installations from being made.

REFERENCE DATA, WATER SUPPLY.

Document.	Appendix No. or file reference.
Report, D. C. & F. to C. G., S. O. S., Mar. 12, 1919	Appendix No. 40.
Reports of section engineers	Appendix Nos. 43 to 52, incl.
Report, water-analysis laboratories	Appendix No. 13.
History, 26th Engineers	Appendix No. R–26.

ELECTRICAL INSTALLATIONS.

Early in 1918 Brig. Gen. M. M. Patrick, chief engineer officer, line of communications, ordered Capt. (later Maj.) J. B. Jackson to prepare an estimate of the probable power needs of the American Expeditionary Forces in France. It was then foreseen that power would be needed for the lighting of hospitals, camps, storage depots, and other Army centers, as well as for operating the machinery at

many shops for ordnance, motor truck, locomotive, and miscellaneous repair work. A thorough investigation of the situation was made and a report submitted estimating that the constructing program then contemplated would involve the utilization of 31,000 kilowatts, sufficient to keep about one and a quarter million electric lights burning.

As soon as these findings had been submitted, a department was organized under the chief engineer, line of communications, charged with the duty of making all investigations relative to power supply either from French sources or from power plants installed by the American Expeditionary Forces. The policy was adopted of utilizing, wherever possible, French power systems both by building transmission lines and by increasing the capacity of plants with machinery purchased by the United States Government.

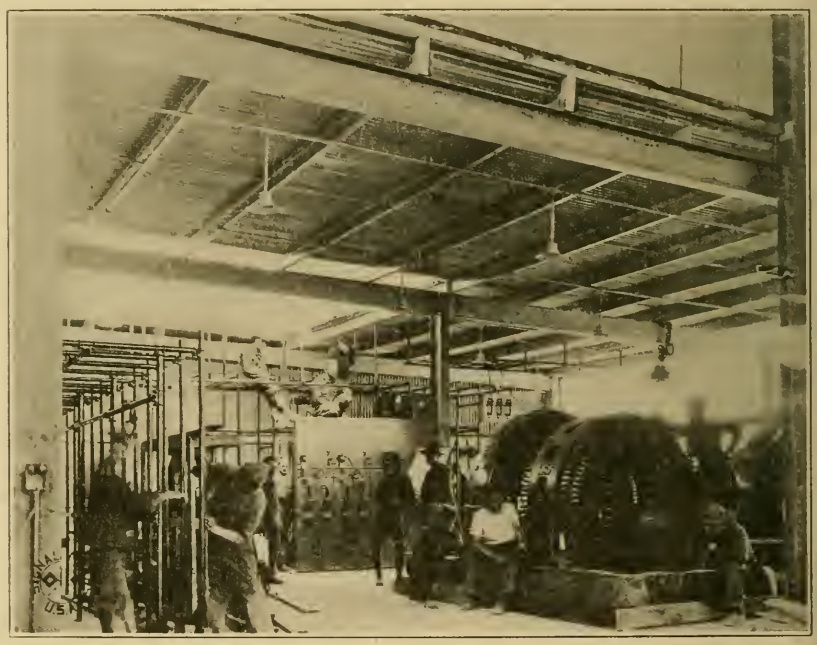
FRENCH POWER MOBILIZED.

All of the power-producing plants of France had been mobilized under Government control and placed under the French Ministere de l'Armament, from which it was necessary to obtain authority for the use of any power from French sources, by means of requests made through a centralized agency of the American Army. Inasmuch as the Ministere de l'Armament, as well as a large number of the main offices of the larger power companies, were located in Paris, it was decided that an American agency should also be located there. This resulted in the formation, by virtue of General Orders, No. 8, General Headquarters, American Expeditionary Forces, 1918, of what was called the technical board, placed under the control of the general purchasing agent and through the latter reporting to the commanding general, Service of Supply.

At the time of the creation of the technical board, its services as an advisory and coordinating agency were undoubtedly desirable because of the fact that control of construction work in the American Expeditionary Forces was not then unified, and three or more independent services were engaged in projects involving the use of power upon a comparatively large scale, with the resulting danger of competition among themselves and of straining an already overtaxed supply.

This situation was, however, changed when General Orders, No. 41, General Headquarters, American Expeditionary Forces, consolidated all construction work under a single control, namely, that of the chief engineer, American Expeditionary Forces. Thereafter the technical board should have been placed under the direct control of the chief engineer, American Expeditionary Forces, since its views and policies could be made practically useful only through their

being put into effect by some agency charged with work of construction. In the American Expeditionary Forces the only agency engaged in the construction and installation of electric light and power plants was the director of construction and forestry, who had succeeded to the functions of the chief engineer, line of communications, while the Engineer purchasing officer was, or should have been, the sole agency in the American Expeditionary Forces engaged in the purchase of electric light and power machinery and supplies in Europe. The activities of the technical board, therefore, impinged upon those of the two Engineer agencies just named, both controlled by the chief engineer, American Expeditionary Forces.

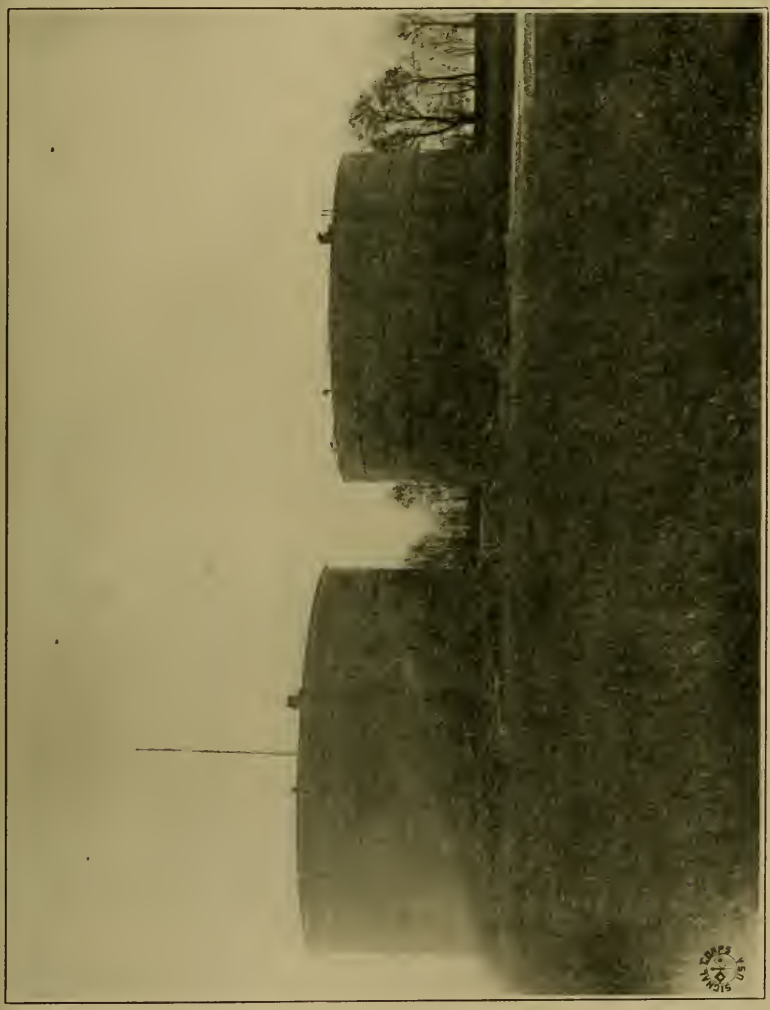


(583–S8) ELECTRIC SUBSTATION AT ORDNANCE BASE DEPOT AT MEHUN.

On questions of a technical nature, connection between the technical board and the Engineer Department was actually made through the Engineer purchasing officer in Paris, was charged with Engineer purchases in Europe and in respect to them came in contact with the general purchasing agent.

In the formation of the division of construction and forestry which succeeded to the work of the chief engineer, line of communications, all engineering, both design, supervision and construction in connection with electric power, was allotted to an electrical-mechanical section which had been consolidated with other sections into the plant construction division under Maj. Van Zile. The

work embraced all electrical and mechanical plants with the exception of water-supply installations. Wherever necessary the views of the technical board regarding proposed installations were solicited, but as a rule conditions indicated the most advantageous plan possible under the rigid limitations existing in France.



(3473-F9) TANKS FOR OIL STORAGE ERECTED AT BLAYE ON GIRONDE RIVER NORTH OF BORDEAUX.

WHERE ELECTRIC POWER WAS NEEDED.

Under the direction of the electrical-mechanical section were placed all electrical installations for hospitals, involving about one hundred and fifty 1,000-bed units, including the 20,000-bed hospitals at Mesves, Mars, Savenay, and Beau Desert, 10,000-bed hospitals at Beaune and Allerey, 5,000-bed hospitals at Perigueux, Kerhoun,

Reignac, Avione, La Suge, and Montoir, the latter four of which were just started at the date of the signing of the armistice.

Steam-generating stations.—Steam-generating stations involving approximately 3,000 kilowatts of power were designed and in process of construction when the armistice was signed. The larger of these were the 900-kilowatt plant for the bakery and storage project at Is-sur-Tille; a 1,000-kilowatt plant for the Bassens project, designed as an emergency stand-by unit for the American Army requirements to operate on a double-bus system with the system of the Energie Electrique du Sud-Ouest at that location; a 750-kilowatt plant for the air-service assembly and repair shops at Romarantin. Both of the latter plants were obtained in Spain, being complete power plants purchased on the ground, dismantled and shipped to France. A 650-kilowatt steam-generating plant was erected at Gievres in the refrigerating station to supply electric light at this locality. The design and construction of a 3,500-kilowatt plant at Aytre was being handled directly by the section Engineer officer, base section No. 7, to supply power for the car works at La Rochelle and docks at La Pallice.

Substations.—Three thousand kilowatts, in rotary converter substations, were designed and under construction. These were at Neuvy Pailloux to serve the tank factory; at Marseille, La Pallice, and St. Nazaire, to serve gantry cranes. A 2,500-kilowatt substation based on plans furnished by the ordnance department was constructed at Mehun to serve the ordnance shops. This installation necessitated the augmentation of an existing plant at Mazieres, near Bourges, with a 5,000-kilowatt turbine generator unit and construction of approximately 9 miles of 33,000-volt transmission line. The power requirements of the shop on October 1 were approximately 2,500 kilowatts, with an ultimate requirement of 7,200 kilowatts. Installation was made by Company B, 38th Engineers. A 2,500-kilowatt substation designed by the transportation department was constructed at Bassens to serve the projects at that point. Of this station 1,500 kilowatts was in rotary converters and the remainder in transformers for miscellaneous light and power, the work being done by Company B, 38th Engineers.

Transmission lines.—One hundred and twenty-five miles of transmission line were constructed or under way. Low-tension distribution systems and interior wiring of all hospitals, storage yards, warehouses, docks, shops, schools, and camps in the Service of Supply were installed.

Arrangements were made wherever possible to use electric power for all activities, including pumping, because of the recognized fuel economy in one large central plant as compared with a number of small units.

The signing of the armistice brought about the cancellation of a large share of the electrical construction program. It became necessary to arrange cancellations of many unfilled requisitions in depots, as well as a great number of orders which had been placed in the European market. However, a few projects remained which were of a very urgent nature, particularly those connected with ports through which troops would embark for the United States.

The locations of the principal mechanical plants for electric power purposes is shown on the accompanying map.

REFERENCE DATA, ELECTRICAL INSTALLATIONS.

	Appendix number or file reference.
Report D. C. & F., to C. G., S. O. S., Mar. 12, 1919	Appendix No. 40
Report, plant construction section, D. C. & F	Appendix No. 41
Personal experience report, Capt. J. B. Jackson	Hist.-Tech. File No. 2166
Reports of section engineers	Appendix No. 43–52, incl.
Report, technical board	Appendix No. 58

Gasoline Storage.

To the Engineer Department the Army's demand for liquid fuel meant the construction throughout France of gasoline and oil storage centers, the inception of which dates from the fall of 1917, when the prospect of 2,000,000 men in the American Expeditionary Forces led the chief engineer, line of communications, to formulate a plan of storage adequate to the needs of the increased force. French consumption per month per man was found to be 1.87 gallons. A per capita consumption per month for the American troops was arbitrarily set at 2.25 gallons, and all storage facilities were based on that figure.

On the basis adopted for the storage of all supplies, storage was required for 13,450,000 gallons of gasoline with the following distribution: Seacoast, 6,725,000 gallons; intermediate, 4,500,000 gallons: and advance areas, 2,225,000 gallons.

In October, 1917, La Pallice, St. Loubes, Blaye, and Furt were recommended as sites for the installation of eight 25,000-barrel tanks, giving a total storage, including facilities early acquired at La Pallice from the Bedford Petroleum Co., of 11,600,000 gallons. Recommendations were also made that tanks of smaller capacity be requisitioned from the States, and on October 10, 1917, an order was placed for the eight 25,000-barrel tanks, nine 10,000-barrel tanks, and one hundred and forty 320-barrel tanks.

Four tanks were erected at La Pallice, two at Blaye, and one at St. Loubes. The tank to have been erected at Furt was never finished. Five of these tanks were in operation at the cessation of hostilities, but owing to the failure of the concrete footing under one of the tanks at Blaye and the inability to secure material for pipe lines and

pumping plant, the two at Blaye, though finished, were never operated.

Footings for all tanks were installed by French contractors and the tanks were fabricated by the James Stewart Co. in the United States and erected by that company in France.

Intermediate storage was provided at Gievres through the erection of four 10,000-barrel tanks. The shops for the fabrication of small tanks at Gievres completed and tested sixty-nine 300-barrel tanks and one hundred and fifty 150-barrel tanks. Of this number twenty-nine 300-barrel tanks and one hundred and nineteen 150-barrel tanks were shipped to various distributing station sites. To facilitate installation all component parts were marked and shipped with the smaller tanks. Installation of intermediate and 300 and 150 barrel tanks was done largely by the James Stewart Co. under the supervision of Engineer officers. Thirty-seven complete smaller stations were distributed, 17 of which were installed, the remainder being canceled at the cessation of hostilities.

REFERENCE DATA, GASOLINE STORAGE.

	Appendix number or file reference.
Reports of section engineer officers in base sections 2 and 7, and in intermediate (west)	Appendix No. 44, 49, and 50
D. C. & F. files on Blaye, Furt, St. Loubes, and La Pallice	D. C. & F. Files
Personal experience report of Maj. Harry Van Zile	Hist.-Tech. File 455

Refrigeration and Bakeries.

REFRIGERATING PLANTS.

In addition to such cold storage as could be secured from the French, the division of construction and forestry built plants for the storage of frozen meats that gave a total refrigeration space of 14,900 tons. Facilities for the production of 500 tons of ice per day were also provided.

The plants at Gievres and at Bassens, built according to plans furnished by the Quartermaster Corps, were the largest, Gievres having a capacity of 7,500 tons and Bassens 6,000 tons. These figures are based upon full utilization of refrigerated space; that is, with elimination of alleyways. The original rated capacities of these plants, making liberal allowances for alleyways, were 5,200 and 4,000 tons, respectively.

Plans were prepared and equipment obtained from the United States for the duplication of the Bassens plant in the advance section, as well as for the duplication of the cold-storage building at the Gievres plant. Plans were also made for a 400-ton plant at Marseille, but these three projects were canceled by General Orders,

No. 54, Headquarters, Service of Supply, 1918. A beef-storage plant at Bendorf, Germany, for the supply of the Third Army, was authorized February 6, 1919, and is included in the total figures given above.

The beef-storage plant at Bassens is cork insulated throughout, 100,000 cubic feet of cork, obtained in the vicinity of Bordeaux,

(3162–D8) THE REFRIGERATION PLANT AT GIEVRES, SHOWING POWER PLANT BUILDING AT RIGHT AND BEEF STORAGE BUILDING AT LEFT.

having been used in the insulation. The floor is reinforced concrete over cork board on a 4-foot sand fill. The cold-storage rooms contain 25½ miles of 2-inch standard pipe. The engine room is modern in every detail; the refrigerating machines are driven by cross-compound condensing Corliss engines; the boiler has a capacity of 900 horsepower; and the reinforced concrete reservoir has a capacity

of 130,000 gallons of water. Due to the use of cork insulation and improved design, the amount of lumber used was only 931,000 feet, board measure. The plant began operation in June, 1918. Reference to the chapter on "Depots" will give detailed information on the Gievres refrigerating plant.

BAKERIES.

Of the several mechanical bakeries constructed by the division of construction and forestry, that at Is-sur-Tille was the largest, having a normal production of 800,000 pounds daily, and an emergency output of 1,000,000 pounds. Plans for the construction were furnished by the Quartermaster Corps. The construction involved the

(390–S8) INTERIOR OF BAKERY BUILDING AT CAMP GENICART.

erection of two steel-truss buildings, each 240 by 380 feet, with corrugated roof and sides and concrete floors throughout. All the machinery in the plant was electrically driven, power being furnished from a modern steam turbo-generating plant of 900-kilowatt capacity, the power house being a separate building 55 by 125 feet. Ovens were built in accordance with the standard British practice, in groups of seven, so arranged as to reduce to a minimum the chances of the entire plant being disabled at one time.

Mechanical bakeries of 150,000 pounds per day capacity were built at Brest and Bordeaux, and one installed at St. Nazaire had a capacity of 120,000 pounds. At the cessation of hostilities plans had been prepared for the construction of a bakery at Liffol-le-Grand with a capacity of 400,000 pounds daily. Plans were furnished for

the construction of field bakeries with an aggregate capacity of 600,000 pounds daily. Construction of facilities capable of producing 500,000 pounds daily was completed before the issuance of General Orders, No. 54, Headquarters, Service of Supply, 1918.

REFERENCE DATA, REFRIGERATION AND BAKERIES.

	Appendix number or file reference.
Report, D. C. & F. to C. G., S. O. S. (through C. E.), dated Mar. 12, 1919	Appendix No. 40
Reports of section engineers, base section No. 2, intermediate section west, and advance section	Appendix No. 44, 50, and 52

Road Work in the Service of Supply.

Road construction and maintenance was originally assigned as one of the activities of the director general of transportation, who was intended to have charge of construction and operation of all lines of communication. Some attempt at a subsidiary organization for this work was made, but very little actual construction done in the field. Later on, when this department was restricted to the operation of railways and a separate construction department formed, road work in the advance section was assigned to the department of light railways and roads (see p. 116), and all road work in base and intermediate sections included as part of the activities of the director of construction and forestry. During the early part of 1918 very little actual road construction and maintenance work was done under any of these departments. All activities were concentrated on works of vital necessity at that time. Such roads as were constructed were those made necessary to provide access to utilities, and a small amount of absolutely necessary maintenance work was done.

The program of work under the department of construction and forestry covered the lines of communication running from the base ports to the advance section. At the beginning of the year 1918 these roads were in better condition than those in other parts of France where the Allied Armies had been operating, and although it was impossible to furnish troops adequately for necessary maintenance, the roads stood up well under intense automobile traffic until the beginning of wet weather in the late autumn. It was realized, however, early in the summer, that systematic maintenance would be necessary and a separate division was organized as part of the general construction section under the director of construction and forestry, to direct and supervise this work. Study was made of the roads in use by the American Expeditionary Forces in each section and necessary road work classified under three heads: First, main lines of communication; second, minor roads utilized in distributing supplies to projects or to divisional areas where troops were concentrated; third, new roads required for the necessary communication

PORTABLE ROCK CRUSHER ON ROAD BETWEEN TOURS AND GIEVRES.

CATERPILLAR TRACTOR AND TRAILERS FOR HAULING CRUSHED ROCK ON ROAD BETWEEN GIEVRES AND BOURGES.

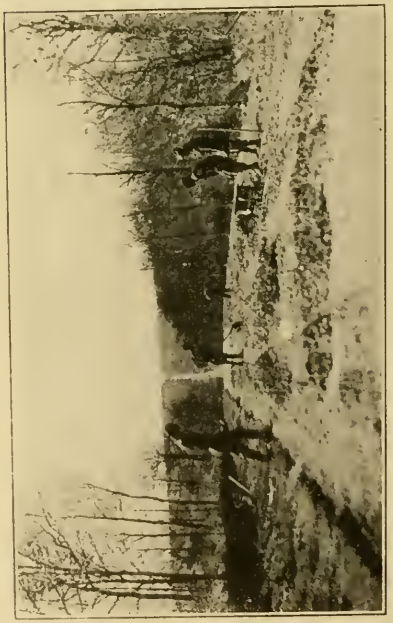
with hospital sites, storage yards, camps, etc. Total mileage of each class of road by sections is shown in the following table:

Section.	Lines of communication.	Existing roads in projects.	New roads to be built.
	Miles.	*Miles.*	*Miles.*
Base section No. 1	367	28.5	18
Base section No. 2	235	36	19
Base section No. 5	13	3.5	7
Base section No. 7	75	.....	.....
Intermediate section (east)	710	7.5	43
Intermediate section (west)	350	.....	.....
Advance section	250	70	80
Total	2,000	145.5	167

In each section an officer was designated by the section engineer to act as superintendent of roads, and had under his direction the necessary assistants for office work and supervision of the field operation, which were in general carried on by troops temporarily or permanently assigned for the purpose, as well as in some cases by Chinese labor or civilian forces hired for the purpose. All roads being of macadam construction, necessary material required consisted only of crushed rock. This was procured in two ways, either by purchase from existing French quarries whenever available or by the operation of local quarries, worked by our own forces, using portable crushing plants and wagon or motor transportation.

When the division of roads of the division of construction and forestry took over the supervision of all repairs in Service of Supply areas there were in all the sections small organizations maintaining such roads as were most vitally in need of repairs, but there had not been the opportunity to work out a comprehensive plan for road work, nor had the necessary machinery been ordered or the troops provided. A matter of first importance was, therefore, to plan a program for future work and make requisition for necessary troops and equipment. On August 1, 1918, the equipment on hand and the organizations in charge of road work were as shown in subjoined table:

Crushers	8	Plows (rooter)	4
Compressors	6	Rollers	23
Drills	11	Scrapers (slip)	2
Dump trucks	93	Scrapers (wheel)	20
Dump wagons	67	Scarifiers	4
Graders	8	Sprinklers (motor)	15
Plows (railroad)	12	Sprinklers (horse)	14
Trailers	6	Tractors	7



AFTER THE ARMISTICE—ROAD REPAIR WORK IN THE INTERMEDIATE SECTION.

Section.	Officers.	Men.
Base section No. 1	10	600
Base section No. 2	18	1,100
Base section No. 3	None.	None.
Base section No. 4	None.	None.
Base section No. 5	None.	None.
Base section No. 6	None.	None.
Base section No. 7	None.	None.
Intermediate section (east)	3	100
Intermediate section (west)	5	220
Advance section	8	500

There were in France, August 1, 1918, 1,150,000 troops, and the troop program for the future was approximately as follows:

To be in France—

Sept. 1, 1918	1,450,000
Oct. 1, 1918	1,750,000
Nov. 1, 1918	2,050,000
Dec. 1, 1918	2,350,000
Jan. 1, 1919	2,650,000
Feb. 1, 1919	2,950,000
Mar. 1, 1919	3,250,000
Apr. 1, 1919	3,550,000
May 1, 1919	3,885,000
June 1, 1919	4,235,000
July 1, 1919	4,585,000

It was estimated that there would be needed at least 15,000 special road troops in addition to labor battalions and details from combat units for maintenance throughout the winter, or a total of 30,000 to be employed on this work throughout the lines of communication by July 1, 1919, when it was expected that there would be an American Army of nearly 5,000,000 men in France. The necessary machinery to maintain the lines of communication adequately was estimated and two requisitions were prepared, one of August 6, 1918, and one of October 17, 1918, which were forwarded for purchase to Washington. These requisitions covered the following equipment:

Compressor plants, with power	120	Graders (12-foot)	80
Drills (complete with hose and connections)	480	Graders (8-foot)	40
Drill steel (tons)	200	Scrapers (slip)	300
Decauville cars and track	500	Scrapers (wheel)	300
Crusher plants, with power	120	Plows (light)	300
Rollers (10-ton)	120	Plows (railroad)	300
Rollers (5-ton)	50	Plows (rooter)	300
Scarifiers	80	Harrows	300
Tractors, 15 to 30 horsepower	40	Dump wagons	1,000
Tractors, 75 horsepower	80	Sprinklers	120

Up to the date of the signing of the armistice, none of this machinery had been received, but there had arrived on a former requisition prepared in the office of the chief engineer, American Expeditionary Forces, the following road equipment:

Crusher plants, with power	17
Rollers (10-ton)	23
Dump wagons	262

The road equipment that was available in the Service of Supply areas at the time of cessation of hostilities is shown as follows. Many of these items were rented or purchased locally:

Road equipment in Service of Supply areas.

Air compressors	20	Scrapers (wheel)	140
Crushers	24	Scarifiers	4
Drills	38	Sprinklers (motor)	2
Engines (gas)	14	Sprinklers (horse)	30
Engines (steam)	10	Tank wagons	4
Graders (road)	10	Tractors (gas)	28
Loaders (wagons)	2	Tractors (steam)	3
Plows	23	Trailers	10
Rollers (gas)	24	Trucks (dump)	88
Rollers (steam)	29	Trucks (cargo)	200
Rollers (horse)	2	Wagons	340
Scrapers (slip)	170		

During the last month of the campaign the successive advances of the American front necessitated a great amount of road construction to maintain the lines of communication, and the great shortage of machinery and equipment required that all available be taken from the zone of the Service of Supply, and accordingly there was removed from Service of Supply road work the following equipment:

Compressors with power, drills, etc.	2	Road graders	5
Crusher plants, with power	4	Mack dump trucks	90
Rollers (10-ton)	6	Sprinkler trucks	6
Scarifiers	2	Sprinkler wagons	4
Tractors	4		

A considerable quantity of small tools was available, and at the time of the signing of the armistice orders had been given for the forwarding for use at the front of all portable crushers in use at base and intermediate sections.

Immediately after the conclusion of the armistice, the department of military engineering and engineer supplies canceled all requisitions for road machinery and equipment that had been placed in the United States, and consequently none of the machinery that had been ordered under the program previously noted was ever

received, although cable advices indicated that a considerable quantity of it was on the wharves ready for shipment by November 11.

The motor traffic on the lines of communication did not diminish during the early part of the armistice period, which was coincident with the arrival of rainy weather. Due to insufficient maintenance, many sections of the main lines of communication began to deteriorate. Added to the necessity of maintenance on these roads was the need for constructing roads across the regions where hostilities had been carried on and for their extension into the occupied territories. Further, the added traffic brought on roads and divisional areas in the advance and intermediate sections as troops were brought back to rest areas pending their embarkation served to increase the amount of road-repair work required.

After conference between the American and French authorities an agreed plan for the maintenance of roads was formulated and published as General Orders, No. 2, General Headquarters, January 2, 1919. This order directed that all roads in continued use by the American Expeditionary Forces be maintained and kept in repair by our forces. In view of the shortage of machinery, it was ordered that work be done as far as possible by hand, employing the large number of idle troops for the purpose, and that the French cantonnier system of maintenance be adopted in principle, utilizing small detachments distributed over long sections of road rather than concentrating large units for work at one point. By this order all road work in France and Luxemburg was placed under the division of construction and forestry. Road work in the occupied territories was placed under the direction of the commanding general, Third Army, although the director of construction and forestry exercised general supervision in order to coordinate the entire scheme of road work in the American Expeditionary Forces.

In accordance with this order the director of construction and forestry made a change in his office, establishing a new road section under the general supervision of Col. J. H. Graham, with Maj. H. W. Durham as his principal assistant. Construction in the field, as before, was under the supervision of the respective section Engineers, and the authority of the Engineer of the advance section was extended to include supervision in Luxemburg and in the occupied territories of the work carried on by the Third Army. As a preliminary step, all section Engineers were immediately directed to make a complete new survey of road conditions in their respective areas, reporting all the mileage necessitating repair and maintenance classified as to whether necessity existed, first, for complete resurfacing; second, light resurfacing and repairs, or third, filling of pot

holes and worn spots only. They were also directed to arrange immediately for the necessary troops to do this work and for their distribution as might be required, and to arrange for the necessary rock supply either by developing quarries then in use, by opening new quarries, or by procuring rock supplies from existing quarries operated by the French. A compilation of reports received in accordance with these directions showed the following amount of road work to be undertaken:

	Mileage.
Base section No. 1	520
Base section No. 2	800
Base section No. 5	50
Base section No. 7	300
Intermediate section (west)	1,520
Intermediate section (east)	350
Advance section	3,180
Total	6,720

The organizations in charge of road work in the various sections were expanded as necessity developed. Other construction work having largely reached an end, it was possible to concentrate attention very largely on these activities.

Coincident with the issuing of orders for the concentration of men on road repairs the office of the director of construction and forestry devoted its particular attention to securing cooperation with the French road authorities in order to obtain all available assistance from them, and also to securing whatever machinery and equipment could be found in the American Expeditionary Forces, either held in storehouses or being salvaged from work in the advance section where it was no longer needed. To secure French cooperation the matter was taken up directly with the director of military roads in the department of public works of the French Government, Col. Mahieu, who, in conformity with the understanding existing between the French and American military authorities, issued orders to all chief engineers of departments calling their attention to the road repair program of the American Army, and directing their cooperation in supplying crushed rock for road repairs, by indicating to the American authorities additional sources of supply and by loaning to them whatever road machinery might be available.

The greatest shortage in the American equipment at this time was road rollers. Consequently special attention was directed to procuring for major repairs as many as could be found. It was discovered that a considerable number of these were in the hands of the French road authorities at Versaille and other points, and application made to them resulted in their agreement to send 48 from their

stock. At the same time those privately owned were rented wherever possible. A small number of portable crushers in the Engineer storage depots were distributed for immediate use. At the same time search was made in all sections for commercial quarries and for stocks of crushed rock.

The next most vital necessity to permit of the utilization of the forces available was transportation, both motor and rail. Energetic steps were taken to secure motor vehicles as fast as they could be made available and turned over to the section Engineers, and arrangements were made through the Transportation Corps for supplying cars for the moving of crushed rock from quarries distant from the scene of work. It was developed that commercial supplies of crushed rock could be found only in a few portions of France, first in the hilly country extending from the Vosges and down toward Auvergne; second, in western Normandy and Brittainy; third, in the Province of Vendee; and fourth, in the vicinity of the Pyrenees and the hilly country immediately north of that region and east of Bordeaux. In other regions rock supply was mainly secured from small quarries operated with portable equipment by our own forces.

At the commencement of the enlarged program, particular attention was directed to three regions and immediate steps taken to supply equipment for work here. First, territories in which the armies had been operating where, naturally, roads were in worse shape and the necessity for continuous transporation most important; second, the embarkation camp at Brest, on which a very concentrated traffic was thrown with the beginning of the return of troops to the States; and, third, the divisional areas around Le Mans, into which troops scheduled for return were moved to await shipping. Due to its greater mileage, the advance section called for a larger amount of road machinery than any other, and in this region there were immediately distributed all salvaged rollers and other machinery which had been in use during active military operations. The Pontanezen Camp suddenly outgrew the available rock supply in that vicinity, and it also became necessary to concentrate on this point and to divert there, temporarily, rock shipments originally intended for adjacent sections. At the same time the rapid expansion of billeting areas around Le Mans threw a heavy traffic on surrounding highways which had heretofore received no attention, and developed a need of maintenance work and supply of crushed rock only secondary in importance to the work at Brest.

By March, 1918, organizations in all sections had been properly developed and adequate supplies of crushed rock were secured, or were in process of acquisition, and enough major repairs had been made to permit of concentrating on maintenance. The following

table shows number of troops on work and the weekly supply of rock at this time:

Section.	Total number of men during week.	Rock distributed during week (tons).
Base section No. 1—St. Nazaire	4,330	6,080
Base section No. 2—Bordeaux	4,290	5,380
(Gravel distributed during week, 1,365 tons.)		
Base section No. 5—Brest	21,630	13,635
Base section No. 7—La Rochelle	960	630
(Gravel distributed during week, 166 tons.)		
Intermediate section (west)—Gievres	13,160	3,800
Intermediate section (east)—Nevers	2,085	2,850
Advance section—Neufchateau	63,000	19,000

SUMMARY.

Total number of men on road and quarry work in France	109,455
Total tons of rock distributed during the week (Mar. 1, 1919)	51,375

By April 1, 1919, crushed rock was being received from about 78 quarries in France in the base and intermediate sections, exclusive of those operated in the advance section. Of this number 9 were in base section No. 1, 17 in base section No. 2, 8 in base section No. 5, 4 in base section No. 7, 3 in intermediate section (west), and 9 in the intermediate section (east). Of this total, 45 were operated by American forces and 33 by the French. The larger quarries, with their daily outputs, included St. Etienne, 350 cubic meters; Brest No. 2, 281 cubic meters; Bruz, 180 cubic meters; Villeneuve, 160 cubic meters; La Fontaine-Sees, 230 cubic meters; St. Ouen, 205 cubic meters; and Mesves, 121 cubic meters.

The extent of the road work is indicated by figures of the director of construction and forestry, covering the 10-day period, March 11 to 20, 1919, inclusive, during which time 98,500 men were employed on road work in France, Luxemburg, and occupied Germany, and 127,000 tons of rock were handled. From the beginning of the year to the middle of April, 1919, it was estimated that 865,000 tons of rock had been employed on road repair and maintenance in France and Luxemburg and 200,000 tons in occupied Germany.

By far the largest amount of work was done in the advance section, where, on April 10, 32,361 men were engaged on road work. The distribution of the road force in the base and intermediate sections on April 10, 1919, was as follows: Base section No. 1, 4,839 men; base section No. 2, 6,151 men; base section No. 5, 1,930 men; base section No. 7, 1,293 men; intermediate section (west), 12,424 men; intermediate section (east), 2,716 men. The above figures include labor by troops and prisoners of war.

To reduce the amount of work on roads in the advance section, Bulletin No. 30, General Headquarters, April 10, 1919, prescribed that after April 15, 1919, only one road would be maintained by American troops from the American areas in eastern France to Luxemburg and

occupied Germany. Instructions specifically limited all trucks, whether going to or returning from Luxemburg, to this one road, between Neufchateau and Luxemburg by way of Vaucouleurs, Void, Commercy, St. Mihiel, Verdun, Etain, Spincourt, Longuyon, Longwy, Luxemburg.

The policy was adopted, in so far as it was possible to do so, to use prisoners of war on road work; in April, 1919 the number thus employed totaled 16,000, the majority of them being stationed in the advance section. As rapidly as possible American troops employed on road work were relieved by prisoner companies, while the effort was made to substitute French cantonnier and civilian labor to release American troops for return to the United States.

REFERENCE DATA, ROADS.

	Appendix number or file reference.
Report, D. C. & F. to C. G., S. O. S., Mar. 12, 1919	Appendix No. 40.
Reports, section engineers	Appendix No. 43–52, incl.
Monthly reports and history, 23d Engineers	Appendix No. R–23.

Air Service Construction.

At the time of the armistice two-thirds of all authorized covered storage for the air service had been completed. This space totaled 7,575,103 square feet, was divided among approximately 30 main projects, and afforded depots for the storage of planes and spare parts, for the salvage of machines disabled at the front, and for the rebuilding of all motor transportation required by the air service.

The largest of the air service installations was the main assembly and salvage depot at Romorantin, near the large storage depot at Gievres. It contained not only shops, storehouses, warehouses, and hangers for the storage and repair of planes and motor vehicles used by the air service, but later authorizations included a balloon depot and repair station and a 1,000-bed hospital.

Construction at Romorantin was authorized December 27, 1917. The Engineers began grading for trackage January 21, 1918, and the same day air service personnel began erecting barracks. The working forces steadily increased until the maximum of 2,684 men were employed. When the armistice put a stop to all air service construction the Romorantin depot was 65 per cent complete, 2,032,000 square feet of the 2,804,200 square feet authorized space being ready for occupancy.

The construction consisted of 1,297,000 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.

Completed construction at Romorantin included 5 fabrication plants, each 500 feet square; 5 warehouses, each 50 by 400 feet; 1 storehouse, 50 by 400 feet; a motor transport unit containing 50,000

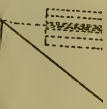
square feet; 6 buildings for the storage of engines and spare parts, giving a total of 150,000 square feet; 307 barracks, giving 616,000 square feet of space; 2 quartermaster storage warehouses, 50,000

(3502–V8) STEEL-FRAME HANGAR CONSTRUCTION FOR AIR SERVICE AT LATRECEY.

square feet; hangers yielding a total covered storage of 371,000 square feet; a 1,000-bed hospital, 126,000 square feet; machine-gun test shed; 2 engine test sheds; and a balloon storage hanger, 24,200

(3195–D8) TYPES OF STRUCTURE AT ISSOUDUN AVIATION INSTRUCTION CENTER.

square feet. Approximately 11 miles of track were laid and the surfacing of 119,500 square yards of roads. The foundations for a 750-kilowatt power plant had been laid, and the machinery was in place when construction was stopped.



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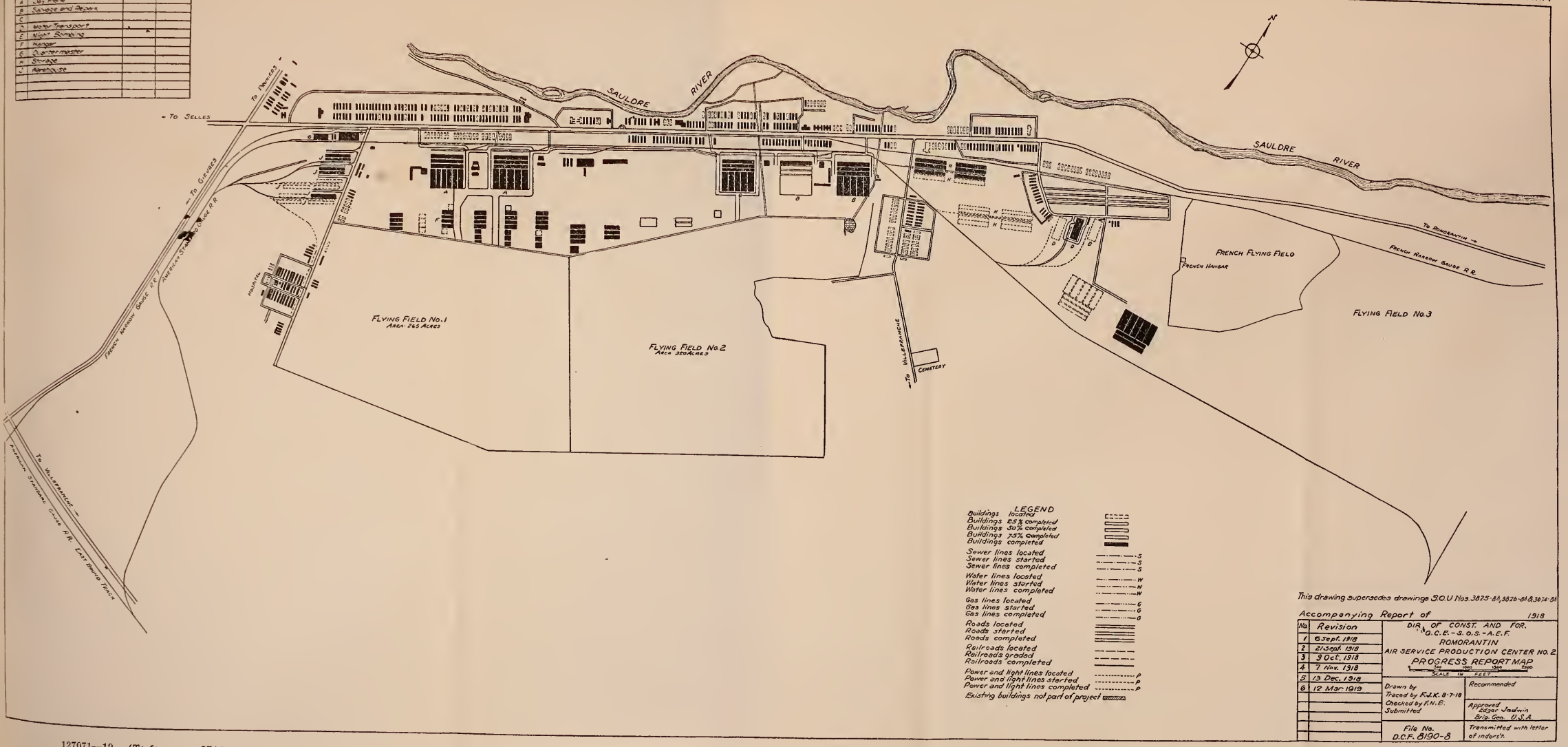
WAR DEPARTMENT

CORPS OF ENGINEERS U.S. ARMY

TABULATION OF BUILDINGS

Ref.	BUILDING	SIZE	SQ. FEET
A	Gas Plant		
B	Salvage and Repair		
C			
D	Motor Transport		
E	Night Bombing		
F	Hangar		
G	Quartermaster		
H	Storage		
J	Warehouse		



LEGEND

Buildings located
Buildings 25% completed
Buildings 50% completed
Buildings 75% completed
Buildings completed

Sewer lines located — S
Sewer lines started — S
Sewer lines completed — S

Water lines located — W
Water lines started — W
Water lines completed — W

Gas lines located — G
Gas lines started — G
Gas lines completed — G

Roads located
Roads started
Roads completed

Railroads located
Railroads graded
Railroads completed

Power and light lines located — P
Power and light lines started — P
Power and light lines completed — P

Existing buildings not part of project

This drawing supersedes drawings S.O.U. Nos. 3825-81, 3826-81 & 3824-81

Accompanying Report of 1918

No.	Revision
1	6 Sept. 1918
2	21 Sept. 1918
3	9 Oct. 1918
4	7 Nov. 1918
5	13 Dec. 1918
6	12 Mar. 1919

DIR. OF CONST. AND FOR.
O.C.E. - S.O.S. - A.E.F.
ROMORANTIN
AIR SERVICE PRODUCTION CENTER NO. 2
PROGRESS REPORT MAP
Scale in Feet

Drawn by
Traced by F.J.K. 8-7-18
Checked by F.N.B.
Submitted

Recommended

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

File No.
D.C.F. 8190-8

Transmitted with letter of indorsh.

The fabricating plants were the largest pieces of construction. In all, five completed plants there were used, English, French, and American steel units, and each fabricating plant contained at least eight of these units, depending upon the size or the kind of units used. Most of the hangars erected were of the American steel-frame type, 65 by 100 feet, complete details of which are found in Appendix 50.

There was considerable clearing and draining necessary to make the two completed flying fields, totaling 585 acres, ready for use.

Although the work was done under the administration and direction of the section engineer, intermediate section (west), most of the personnel used came from aero construction units and temporarily assigned troops of other branches of the service. Several Chinese labor companies were also employed.

Among the other larger installations made for the air service were those at Issoudun, Orly, Latrecey, St. Jean des Monts, Tours, Colombey-les-Belles, and Aulnat, though none of these installations were complete when hostilities ended.

An acceptance park was built at Orly, near Paris, as well as an experimenting field and an air-service depot. All construction authorized there had been completed, total space being 616,000 square feet. An aerial gunnery school was erected at St. Jean des Monts.

Minor installations were made for the air service at Amantry, Autreville, Chatillon-sur-Seine, Chatenay, De Louze, Ourches, Vaucouleurs, and Vinets, in the advance section; and at St. Maxient, in the intermediate section.

In all construction most of the covered storage was afforded by the erection of either English, French, or American steel hangars, complementary construction, including the erection of barracks, latrines, mess halls, etc.

REFERENCE DATA, AIR-SERVICE PROJECTS.

	Appendix number or file reference.
Report, D. C. & F., to C. G., S. O. S. (through C. E.), dated Mar. 12, 1919	Appendix No. 40.
Reports of section engineers	Appendix No. 50 and 52.

Construction for Motor Transport Corps.

The principal work done by the division of construction and forestry for the Motor Transport Corps consisted of the construction of motor reception parks at base ports. The installations at Brest were among the largest, three separate parks being built. Near the Port du Commerce, 8 small buildings were either overhauled or built, the largest being a garage 25 feet by 230 feet; in the Place de la Liberte, a repair shop and 2 garage sheds were erected; in the Rue de Paris,

(1258-F9) BUILDING FOR MOTOR RECEPTION PARK CONSTRUCTED AT BREST.

(3389-F9) STEEL-FRAME BUILDINGS ERECTED AT MOTOR RECEPTION PARK NEAR BASSENS.

14 buildings were erected. The largest of the latter group was an erecting shop with a floor area of 20,000 square feet.

Motor reception parks were either built new or installed in rehabilitated French buildings in Le Havre, La Pallice, Bordeaux, and Marseille. In each case they included buildings for the storage of new cars, the repair of trucks, motor cycles, and automobiles, and the storage of spare parts, besides the buildings for operating personnel.

Other installations for the Motor Transport Corps included overhaul parks in the intermediate and advance sections and various supply depots.

The reception park at Verneuil was the largest of the Motor Transport Corps installation. Although the latter part of the construction, and the partial supply of materials during the entire construction, were undertaken by the division of construction and forestry, the bulk of the work was done by motor-transport personnel.

REFERENCE DATA, MOTOR-TRANSPORT CONSTRUCTION.

	Appendix number or file reference.
Report, D. C. & F. to C. G., S. O. S. (through C. E.), dated Mar. 12, 1919	Appendix No. 40
Reports of section engineers, base section Nos. 1, 2, 5, and 6, and intermediate section (west)	Appendix Nos. 43, 44, 47, 48, and 50

Forestry.

The forestry section of the division of construction and forestry was organized to supply the American Expeditionary Forces and to a small degree the French and British Armies with forest products cut in accordance with the principles of French forestry from the carefully managed forests of France. Although the forestry section, even at the crest of its activities, contributed only in a small way to the timber needs of the French and British forces, the request of the Allies for this assistance upon our entry into the war represents the birth of a forestry branch in the American military organization. The conservation of tonnage, which quickly became a grave problem, made necessary the elimination, in so far as possible, of the transportation of war material across the water and its procurement in France, and as a result the French and British had already developed their lumber-producing services to a large degree when the United States entered upon the scene.

ALLIES REQUEST AMERICAN FORESTERS.

The request of the British mission to the War Department in Washington for the loan of one regiment of forestry troops was quickly granted, and likewise the similar request from the French, without much realization of the needs of the American Army in this

respect. These needs did not become apparent until a few weeks later, early in May, 1917, when the preliminary investigations of Gen. Pershing's staff and the information contributed by the French mission indicated the immensity of the task before the American Army in preparing for its activity in France. They showed that vast

(138-M8) FORESTRY TROOPS FELLING TIMBER AT GIEN.

quantities of lumber and forest products would be required in developing port facilities, lines of communication, and in the general housing and supply of the American forces.

The harbors, railroads, warehouses, barracks, and hospitals serving the French and British were being used to the limit of their capacity, thereby making necessary completely new developments of this char-

acter for the American forces. The ports of Bordeaux, St. Nazaire, and Brest were placed at the disposal of the United States by the French, who, at the same time, pointed out that the meager peacetime facilities at these points of entry were entirely inadequate and barely served as beginning for the tremendous load that would be placed upon them by military activity.

Consequently the Chief of Engineers, United States Army, to whom had been delegated the organization of the Forestry regiments for the British and French, realized the urgent and immediate need of the American Army for a large number of forestry troops to serve itself, a need so urgent that these troops must be set to work in France in advance of all other troops, to produce piling and timbers for the immense wharves to be immediately constructed, ties for railroad yards and sidings, lumber for warehouses, barracks and hospitals, and cordwood for fuel. In view of the needs of the American Army assistance was not given to the French and British as soon as had been originally intended, but nevertheless the 6th Battalion served the British from April 1 to September 30, 1918, and the 7th Battalion worked for the French from March 1, 1918, to February 1, 1919.

FIRST FORESTRY REGIMENT ORGANIZED.

During the months of May and June, 1917, the War Department formally authorized the organization of the 10th Engineers, and solicited the Forest Service of the Department of Agriculture to bring together the personnel and designate the required equipment. Maj. (now Col.) James A. Woodruff, deputy director of construction and forestry, was made the regimental commander, and under his direction this regiment, the first of its kind in American history, came into being as rapidly as the obstacles attending the formation of such a new unit and service would permit.

Upon his arrival in France August 20, 1917, Lieut. Col. Greeley was assigned to the examination of forests which had been tentatively offered for American exploitation by the French ministry of armament.

After lengthy discussions and conferences with the French the American Expeditionary Forces was admitted to membership on the "Comite Interallie des Bois de Guerre," which had acted up to that time as a Franco-British committee solely for the approval of timber purchases and their allocation to the respective armies. With the inclusion of the Americans the committee became a much broader organization, filling requisitions from the different allies and adjusting rival claims for the exploitation of the same areas.

The complete absence of information as to the conditions under which these troops must operate, such as the character and size of timber, the topography, transportation facilities, location of the tim-

ber with respect to the point of use, led to the sending to France of two men to secure and report information on these points of uncertainty. These men were Henry S. Graves, Chief Forester, Forest Service, commissioned as a major in the Engineer Officers' Reserve Corps, and Barrington Moore, private forester, familiar with France, the French language, and the French forest service. They discovered immediately upon their arrival early in June that suitable tracts of timber must first be located and acquired, either from private owners or from the state. Consequently, Maj. Greeley and 12 men, expert in estimating, examination, and mapping of timberlands, reached France during July, 1917, and immediately set to work to secure timber for the coming forestry troops. This force then became the forestry section with headquarters at Paris, with Lieut. Col. Graves in charge, under the Engineer purchasing officer.

ORGANIZATION DEVELOPED.

The program at that time consisted of the production of 12,000,000 feet per month of sawed lumber and ties, 15,000 telephone and telegraph poles, 16,000 small poles and pickets, and 35,000 steres of fuel wood. For the fulfillment of this program a much larger operating force was required in France, and additional troops were authorized under the designation of the 20th Engineers (forestry). This unusual regiment was organized by Col. W. A. Mitchell, and consisted of 10 battalions of forestry troops and 3 highway battalions, while 36 service companies were ordered for forestry work. By July 1, 1918, the forest Engineers in France comprised the following:

10th Engineers (2 battalions)—6 companies.
20th Engineers (10 battalions)—30 companies.
41st Engineers (1 battalion)—4 companies (highway).
42d Engineers (1 battalion)—4 companies (highway).
43d Engineers (1 battalion)—4 companies (highway).
503d Engineers (1 battalion)—4 companies (service).
507th Engineers (1 battalion)—4 companies (service).
517th Engineers (1 battalion)—4 companies (service).
519th Engineers (1 battalion)—4 companies (service).
523d Engineers (1 battalion)—4 companies (service.
531st Engineers (1 battalion)—4 companies (service).
533d Engineers (1 battalion)—4 companies (service).

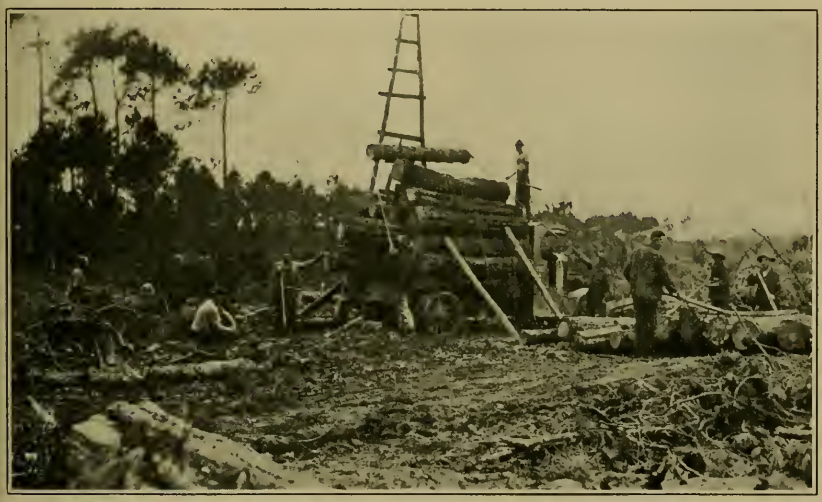
The first troops to arrive, the 10th Engineers, struggled against the handicap of having at the outset, almost no equipment. By July, 1918, the equipment for the entire two regiments was sufficient for the performance of their program, with a few minor exceptions. In the meantime the original program had been expanded in keeping with the increased troop movements to France, to the amount of

40,000,000 feet of sawn lumber monthly and a proportional increase in the amount of piling, poles, fuelwood, and other forest products.

In February, 1918, the forestry section was moved to Tours with the headquarters of the chief engineer, line of communications, became a part of the reorganized Service of Supply, and found its place as the forestry section of the department of construction and forestry, under the chief engineer, American Expeditionary Forces. The organization of the forestry section itself consisted of central headquarters at Tours, comprising the following officers:

Adjutant: To care for the military administration of the forestry troops.

Acquisition: To handle the purchasing of timber, in direct charge of Lieut. Col. Greeley.



(463-S8) FORESTRY TROOPS LOADING MOTOR TRUCK IN CASTETS DISTRICT.

Technical equipment and operation: To provide technical equipment for the forestry operations, and to supervise the methods of operation, under the immediate direction of Lieut. Col. George H. Kelly.

Shipments and products: To distribute among the various operations the requisitions for forest products received from all branches of the American Expeditionary Forces and provide transportation, under the immediate direction of Lieut. Col. R. A. Johnson.

In the beginning the purchase of timber was made with little regard for location, so that the troops might be placed immediately at work upon their arrival. Later, however, as the acquisition of timber gradually gained headway on the needs, more attention was given to the location of timber tracts with respect to the products

required by the various services of the American Expeditionary Forces and to the point of ultimate use.

Eventually all such questions as size and kind of timber, logging conditions, proximity of the timber to projects upon which the output would be used, and the shipment of the products by railroads and highways in such a way as to prevent congestion, were given careful consideration in the acquisition of timber tracts. This naturally led to the distribution of forestry troops over a wide area, extending in a belt from the western coast of France to its eastern frontier, with a large group south of Bordeaux, in the Department of the Landes, and a smaller group in the plateau region of south central France, in the Department of Cantal.

107 MILLS OPERATING.

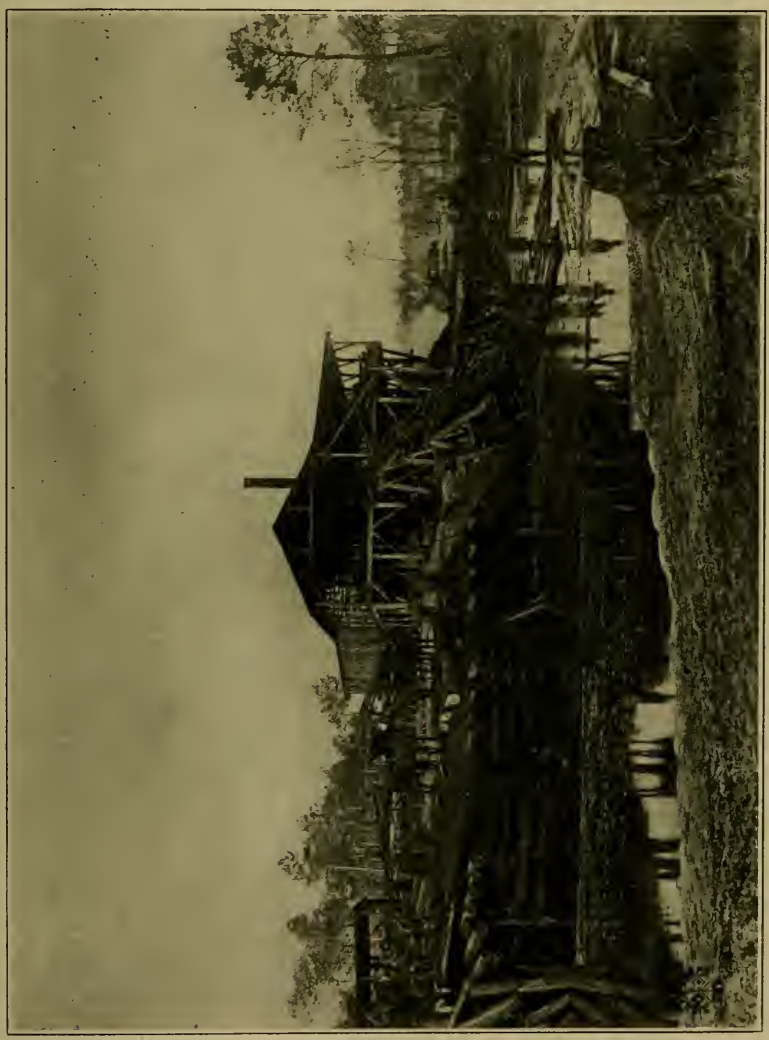
The largest number of active operations was in October, 1918, when there were 107 mills of varying capacity. This scattering of the forestry operations over such a wide territory made imperative the grouping of operations into districts, each in charge of a district commander, of which there were 14 at the height of activity. Each district had a district office organization, copying in minature the central office organization, and to him the operation commanders within his district were responsible. The district commander in turn was directly responsible to central headquarters.

To this plan there were two exceptions, namely, the operations in the Landes and those in the advance section, which were made responsible to two section forestry officers attached respectively to the office of the section engineer, base section No. 2, and of the section engineer of the advance section. The purpose of this arrangement was to facilitate and expedite the action upon requisitions received in those sections. Lieut. Col. Chapman became the section forestry officer for the advance section, with headquarters at Neufchateau, and Lieut. Col. Benedict for the operations in the Landes, with headquarters at Bordeaux, base section No. 2. The responsibilities of the section forestry officer at Bordeaux were greatly increased by the difficulties and intricacies of the transportation problem in the Pontenx, Mimizan, Dax, and Labrit districts. Maj. La Londe was stationed at Bordeaux, even prior to the designation of the section forestry officer, to work out the transportation problems of the Landes operations, thereby supplementing the work of the individual districts in the Landes territory.

HOW FIELD WORK WAS ORGANIZED.

The organization of each individual operation resembled very closely the general scheme of any representative American commercial logging job, with a camp superintendent in the person of the

operation or company commander, a mill foreman, usually a lieutenant, and woods foreman or logging boss, a lieutenant. The military administration and operation were either combined under one lieutenant or divided between two or more. This general arrangement varied with the requirements of each job, with a less or greater



(3466-F9) SAWMILL AT CAMP BROOKINGS IN THE DAX DISTRICT. DECEMBER 14, 1918.

number of officers and men, depending upon the work to be done; as in the case of the Pontenx district, an officer was placed in charge of railroad operations with a separate corps of locomotive engineers, brakemen, conductors, and repair men; or, as at Subligny-Villeroy, in the Gien district, an officer was placed in charge of road repair with troops assigned to that special task.

Although the report upon which purchase of a tract was based provided a plan of operation indicating the position of the mill, sidings, roads to be used, the methods to be followed in logging, etc., nevertheless the actual exploitation of a body of timber and the ultimate success of the operation rested almost entirely upon the operation commander. Some assistance could be obtained from his district commander, and in turn from central headquarters. It is these operations, frequently secluded and isolated in dense forests, ranging in size from small detachments with a tiny Bolter mill driven by a gasoline engine and a small complement of woods tools, to a camp of 3,000 men operating tandem 20M mills driven by 200-horsepower engines, which represented the task and achievement of the forestry troops.

SPEEDY WORK IN PRODUCING TIES.

Examples of the resourcefulness and high sense of duty demanded in order to obtain maximum results may be picked from any of the individual companies or their detachments, but exemplifying the whole may be quoted the instance of the 4th Battalion at Mimizan, which had produced 10,000 ties in France 38 days after the organization of the battalion was authorized and 11 days after it had landed in France. Lacking harness for their draft animals, the men of this battalion set to making harness out of the materials at hand. Gunnysacks were transformed into breaststraps, tugs and reins were made of rope, and sixtypenny nails did service as bits for the makeshift bridles.

In other operations, where horse transportation was lacking, the products were carried from the woods to the railroad on the backs of men, particularly in the case of much lighter products as ties, poles, and cordwood; for weeks logs were dragged on the ground by hand and piling was brought out of the woods on logging wheels improvised from dump carts and the running gears of transport wagons and pulled by teams of 20 men. Much of this work was done in continuous cold rain, for which the men were not properly dressed, and which was the harder to bear from the fact that they had no stoves in their tents during the worst of that time.

It is only just to these men that some of their unspectacular triumphs be recorded. Although coming from the forest and mountain regions of the United States and possessed of that adventurous turn of mind found in the best of soldiers, they were obliged to prove their mettle under very uninspiring circumstances. Working monotonously in quiet French forests, often very remote from the war, they still maintained a splendid morale. Having no contact with the enemy, they were denied the stimulus of combat and never knew the exhilaration of victory.

HOW RUSH ORDERS WERE FILLED.

To one district came an order for entanglement stakes. The order was marked "Rush"; the stakes were needed in a hurry. The operation lacked horses, wagons, and motor vehicles, but there was no stopping on that account. A standing order was issued that no man should return from the woods without all the entanglement stakes he could pack. At once, from every quarter, stakes were moving out of the woods on the backs of men in an endless stream. That the order was promptly filled is evidenced by the wire which was soon received: "Stop sending stakes; can't use any more."

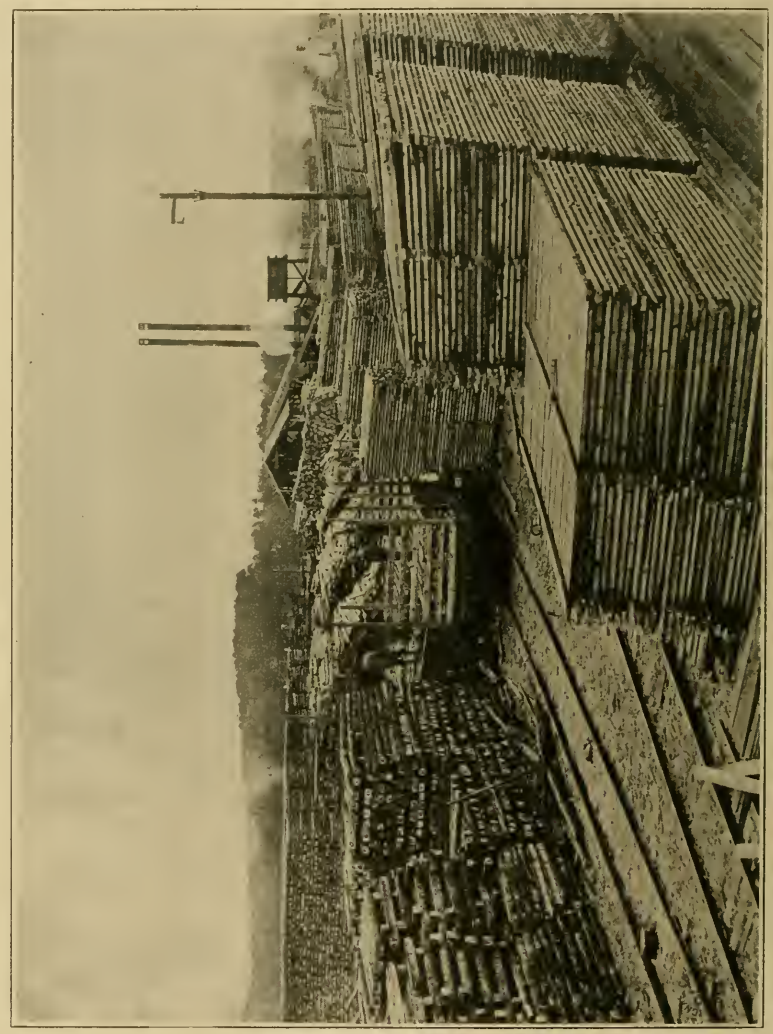
Another operation received a dispatch calling for poles—as many as could be furnished and as quickly as possible. This, too, was before the forestry Engineers had been put to the test. After about two days of production of poles, just when the work was well organized to win the war with poles, another dispatch flashed in to the commanding major: "Flooded with poles; cancel further shipments."

Nearly coincident with this there was an order for 10,000 ties with which to construct a railroad spur at a hospital that was being put up in a hurry. In six days those ties were hewed, and that without a broad adz in the outfit, ordinary chopping and falling axes having been used to do the work.

RATED MILL OUTPUT TRIPLED.

Taken altogether, the early labors of the forestry Engineers in France stand as a paradox of pioneering in an old and densely settled region, using such haphazard equipment as our ships were able to bring, accepting gratefully the generous assistance of the French and supplying the lacks with characteristic resourcefulness. As the equipment arrived and was supplied to the troops the energy and enthusiasm of the men served to push the use of that equipment to unheard-of limits. Sawmills that were purchased with the manufacturer's commercial rating of 10,000 feet b. m. in 10 hours were made to give three times that amount. Small bolter mills, rated at 5,000 b. m. per 10 hours, with such slight homemade and rough modifications as could be applied, frequently recorded 30,000 feet b. m. of sawn timber in 20 hours. A 20,000 daily 10-hour capacity mill recorded an output of 80,000 feet b. m. in 20 hours. The performance of the troops was so remarkable that all predictions were surpassed in October with a total production in that month of 30,000,000 feet b. m.

But the mere production of this material did not end the activity of the forestry section, which took upon itself the job of seeing that its products were shipped to the projects upon which they would be used. In spite of the shortage of railroad cars and deficiencies in



(3454-F9) LUMBER STORAGE IN REAR OF SAWMILL IN MIMIZAN DISTRICT.

motor transport, which became more stringent each month from the increased number of troops landing in France, the record of shipments increased and kept pace with the forest products made available by the troops in the woods. The total production of the forestry troops up to May 1, 1919, is represented by the following:

Production to May 1, 1919.

Lumber	feet, b. m.	218,211,000
Standard-gauge ties	pieces	3,051,137
Small ties	pieces	954,667
Miscellaneous round products	pieces	1,926,603
Piling	pieces	39,095
Fagots and facenes	pieces	4,669
Fuel wood	cords	340,000

(1167–J8) HAULING LONG TIMBER PILING WITH MOTOR TRUCK AND TRAILER NEAR BRUYERES. JULY, 1918.

The production of fuel wood became a particularly important part f the work of the forestry section. During the winter of 1917 to 018, the needs of the Army were largely supplied from French ources. Early in the summer of 1918 it became apparent that the itput of fuel wood from the forest troops as a by-product would not e sufficient and that the French supply could not be depended upon care for our Army. Consequently the quartermaster furnished

10,000 service troops under the direction of 20 officers from the fore try section, in charge of Lieut. Col. Allen S. Peck, for the cutting o fuel wood in the advance section. The organization of this speci force was started in July, 1918. Their work was carried on wit vigor until January, 1919, when the production of fuel wood fro all sources gained sufficiently upon the requirements to permit slackening of effort. The extent of this task is best expressed by th total production of forestry and quartermaster troops under fore try direction to the amount of 534,000 cords up to May 1, 1919.

FORESTRY SECTION REORGANIZED.

The increased program presented on July 1, 1918, on the basis o the arrival of 250,000 troops in France per month, demanding monthly production of 70,000,000 board feet of lumber, or a total o 700,000,000 feet in 10 months. In order to meet this schedule and a the same time furnish assistance urgently requested by the Frenc 24,000 additional forestry troops were cabled for, together wit 108 additional 10-M sawmills and other equipment. In Octobe 1918, in order to properly absorb and take care of this tremendou expansion in the organization, the forestry section was reorganize into one huge regiment, known as the 20th Engineers, providing fo the 49 Engineer companies, 28 Engineer service companies, and 1 battalion headquarters already in France, with 96 additional con panies and 15 additional battalion headquarters to be recruited i the States and sent to France as soon as possible. The schedule pro vided for the arrival of the entire new complement in France b March, 1919.

After the armistice, however, the activities of the forestry sectio decreased until, on December 31, 1918, nearly all of the mills had shu down, many had been dismantled and sent for salvage to Enginee depots. Only the mill at Eclaron (Haute-Marne) was held inta to meet any possible emergency while other operations continue running their sawmills only long enough to cut up such logs as ha been felled.

There were two exceptions deserving of mention. At Pontenx-le Forges, in the Landes, there were concentrated a number of con panies from other districts for the purpose of cutting 140,000 fir killed trees which had been contracted for prior to the armistice an whose products were needed, to supply enough material for comple ing the embarkation facilities of the Army and furnishing packin lumber for homeward-bound freight. Six 20-M mills were erecte and began operation on February 3, 1919, at which time there we over 3,000 troops concentrated in the burned area. At Capitieu

(Gironde) a similar burned-timber project containing 55,000 trees vas exploited by the 6th Battalion with the 48th Company attached, nvolving five sawmills and 10 miles of logging railroad.

The shipment of forest products for any one month never equaled he production for that month, and at the cessation of hostilities here was almost enough of a surplus to complete projected facilities. The following table indicates, by months, the ratio existing between upply and shipments.

Production and shipment of forest products.

Month.	Production and shipments.	Lumber.	Ties.	Round products and piling.	Cord-wood.
1918.					
ebruary	Production	2,892,000	37,201	410,689	8,788
	Shipments	2,622,757	11,595	217,910	3,098
arch	Production	6,583,240	156,556	188,595	15,631
	Shipments	3,447,964	66,258	83,416	3,244
pril	Production	11,640,544	282,710	172,368	25,493
	Shipments	6,652,454	133,304	73,431	6,673
ay	Production	13,133,313	303,962	172,035	38,353
	Shipments	11,046,751	267,998	125,181	16,474
une	Production	16,257,689	313,273	177,248	65,046
	Shipments	13,402,950	302,802	253,024	20,816
ily	Production	23,285,118	357,188	239,212	97,913
	Shipments	18,684,877	304,828	158,767	40,359
ugust	Production	23,498,129	420,188	501.031	160,821
	Shipments	23,908,200	325,392	165,928	49,627
eptember	Production	28,343,166	519,887	546,597	136,283
	Shipments	23,030,872	383,662	223,361	46,973
ctober	Production	28,496,954	738,383	259,943	155,754
	Shipments	24,800,408	554,459	233,369	64,860
ovember	Production	26,379,987	493,969	49,574	177,800
	Shipments	19,087,456	398,554	62,060	61,144
ecember	Production	13,867,342	258,376	1,950	201,970
	Shipments	12,927,236	72,570	4 289	73,215
1919.					
nuary	Production	2,532,571	36,594	18,432	65,126
	Shipments	12,122,975	20,063	5,502	92,751
ebruary	Production	1,996,098	20,774	39,481	17,514
	Shipments	5,816,402	57,943	6,766	69,638

The scheme arranged for sending home the forestry troops called or their embarkation for America in the same order in which they ad sailed for France. In accordance with this plan, the 11th and 2th Battalions, comprising the original 10th Engineers, were the irst to leave France, sailing on the 15th and 28th of January, 1919, espectively.

REFERENCE DATA—FORESTRY.

	Appendix number or file reference.
inal report of the forestry section, D. C. & F.	Appendix No. 55, 56, and 57
fonthly reports of 20th Engineers	Appendix No. R-20
ersonal experience report of Lieut. Col. W. B. Greeley	Hist.-Tech. File 222.
ersonal experience report of Maj. Francis Kiefer	Hist.-Tech. File 1666.
eport, C. E., A. E. F., to C. G., S. O. S.	Appendix No. 40

Concrete Stadium for Interallied Athletic Games.

To accommodate spectators at the Interallied Athletic Game scheduled to begin June 22, 1919, Pershing Stadium, a reinforced con crete structure with a seating capacity of 15,000, was built by th division of construction and forestry at Joinville, near Paris. A contract for the work had been made with French contractors o February 25, 1919, the date of completion being set for May 2 1919. On May 5, however, the structure was only about one-thir finished, and to insure its completion on time, Engineer troops wer substituted for contract labor. Up to May 5 the French contractor had handled 617 cubic meters—out of a total of about 1,750 cubi meters of concrete—which called in all for 120 tons of steel rein forcement and 350,000 feet b. m. of lumber for forms.

The first troops arrived at the site May 5, only 3½ hours after th division of construction and forestry had received telegraphic in structions to take over the construction. The first concrete wa poured May 6, and by May 19 the construction force numbered 3,10 men, drawn from the 22d, 55th, 122d, 128th, 131st Engineers, and th 59th and 806th Pioneer Infantry. On May 21 there had been place 486 cubic meters of concrete, 90 tons of steel reinforcement, an 250,000 feet b. m. of lumber for forms. Operations were carried o day and night in three 8-hour shifts, with construction plant con sisting of 12 concrete mixers, 18 hoists, 6 portable saws, 40 moto trucks, 40 dump cars, 12 dump wagons, 2 tractors, 3 road rollers, an 2,000 feet of narrow-gauge track. Some of the material was trans ported by motor truck from the Engineer depot at Gievres, a dis tance of 125 miles. Time was the essence of this work, and the fol lowing schedule, governed operations: Completion of placing ne concrete, June 1; completion of placing precast slabs, June 12; com pletion of stadium, June 20.

The stadium construction project was under the direction of th section engineer, intermediate section (west), Col. E. L. Daley, wit Lieut. Col. H. P. Warren in immediate charge.

Effect of Armistice on Engineer Work.

Early in November the chief engineer, American Expeditionar Forces, following the receipt of confidential communications fro general headquarters and headquarters Service of Supply, took step to prepare for radical changes in the policy of the Engineer Depart ment in the event of the cessation of hostilities which then seeme probable. On November 5, he sent to the directors of his division of construction and forestry, light railways and roads, and militar

engineering and engineer supplies instructions "to take under consideration the status of our project and be prepared to submit prompt recommendations as to what changes should be made in our orders both in Europe and the United States." These data were supplied and later supplemented and consolidated to form the basis of a large portion of General Orders, No. 54, headquarters, Service of Supply, issued November 14, 1918. This document was one of far-reaching importance for the Engineer Department, for it called for a drastic cancellation or reduction of the vast construction program which was being prosecuted by the Engineer Department in the Service of Supply.

Effect of General Orders, No. 54, and supplementary cancellations on the work of the Engineer Department—principally that of the division of construction and forestry—is indicated by the fact that an estimated saving of $134,500,000 was made by cancellation or reduction of construction projects up to March 1, 1919. After the general order was put into effect a canvass of the situation showed that of the 793 completed and uncompleted Engineer projects in the Service of Supply, 246 projects had been canceled (this number including 166 projects on which no work had been done), while 8 others, uncompleted, were affected in varying degrees. Under the new policy the status of 81 uncompleted and 458 previously completed projects remained unchanged. Table No. 1 shows the status of divisions of construction and forestry projects March 1, 1919.

TABLE 1.—*Status of construction projects, Mar. 1, 1919.*

Section.	Projects complete.	Projects canceled since Nov. 14.	Uncompleted not affected by General Order No. 54.	Uncompleted affected by General Order No. 54.
Base No. 1	90	28	13	0
Base No. 2	58	21	10	1
Base No. 3	26	23	0	0
Base No. 4	10	8	1	0
Base No. 5	30	5	13	1
Base No. 6	3	7	1	0
Base No. 7	22	11	0	1
Intermediate (east)	32	27	10	1
Intermediate (west) and Paris district	74	42	23	2
Tours district	15	1	3	1
Advance section	98	73	7	1
	[1] 458	[2] 246	81	8

Total, 793.

[1] These projects include 97 projects which have been canceled since Nov. 14, but which were completed or practically completed before orders for cancellation were effective.

[2] These cancellations include 166 projects on which no work had been done. The list does not include 9 projects canceled prior to Nov. 14, on which no work had been done.

The following summary indicates the amount of canceled work under the main items of construction, March 1, 1919:

Approximate amount of money saved by division of construction and forestry by cancellations in General Orders, No. 54, and supplements thereto, as of March 1, 1919.

Railroad installations, approximately 450 miles	$13,500,000
Dock construction, approximately 13,000 linear feet	12,500,000
Hospital construction:	
Base hospitals, approximately 157,904 beds	63,161,600
Camp hospitals, approximately 7,574 beds	3,029,600
Convalescent camps, approximately 55,060 beds	5,506,000
Buildings obtained from French, approximately 86,469 beds	4,323,450
Remount and veterinary stables, approximately 1,319,000 square feet	1,450,900
Divisional area construction, approximately 1,768,000 square feet	1,768,000
Covered storage space:	
Depot storage, approximately 10,380,000 square feet	10,380,000
Dock storage, approximately 1,131,000 square feet	1,413,750
Miscellaneous storage, approximately 150,000 square feet	150,000
Air service construction, including shops, storehouses, warehouses, and hangars, approximately 3,890,000 square feet	7,780,000
Water-supply installations, exclusive of interior installations and fire protection	1,500,000
Electrical installations, transmission, generation, etc., not including low-tension distribution	1,700,000
Refrigeration	1,000,000
Gasoline storage and distributing stations	530,000
Bakeries	300,000
Roads	3,000,000
Miscellaneous construction, including camps	1,500,000
Total	134,493,300

The immediate effect of General Orders, No. 54, was to make unnecessary great quantities of material and supplies called for on priority cables which had already been sent to Washington, and all chiefs of services were instructed to give right of way to the preparation of detailed cablegrams to the War Department cancelling shipments of goods. Following these instructions the chief engineer, on November 14, the day following the receipt of General Orders, No. 54, forwarded a cable to Washington, giving detailed instructions for stopping shipments on much of the Engineer material and supplies previously ordered.

With two important exceptions the signing of the armistice resulted in an extensive shut-down of Engineer construction. The first of these exceptions involved construction work at embarkation centers where new facilities had to be provided for large number of troops en route to base ports. The second exception called for a large-scale program of road reconstruction and maintenance

throughout all areas which were or had been occupied by American troops. The magnitude of this road work is indicated by the fact that on March 1 a force of about 110,000 was at work on highway repair, and as much as 90,000 tons of crushed rock were being used in a 10-day period.

In accordance with the desires of the commander in chief, a study was made of the road situation, and General Orders, No. 2, General Headquarters, January 2, 1919, was issued, whereby the construction, reconstruction, repair, and maintenance of all highways in France heretofore utilized or being utilized by American traffic were taken over by the chief engineer, American Expeditionary Forces, for active reconstruction and maintenance. General Orders, No. 2, placed all this work, including that in the occupied areas, under the immediate charge of the director of construction and forestry, by whom an additional section was formed at headquarters, Service of Supply, to assume charge of this work.

General Orders, No. 2, required the adoption of the French cantonnier system in principle, involving the placing of men along short sections of the highways to repair and maintain the surface by constant patrol. Engineer troops were immediately placed on this work in the various sections, being augmented by troops of other branches of the service as needed and available. Some additional equipment was secured from the French, principally 48 road rollers. Cooperation with the French authorities was obtained through the director of French military roads, who issued instructions to all departmental chief engineers in charge of highways to use every effort to assist and facilitate the work of the American Army. All section engineers were directed to place themselves in touch with the local French authorities and the general plan of the work to be done was adopted after study had been made by them in all sections and recommendation submitted to the headquarters office. The general scheme of road work, including plans for all lines taken over by the American Army for maintenance, was concurred in by the office of the French director of military roads, and active construction was immediately undertaken.

The organization for this work was practically started the 1st of January, and by the 10th of February, 4,100 kilometers of road had been taken over for maintenance and repair, and 450 kilometers for resurfacing. Approximately 60,000 men were distributed and employed by this date, handling per week a total of 50,000 tons of stone, obtained from quarries operated by troop labor and from commercial French quarries, and distributed by means of railroad cars, trucks, and wagons.

It was estimated that to maintain and repair the roads would require a force of 90,000 men and the handling of 80,000 tons of stone

per week, that this force would be available by March 15, and that the roads would be in satisfactory state of repair by May 15th. The estimates as to the size of the construction force and the amount of stone were both exceeded by the actual performance on March 1, as previously noted.

DISPOSAL OF PROPERTY.

Under the provision of War Department general orders, the United States Liquidation Commission was created as the central agency to supervise and direct the disposition of European claims against the American Expeditionary Forces and of surplus property in Europe belonging to the United States. The commission was intended not to supersede but rather to supervise and direct activities of existing agencies in the American Expeditionary Forces which had been discharging, in whole or in part, duties relating to the disposal of war supplies. The Liquidation Commission arrived in France early in 1919 and entered upon the discharge of the above supervisory duties.

By authority contained in paragraph 8, Special Orders, No. 273, Headquarters Service of Supply, December 9, 1918, and paragraph 7, Special Orders, No. 24, Headquarters, Service of Supply, January 24, 1919, a board of officers consisting of Brig. Gen. Edgar Jadwin, Col. T. H. Jackson, Col. J. H. Graham, Maj. F. F. Senior, and Maj. A. E. McKennett had been appointed, with the duty of compiling and submitting estimates of costs of all buildings, warehouses, hospitals, barracks, manufacturing plants, track, piers—in fact, all classes of permanent or semipermanent projects completed or begun in the American Expeditionary Forces. The board's evaluation of all construction and installations to December 31, 1918, based on actual inventories, indicated a war cost of $165,661,445, and a normal peace-time cost of $81,543,857. This inventory was submitted to the Liquidation Commission and served as a basis for its proceedings.

Detailed and classified inventories of stocks of tools, machinery, and materials were also prepared for the use of the commission in accordance with its instructions.

Following the submission of these inventories, a definite policy as to the disposition of installations and equipment was adopted May 10, 1919, when instructions were issued by the commanding general Service of Supply, to all section commanders stating that all "installations" would be transferred to the French. Section commanders, as representatives of the commanding general, Service of Supply, were authorized to transfer to accredited representatives of the French Government installations whose abandonment was necessary in carrying out the evacuation program. The term "installations," as specifically defined, covered all structures "attached to the

land, together with all equipment in the nature of fixtures and tools pertaining to or used in connection therewith." The authorized transfer of installations, therefore, included barracks, hospitals, warehouses, storehouses, manufacturing and assembling plants, machine shops, railroads, sidings, docks, wharves, and other transportation facilities, together with additions or improvements to French buildings. On the foregoing basis the transfer of installations to the French was carried out, a discriptive inventory of the material being turned over with the installations. Upon completion of the formalities of transfer, the American Army representatives received releases from accountability, and the United States Liquidation Commission assumed charge of the final settlement with the French Government. Installations necessary for the evacuation of the Service of Supply were retained until their usefulness had ceased.

On May 27, 1919, section commanders were directed by the commanding general, Service of Supply, acting on authority from the United States Liquidation Commission, to deliver to accredited representatives of the French Government excess *movable* supplies and war materials, other than the "installations" previously referred to, at locations abandoned in the evacuation program and not included in a list of concentration points and other locations which accompanied the instructions as to procedure in the transfer of this property.

Part IV.

GENERAL COMMENTS AND RECOMMENDATIONS.

The foregoing description of the operations of the Engineer Service in France gives some idea of the character and magnitude of the work required of the Engineers when a large army and the facilities for it must be created after the declaration of war. Under these conditions all Army services are confronted by continuous emergencies and difficulties in meeting satisfactorily the large and unforseeable demands that must be met if the Army is to be put in satisfactory condition for field warfare and at the same time protected from unnecessary hardships and inconveniences.

While as a rule it is contemplated that our Army will operate in the United States or, at any rate, upon the American Continent, and while all difficulties experienced in France were aggravated by the fact that the two large Allied armies, the French and the British, had during three years of active warfare strained to the limit the resources not only of France, but of practically the entire civilized world, it must be accepted as a fact that any future war in which we may become involved would probably require the solution of problems of great magnitude, and that all our national resources in personnel and in material would be required to cooperate efficiently upon a scale approximating that of our recent effort.

If the above assumptions are correct this report will derive its chief value by indicating to succeeding generations the character and extent of the difficulties that were experienced and the problems that required to be solved. Therefore, with a view to emphasizing some of the points which are noticed only incidentally, if at all, in the body of the report, advantage is taken of this opportunity to add the following:

As all construction work in the theater of operations is assigned to the Engineers, the Engineer must be the first man on the field, and, the war having been concluded, the dismantling and closing of the various establishments that have been created for the Army will cause him also to be the last man to leave the scene of operations. Accordingly, pertinent comment on the Engineer Service of the American Expeditionary Forces relates to its very beginning.

It will have been noted that the chief engineer took with him to France only five assistants, and that for a long time thereafter he was hampered by the lack of a sufficient force; yet it must have been apparent that the Engineer program in France was one that would call for an enormous number of skilled engineers and large forces of labor of all kinds. It is evident, therefore, that for future operations proper arrangements must be made to have promptly assembled an adequate force for the many phases of preliminary work, including surveys, examinations, the preparation of plans and estimates, etc., that are necessary to enable the commander in chief of the forces to make final and definite decision as to the lines upon which construction activities should expand. The lack by the chief engineer of an adequate force must delay always the final organization and training of expeditionary armies or, in fact, of any army. The data given in this report will permit a more or less definite conception to be formed as to the preliminary force which a chief engineer should have; for an expedition similar to the one under consideration this should certainly be not less than 200 officers and 1,000 clerks and draftsmen, survey men, and assistants of various kinds, followed very quickly by the troops or labor necessary for construction work.

A careful reading of the report will show that for a long period the Engineer Department was in a state of some uncertainty as to the scope of its duties and authority, and that details of its organization consequently could not be settled promptly. When emergencies succeed each other as rapidly and continuously as they did in the American Expeditionary Forces, no organization, no matter how perfect theoretically, can be expected always to operate satisfactorily. Men who are excellent in some capacities unexpectedly prove unreliable in others and failures are, therefore, bound to occur. It is better, however, not to make frequent changes in organization resulting often merely in the transfer of duties from one authority to another, when by permitting an established organization to become practiced and experienced it is certain that its efficiency will improve. It should, therefore, be the rule to decide in advance as to the distribution of duties and thereafter to make as few changes as possible. It may be necessary to change personnel, to relieve an inefficient officer and replace him by a better one, but in the end it is the men that count and not the form of the organization under which theoretically they are working, and this fact should receive permanent recognition in future regulations.

It is believed that too great subdivision into independent departments existed in the American Expeditionary Forces. For example, the gas service was a comparatively small one, officered largely with Engineer personnel. There was no good reason why it should not

have remained an Engineer activity, and it is certain that an officer qualified to discharge the duties of chief engineer would have experienced no difficulty in also administering the gas service. To the gas service, the resulting advantage would have been a claim upon the support and assistance of the much larger organization of the chief engineer, and in the end it is believed that the efficiency of the Army, as a whole, would have been enhanced by leaving the gas service where it was originally designed to be, namely, under the Engineers.

It is thought, also, that it was a mistake to have created an independent transportation department. It is believed that this department would have been far more satisfactory had it been headed by experienced officers who could as readily have been chosen from among the Engineers of the Army, as were the heads of three other special services of the American Expeditionary Forces. The chief engineer would naturally call to his assistance the necessary number of experienced railway men, judged from their known records to be most suited to the problem in hand. The maintenance of an Engineer Reserve Corps, with a live and efficient personnel, affords the natural means of securing the necessary technical experts. Certainly if the entire Service of Supply, with all its technical services, can be commanded by a single officer, there is no reason to question the ability of a competent chief engineer to command an Engineer service expanded to include transportation and chemical warfare, and during times of peace both the latter services would profit by the stimulation and encouragement given them by the Engineer Corps.

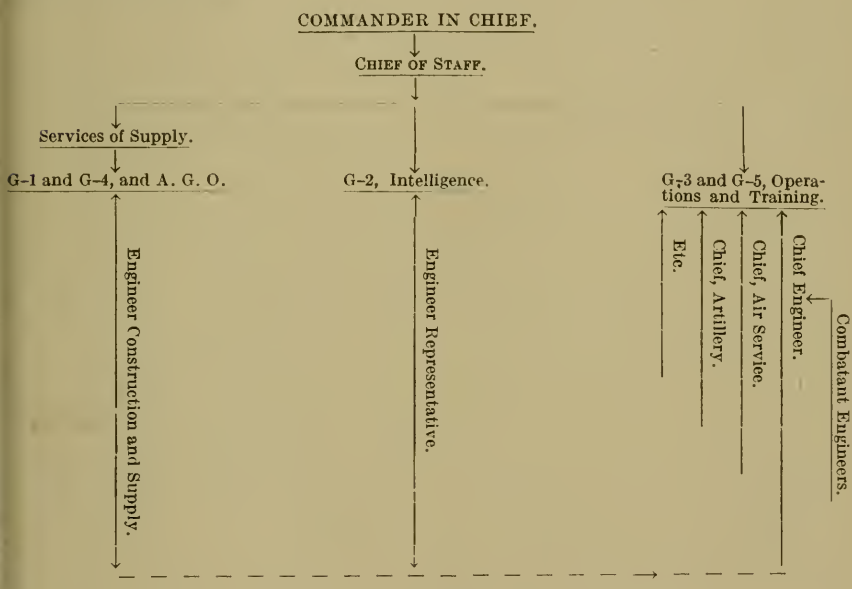
Something should be said regarding the relation of the chief engineer to the commander in chief. While the Engineer Service exists for the Army and must conform to its requirements, this can best be done when the most cordial sympathy and complete understanding exist. The chief engineer is, or should be, an important technical adviser of the commander in chief. He should be a man of large technical and constructive ability, selected by the commander in chief because the latter has confidence in his judgment and in his capacity to perform the important functions of the office, and, having been so selected, he should be kept fully advised regarding those plans of the commander in chief that involve engineer responsibilities. He should be consulted and his judgment respected regarding purely engineer matters. To do otherwise would detract from the ability of the chief engineer to cooperate most efficiently in the plans of the commander in chief. Especially in purely technical matters is this true; and certainly no decision should be made regarding any matter which is strictly or even largely engineering in character or which depends on Engineer activities without affording the chief engineer an opportunity to be heard.

This matter of the relation between the commander in chief and the chief engineer is intimately bound up in the question of proper staff organization. Under the form of organization that existed in France the Engineer of a division or of a corps was nominally under the direct control of his G–1, usually a younger and less-experienced officer than the Engineer concerned and certainly less able to judge correctly the demands of the situation with regard to engineer work and the possibilities and limitations of the available engineer resources in men and materials. This system is wrong and the Engineer of a division or corps should report directly only to its chief of staff, whose orders as to engineer operations should be made only after full consultation with the Engineer. In other words, the latter should be an assistant to the chief of staff so far as concerns Engineer operations, and the chief of staff should in turn be an officer of adequate rank, experience, and practical training. Similarly as to the staff of the commander in chief himself and to the place of the chief engineer therein—this staff should be composed of officers of rank, experience, and proven ability. In addition to the chief of staff, there should be not to exceed three assistant chiefs of staff—G–1 to have all duties now assigned to G–1 and G–4, G–2 as now, and G–3 to combine the present functions of G–3 and G–5.

The chief engineer should be of coordinate rank with these assistant chiefs of staff, and in vital technical matters he should communicate direct with the chief of staff and, as above stated, be consulted by the commander in chief and kept fully advised regarding important operations. As to matters involving the combat functions of Engineers, the assistant chief of staff, G-3, should consult with, and defer to, the chief engineer, who should originate all plans and recommendations for the employment of Engineer troops, but, with a view to simplicity of organization and upon the clear understanding as to his position of authority with respect to Engineer plans and troops, the chief engineer may be nominally designated as an assistant to G-3. In actual fact he should be an associate. Inasmuch as Engineer personnel will be used on construction work as well as for combat purposes, and as shortage of Engineers is likely to be the rule in the future as it has been throughout the history of the American Expeditionary Forces, there will probably always be a necessity of deciding between conflicting demands for Engineers. Such decision should rest with the chief engineer who, in such capacity, should be thoroughly acquainted with the relative importance of the needs to be served. Similar considerations exist with reference to the question of supply, and it is my belief that Engineer construction and supply should be joined under a single head, who should be an assistant to the chief engineer, and should occupy to

ward G-1 the same relation as the chief engineer bears to G-3. This Engineer of construction and supply should, with the antecedent approval of the chief engineer, be called upon to prepare all the plans and recommendations for Engineer construction and for Engineer supply which may be required by G-1.

It must be emphasized again that officers of age, experience, and technical accomplishments should not be subjected to the control of officers of less rank and dignity, and that proper military policy will seek to protect them from the anomaly of receiving orders from younger and less competent juniors. A diagram showing the proposed organization of the staff of general headquarters or of an army is as follows:



Proposed organization.

Finally, a word as to the nature of the Engineer Service. Satisfactory Engineer personnel should be doubly qualified, for both men and officers should have good technical training in all the usual peace-time activities of the Engineer—that is, in the organization and conduct of construction work of every conceivable variety. They should also be skilled in strictly warlike duties, those of the sapper, and fully trained as first-rate combat troops. Such a combination of qualifications calls for men of the highest type and this is the experience of all armies. To induce such men to interest themselves in the Engineer branch of the service, calling as it does for extraordinary exertions, usually under conditions far from stimulating, demands that the service shall be made attractive by granting

special consideration in the way of promotion and compensation. Since the success of the Army as a whole rests largely upon the efficiency of the Engineer arm, all branches of the service should concede to it fitting recognition. Unless this is done, great difficulty will be encountered in maintaining a satisfactory Engineer personnel.

CONCLUSION.

In conclusion, the following is quoted from a report from the chief engineer, American Expeditionary Forces, to the commanding general, Service of Supply:

The following officers serving under the Chief Engineer, American Expeditionary Forces, should be especially mentioned for their excellent service and devotion to a duty always arduous, sometimes necessarily unpleasant, and without the excitement of combat activities to spur them on. Without their efficient aid the results desired would not have been so surely and fully accomplished. Their work reflects the greatest credit on their efficiency and zeal.

Some officers are named twice owing to change of duties.

IN OFFICE OF CHIEF ENGINEER, AMERICAN EXPEDITIONARY FORCES.

Gens. Thomas H. Rees, J. J. Morrow, and Charles Keller, as deputy chief engineer.

Cols. S. C. Godfrey, D. C. Jones, and Lieut. Col. Christopher Van Deventer, in charge of personnel section.

Capt. S. M. Felton, jr., as adjutant and aid to the chief engineer.

Capt. R. K. Tomlin, jr., in charge of historical-technical section.

IN DIVISION OF MILITARY ENGINEERING AND ENGINEER SUPPLIES.

Gen. Harry Taylor, Col. F. C. Boggs, Gen. J. F. McIndoe, as director of that department.

Col. F. F. Longley, in charge of water supply section.

Maj. G. W. Semmes, in charge of electrical-mechanical section.

Col. F. A. Molitor, in charge of supply section.

IN DIVISION OF CONSTRUCTION AND FORESTRY.

Gens. M. M. Patrick and Edgar Jadwin, as directors.

Col. J. A. Woodruff, as deputy director and in charge of forestry operations.

Cols. J. B. Cavanaugh, T. H. Jackson, Ernest Graves, and John Sewell, as section engineers.

IN DIVISION OF LIGHT RAILWAYS AND ROADS.

Gens. Edgar Jadwin, Herbert Deakyne, C. H. McKinstry, and Col. A. T. Perkins, as directors.

Col. A. T. Perkins, as general manager.

Lieut. Col. F. G. Jonah, as chief engineer.

Maj. George J. Richers, as superintendent of motive power and shops.

IN THE OFFICE OF ASSISTANT TO CHIEF ENGINEER, GENERAL HEADQUARTERS.

Gens. Meriwether L. Walker, S. A. Cheney, Charles Keller, and Col. G. R. Spalding, in charge.

Col. G. A. Youngberg, in operations section.

Maj. J. H. Wickersham, in supply section.

Col. James G. B. Lampert, in bridge section.

Col. Francis B. Wilby, in intelligence section.

Col. A. H. Brooks, in geological section.

IN ENGINEER PURCHASING OFFICE, PARIS.

Cols. C. McD. Townsend, F. C. Boggs, and T. H. Jackson, in charge.

REFERENCE DATA, ENGINEER DEPARTMENT.

May 26, 1917. Appointing Col. H. Taylor chief engineer officer, American Expeditionary Forces. (G. O. No. 1, Hq., A. E. F., Washington, D. C.)

June 22, 1917. List of officers, soldiers, and civilians on duty in office of the chief engineer, American Expeditionary Forces. File 30-83, E. S.)

June 22, 1917. Letter chief engineer, American Expeditionary Forces, to chief of staff. Report on personnel at Paris office.

July 5, 1917. Tables of organization. (G. O. 8, G. H. Q., A. E. F.)

July 5, 1917. Organization memorandum by Col. Black.

Aug. 13, 1917. Line of communications established. Base sections, etc., defined. (G. O. 20, G. H. Q., A. E. F.)

Aug. 13, 1917. Coordinating information officer. (G. O. 21.)

Aug. 13, 1917. Letter of chief of staff to commanding general line of communications. Geographical limits of sections, etc., line of communications. (E. S. 15–1–3.)

Aug. 13, 1917. Letter of chief of staff, American Expeditionary Forces, reorganization of general staff and revision of General Orders, No. 8, 1917. (E. S. 15–1–3.).

Aug. 18, 1917. List of officers assigned to duty in office of chief engineer, American Expeditionary Forces. (E. S. 29-26.)

Aug. 20, 1917. General purchasing board established. (G. O. 23, G. H. Q., A. E. F.)

Aug. 23, 1917. Officer organization of engineer department in line of communications. (Memo. No. 1, L. of C.)

Aug. 25, 1917. Memorandum on location of engineer regiments.

Aug. 29, 1917. Engineer personnel in line of communications. (G. O. No. 1, L. of C.)

Aug. 30, 1917. War diaries. (G. O. 2, L. of C.)

Sept. 5, 1917. List of officers and civilians on duty in office of chief engineer, American Expeditionary Forces. (E. S. File 2–4–83a.)

September, 1917. War diary of Gen. Taylor, re operations of the Engineer Department from July 27, 1917, to September 6, 1917. (E. S. Files 20–23, and 69. 1, 2, 3, 4, 5, 6, and 7.)

September, 1917. Data for war diary furnished by the chief engineer, American Expeditionary Forces, covering the Engineer Department, July 27 to September 6, 1917. (E. S. Files 30–23, and 69 1, 2, 3, 4, 5, 6, and 7.)

Sept. 12, 1917. List of officers showing sections to which assigned in the office of the chief engineer, line of communications. (P. S. Files.)

Sept. 18, 1917. Charts of Engineer Department. (E. S. File 15–1–9.)

Sept. 25, 1917. Organization diagram of the Engineer Service at large. (E. S. File 15–1–9.)

Sept. 28, 1917. Brig. Gen. William C. Langfitt, National Army, relieved as chief of staff, line of communication, and succeeded by Maj. J. P. Adams, Infantry, United States Army. (G. O. 4, Hq. S. O. S.)

Oct. 14, 1917. Functions of chief engineer under line of communication. (E. S. File 3–1.)

Oct. 14, 1917. Director general of transportation, functions compared with those of chief engineer officer. Letter of chief engineer to director general of transportation. (E. S. File 3–1.)

Oct. 30, 1917. Report on Engineer Service, British Army, by Col. G. A. Youngberg. (E. S. File 3–4–45.)

Nov. 9, 1917. Chart of chief engineer organization. (E. S.)

Nov. 10, 1917. Officers announced as members of general staff: Col. W. D. Connor, Corps of Engineers; Lieut. Col. R. G. Alexander, Corps of Engineers; Lieut. Col. A. B. Barber, Corps of Engineers. (G. O. 58, 1917, G. H. Q., A. E. F.)

Nov. 14, 1917. Lieut. Col. Hodge, Corps of Engineers, made manager of roads. (G. O. 61, 1917, G. H. Q., A. E. F.)

Nov. 27, 1917. Brig. Gen. Mason M. Patrick relieved as commanding general, line of communication, by Maj. Gen. Kernan. Base sections Nos. 3 and 4 established. Requisitions of French government. (G. O. 66, 1917, G. H. Q., A. E. F.)

Dec. 8, 1917. Letter of chief engineer, line of communication, re officer to be sent to the United States to represent the needs of the Engineer Department. (E. S. File 16–2–356.)

Dec. 13, 1917. Classifications of positions in the American Expeditionary Forces. Salary adjustments. (G. O. 74, 1917, G. H. Q., A. E. F.)

Dec. 14, 1917. Line of communication, advance sections, base and intermediate sections, described. (G. O. 75, 1917, G. H. Q., A. E. F.)

Dec. 17, 1917. Divisional area work in charge of engineer officer, advance section, line of communication. (Circular No. 12, Adv. Sec. L. of C.)

Dec. 21, 1917. Report of chief engineer, American Expeditionary Forces, to Chief of Engineers, United States Army, re Engineer operations in France up to Dec. 1, 1917. (E. S. File 3–4–58.)

Dec. 21, 1917. Chief engineer officer's report on Engineer operations in France since June 11, 1917. (E. S.)

Jan. 3, 1918. Memorandum of chief engineer, American Expeditionary Forces, to chief of staff, American Expeditionary Forces, recommending that orders be issued defining more clearly the functions of the Engineer Department, to avoid duplication of duties with the director general of transportation. (E. S. File 3–4–68.)

Jan. 3, 1918. Headquarters line of communications will be established at Tours at noon Tuesday, Jan. 15. (G. H. Q. Memo.)

Jan. 7, 1918. Regulations between heads of staff departments in American Expeditionary Forces, and line of communications defined. (Memo. G. H. Q. to L. of C., E. S. 3–1.)

Jan. 9, 1918. Lieut. Col. E. R. Graves, Corps of Engineers, announced as member of general staff. (G. O. 7, 1918, G. H. Q., A. E. F.)

Jan. 21, 1918. Engineers to install portable shower baths. Following officers announced as members of general staff: Lieut. Col. Harold S. Hetrick, Corps of Engineers; Lieut. Col. Lewis H. Watkins, Corps of Engineers; Maj. Charles F. Williams, Corps of Engineers. (G. O. 13, 1918, G. H. Q., A. E. F.)

Jan. 25, 1918. Engineer Department charged with technical photography of Engineer operations. (G. O. 15, 1918, G. H. Q., A. E. F.)

Feb. 6, 1918. Translation of general order issued by French authorities in dealing with the American services. (Bul. 11, Hq. L. of C.)

Feb. 6, 1918. Corrected Tables of Organization. (G. O. 31, 1918, G. H. Q., A. E. F.)

Feb. 8, 1918. Letter chief engineer to secretary general staff, functioning Corps of Engineers—relationship between Chief of Engineers and Commander in Chief is similar to that of Chief of Engineers and Secretary of War. (E. S. File 3–1.)

Feb. 15, 1918. Lieut. Col. E. R. Graves, Corps of Engineers, relieved from duty as member of general staff. (G. O. 30, 1918, G. H. Q., A. E. F.)
member of general staff. (G. O. 30, 1918, G. H. Q., A. E. F.)

Feb. 16, 1918. Service of Supply created; chief engineer, American Expeditionary Forces, under commanding general, Service of Supply. (G. O. 31, 1918, G. H. Q., A. E. F.)

Mar. 6, 1918. Following officers announced as members of general staff: Maj. Charles L. Hall, Corps of Engineers; Maj. J. H. Poole, Engineer Officers' Reserve Corps. (G. O. 36, G. H. Q., A. E. F.)

Mar. 9, 1918. Gen. W. C. Langfitt, chief of utilities. Engineer Department functions changed. (G. O. 38, 1918, G. H. Q., A. E. F.)

Mar. 19, 1918. Office of chief engineer moved from Chamount to Tours.

Apr. 8, 1918. Chief engineer to commander in chief letter—"The principal activities of the Engineer Department in which I have control," etc. (E. S. File 3–4.)

Apr. 8, 1918. Maj. William C. Sherman, Corps of Engineers, announced as acting general staff officer. (G. O. 54, 1918, G. H. Q., A. E. F.)

Apr. 8, 1918. All commissioned officers to make personal report monthly to Chief of Engineers at Washington, sending copy to chief engineer, American Expeditionary Forces. (S. O. S. Circ. 35.)

Apr. 30, 1918. Procedure for handling communications at headquarters, Service of Supply. The fourth section to be under Col. H. C. Smither, chief of staff (G–4), to receive communications as to supply, construction, and transportation. (S. O. S. Memo. 24.)

May 10, 1918. All chiefs of supply and technical departments of Service of Supply to make frequent personal inspections of the projects. (S. O. S. Memo. 30.)

May 13, 1918. General superintendent of transportation announced with names of his assistants. (Gen. Notice 3, D. G. T.)

May 25, 1918. Col. Hugh L. Cooper, engineers, and Maj. J. C. Nutt, R. T. C., N. A., assigned to the office of chief of utilities for duty and station. Technical matters of construction referred to Col. Cooper. Technical matters of transportation referred to Maj. Nutt. (Circ. 20, C. of U.)

May 26, 1918. Officers announced for the organization of the 58th, 59th, 64th, 65th, and 67th Engineers and the battalions assigned to their lines. (G. O. 17, D. G. T.)

May 29, 1918. Brig. Gen. Mason M. Patrick announced as chief of air service. (G. O. 81, 1918, G. H. Q., A. E. F.)

May 31, 1918. Signature of cables originating in Office of Chief of Engineers to be "Taylor." (Circ. 22, C. of U.)

June 4, 1918. Col. Charles W. Kutz, Corps of Engineers, assigned to duty as assistant chief of staff, first section (G–1), Service of Supply, relieving Col. Alvin B. Barber, general staff. (G. O. 21, 1918, G. H. Q., A. E. F.)

June 13, 1918. Railway transportation office established. (Bul. 16, Hq. S. O. S.)

June 18, 1918. Duties of chief engineer of Army and chief engineer of Army corps. (G. O. 98, 1918, G. H. Q., A. E. F.)

June 19, 1918. Personnel and material allowance for each Engineer regiment. (G. O. 99, 1918, G. H. Q., A. E. F.)

June 20, 1918. District engineers' duties outlined as representatives of the engineer of construction. (G. O. 20, D. G. T.)

June 20, 1918. Col. Charles G. Dawes announced as representative of American Expeditionary Forces on military board of allied supply. (G. O. 100, G. H. Q., A. E. F.)

June 25, 1918. Second Army Corps formed; Col. H. S. Hetrick, Engineers, assistant chief of staff; Col. H. B. Ferguson, Engineers, chief engineer. Third Army Corps, Col. W. P. Wooten, Engineers, chief engineer. Fourth Army Corps, Col. James F. McIndoe, Engineers, chief engineer. (G. O. 102, 1918, G. H. Q., A. E. F.)

July 1, 1918. Papers from general headquarters to chief engineer to be handled direct without passing through headquarters, Service of Supply. (Letter.)

July 2, 1918. Col. G. A. Youngberg, Corps of Engineers, announced as acting general staff officer. (G. O. 107, 1918, G. H. Q., A. E. F.)

July 11, 1918. Construction and forestry and light railways and roads added to functions of the Engineers. Maj. Gen. William C. Langfitt, National Army, appointed chief engineer, American Expeditionary Forces, relieving Brig. Gen. Harry Taylor. (G. O. 114, 1918, G. H. Q., A. E. F.)

July 12, 1918. Under provisions of order announcing Maj. Gen. Langfitt, National Army, as chief engineer, American Expeditionary Forces, the following subdivision of the office of the chief engineer with their respective heads announced: Division of military engineering and engineer supplies, Brig. Gen. Harry Taylor, National Army; division of construction and forestry, Brig. Gen. Edgar Jadwin, National Army, director; division of light railways and roads, Brig. Gen. Charles H. McKinstry, National Army, director. Personnel and material assigned to these agencies transferred to Engineer Department. (G. O. 29, Hq. S. O. S.)

July 22, 1918. Col. J. B. Cavanaugh, chief of engineers, assigned to duty as assistant chief of staff. first section, (G–1), Service of Supply, relieving Brig. Gen. Charles W. Kutz, National Army. Lieut. Col. J. H. Poole, general staff, assigned to duty as deputy assistant chief of staff, fourth section (G–4), Service of Supply, vice Col. Avery D. Andrews, Engineers, National Army. (G. O., Hq. S. O. S.)

July 24, 1918. Brig. Gen. Jay J. Morrow designated as chief engineer, First Army. (G. O. 120, 1918, G. H. Q., A. E. F.)

July 24, 1918. Col. John S. Sewell, Engineers, National Army, announced commanding officer base section No. 1. Col. W. J. Wilgus, Engineers, National Army, relieved as deputy director general of transportation and announced as assistant director general of transportation. (G. O. 32, Hq. S. O. S.)

Aug. 2, 1918. Following officers announced as acting members general staff: Maj. E. P. Conway, Engineers; Capt. L. M. Rhoades, Engineers; First Lieut. C. J. Chaffin, Engineers; First Lieut. H. W. French, Engineers; First Lieut. S. L. Wolfe, Engineers; First Lieut. B. H. Wulfkoetter, Engineers. (G. O. 138, G. H. Q., A. E. F.)

Aug. 7, 1918. Engineer Department's responsibility in connection with water supplies. Corps Engineer regiments, minus their second battalions, to be transferred to depot Division. (G. O. 131, 1918, G. H. Q., A. E. F.)

Aug. 15, 1918. Maj. Wilhelm D. Styer, Corps of Engineers, announced as acting general staff officer. (G. O. 134, G. H. Q., A. E. F.)

Aug. 19, 1918. Col. Thomas H. Emerson, Corps of Engineers, appointed assistant chief of staff, Fifth Army Corps. Col. Harry Burgess, Corps of Engineers, appointed chief engineer, Fifth Army Corps. (G. O. 136, 1918, G. H. Q., A. E. F.)

Aug. 21, 1918. Col. Avery D. Andrews, Corps of Engineers, appointed assistant chief of staff, G–1. (G. O. 137, 1918, G. H. Q., A. E. F.)

Aug. 29, 1918. Additions to duties of chief engineer, American Expeditionary Forces. (G. O. 144, 1918, G. H. Q., A. E. F.)

Sept. 2, 1918. Following Engineer regiments transferred to the Transportation Corps: 19th, 31st, 35th, 36th, 38th, 39th, 44th, 45th, 46th, 47th, 48th, 49th, 60th, 61st, 62d, 63d, 64th, 65th, 66th, 67th, 446th, and 449th. (G. O. 42, 1918, Hq. S. O. S.)

Sept. 12, 1918. Col. Warren T. Hannum, Corps of Engineers, acting general staff officer. (G. O. 154, 1918, G. H. Q., A. E. F.)

Sept. 26, 1918. Col. F. Mears, Engineers, announced as general manager. (G. O. 29, D. G. T.)

Oct. 8, 1918. Following nominations to Senate by President: To be major generals: Brig. Gen. Henry Jervey, National Army; Brig. Gen. Clement A. F. Flagler, National Army. To be brigadier generals: Col. Sanford B. Stanberry, Engineers, National Army; Col. Charles I. Dobovoise, Engineers, National Army; Col. William H. Rose, Engineers, National Army; Col. Avery D. Andrews, Engineers, National Army; Col. Sherwood A. Cheney, Engineers, National Army; Col. Herbert Deakyne, Engineers, National Army; Col. James F. McIndoe, Engineers; Col. Charles G. Dawes, Engineers. (Memo. 120, S. O. S.)

Oct. 10, 1918. Col. Herbert Deakyne appointed chief engineer, Second Army. (G. O. 175, 1918, G. H. Q., A. E. F.)

Oct. 12, 1918. Maj. E. P. Conway, Corps of Engineers, relieved as general staff officer. (G. O. 177, 1918, G. H. Q., A. E. F.)

Oct. 14, 1918. Col. T. H. Emerson and Maj. John C. Low announced as acting general staff officers.

Oct. 15, 1918. Brig. Gen. Charles Keller, Engineers, assigned as deputy chief engineer, American Expeditionary Forces. Brig. Gen. T. H. Rees relieved from duty as deputy chief engineer. Brig. Gen. J. F. McIndoe assigned as director of military engineering and engineer supplies. (G. O. 1, O. C. E.)

Oct. 18, 1918. 68th Engineers transferred to Transportation Corps. Engineer forestry troops to be organized into one regiment, the 20th Engineers, and attached Engineer service companies. (G. O. 47, Hq. S. O. S.)

Oct. 23, 1918. Col. Clarence O. Sherrill announced as acting member of general staff. (G. O. 185, 1918, G. H. Q., A. E. F.)

Oct. 28, 1918. Maj. J. H. Wickersham, Engineers, appointed deputy engineer supply officer at general headquarters. (G. O. 2, O. C. E.)

Nov. 7, 1918. Col. Jay J. Morrow made chief engineer, Third Army. (G. O. 198, 1918, G. H. Q., A. E. F.)

Nov. 8, 1918. Organization of 227th Engineers (supply and shop) and 228th Engineers (water supply) authorized. (G. O. 199, 1918, G. H. Q., A. E. F.)

Nov. 11, 1918. Chiefs of services to report on work made nonessential by signing of armistice. Col. Ralph T. Ward and Maj. Cuthbert P. Noland detailed as acting general staff officers. All work connected with sound and flash ranging of airplanes and directing of searchlights for antiaircraft guns to be conducted by Engineers, who will furnish supplies. Allowance of ally personnel to Engineer Regiments. (G. O. 202, 1918, G. H. Q., A. E. F.)

Nov. 14, 1918. Maj. John P. Hogan, Engineers, detailed as acting general staff officer. (G. O. 205, 1918, G. H. Q., A. E. F.)

Nov. 16, 1918. Brig. Gen. J. J. Morrow assigned as deputy chief engineer, A. E. F., relieving Brig. Gen. Charles Keller. (G. O. 3, O. C. E.)

Nov. 18, 1918. Publication of letter from commanding general, American Expeditionary Forces, concerning return of officers to States in quest of officers for special Engineer work, especially forestry. Also in regard to personnel branch of general staff and selection of candidates for commissions direct from civil life. (Memorandum 152.)

Undated, 1918. Organization of water supply service under the Engineer Corps (Bul. 55, G. H. Q., A. E. F.)

Undated, 1918. Duties of Army Engineer Corps and duties of chief engineer. (Bul. 65, G. H. Q., A. E. F.)

Undated, 1918. Calling attention to cablegram S–164, paragraph 1, for reference chief of staff. Reference X–74, paragraph 10, requesting definition of "matters of engineering, designing, and special assemblies." (Memo. 114, Hq. S. O. S.)

Nov. 27, 1918. Advisory liquidation board appointed. Membership includes Brig. Gen. Charles G. Dawes, Engineers. (G. O. 59, Hq. S. O. S.)

Nov. 29, 1918. Eighth Army Corps organized. Col. William A. Mitchell appointed chief engineer. (G. O. 219, 1918, G. H. Q., A. E. F.)

Nov. 29, 1918. Ninth Army Corps organized. Col. William J. Barden appointed chief engineer. (G. O. 219, 1918, G. H. Q., A. E. F.)

Dec. 1, 1918. Second Battalion, 29th Engineers, changed to First Battalion, 74th Engineers. Companies F, B, C, D, and E of 29th Engineers changed to Companies A, B, C, D, and E, 74th Engineers, respectively. 74th Engineers composed of flash and sound ranging troops. (G. O. 221, 1918, G. H. Q., A. E. F.)

Dec. 7, 1918. Technical board to operate under chief engineer, American Expeditionary Forces. (G. O. 63, Hq. S. O. S.)

Dec. 9, 1918. Lieut. Col. George L. Watson, Engineers, detailed acting general staff officer. (G. O. 224, 1918, G. H. Q., A. E. F.)

Dec. 14, 1918. Following Engineer officers detailed as acting members of general staff: Col. Henry C. Jewett, Lieut. Col. Brehon B. Somervell, and Maj. Spencer Roberts. (G. O. 229, 1918, G. H. Q., A. E. F.)

Jan. 8, 1919. Capt. B. H. Wolfekoetter detailed acting member of general staff. (G. O. 6, 1919, G. H. Q., A. E. F.)

Jan. 17, 1919. Capt. Hobart W. French, Engineers, relieved from duty as member of general staff. (G. O. 13, 1919, G. H. Q., A. E. F.)

Jan. 19, 1919. War damages board created to evaluate war damages in France. Brig. Gen. C. H. McKinstry, senior member. The chief engineer, American Expeditionary Forces, shall direct and control the expenditure of the necessary funds in accordance with a policy to be prescribed by these headquarters and shall authorize the employment of the necessary civilian personnel. (G. O. 15, 1919, G. H. Q., A. E. F.)

Jan. 22, 1919. Col. Ralph T. Ward, Engineers, relieved from duty as a member of the general staff, American Expeditionary Forces, and from further duty as an acting general staff officer. (G. O. 16, G. H. Q., A. E. F.)

Mar 7, 1919. Col. Charles L. Hall, Corps of Engineers, relieved from duty as member of general staff, American Expeditionary Forces, and from further duty as acting general staff officer. (G. O. 44, 1919, G. H. Q., A. E. F.)

SERVICE OF UTILITIES.

Mar. 9, 1918. Gen. Langfitt, chief of utilities, Engineer Department, functions changed. (G. O. 38.)

Mar. 12, 1918. Personnel under chief of utilities. (G. O. 8, S. G. S.)

Apr. 10, 1918. Requisitions for engineering and construction material will be made upon the chief engineer officer. Capt. R. T. Frazier, jr., Engineer Officers' Reserve Corps, appointed supply officer, Service of Utilities. (Circ. 9, C. of U.)

May 25, 1918. Col. Hugh L. Cooper, Engineers, and Maj. J. C. Nutt, R. T. C., N. A., assigned to the office of chief of utilities for duty and station. Technical matters of construction referred to Col. Cooper. Technical matters of transportation referred to Maj. Nutt. (Circ. 20, C. of U.)

May 31, 1918. Signature of cables originating in office of chief engineer to be signed "Taylor." (Circ. 22, C. of U.)

TRANSPORTATION.

May 31, 1917. Letter of adjutant general, American Expeditionary Forces (on board S. S. *Baltic*) appointing "Board to report on Forts." Report of board attached. (E. S. File 35–1–8.)

May 31, 1917. Letter of adjutant general, American Expeditionary Forces (on board S. S. *Baltic*), detailing a board to report on port facilities, including railway facilities. Report attached, dated June 20, 1917. (E. S. File 35–1–8.)

June 7, 1917. Letter of undersecretary of state for transportation, reconstruction at various ports in France. (E. S. File 24–2.)

June 7, 1917. Letter of undersecretary of state for transportation, reconstruction of railways, etc., by American troops. (E. S. File 24–2.)

June 7, 1917. Military and commercial exploitation of French maritime ports. Communication from undersecretary of state, French Republic, to Maj. W. B. Parsons. (E. S. File 24–2.)

June 20, 1917. Report of board on ports (bases). Col. H. Taylor a member. (E. S. File 35–1–8.)

June 27, 1917. Letter of Maj. Wilgus relative to organization of transportation department, with diagram attached. (E. S. File 12–13.)

July 1. 1917. Letter of M. Claveille setting forth the need of American railway regiments for operation and maintenance of French railways. (E. S. File 40–8.)

July 1, 1917. Translation of document from undersecretary of state for transportation to the minister of public work and transportation (French). (E. S. File 40–8.)

July 1, 1917. Letter of undersecretary of state for transportation, re urgent need of workmen for railway transportation. (E. S. File 40–8.)

July 2, 1917. Letter of chief quartermaster, American Expeditionary Forces, relative to organization of the nine railway regiments (Nos. 11 to 19, inclusive), equipping and rationing them. (E. S. File 12–10 Misc.)

July 5, 1917. Letter of Maj. Wilgus recommending certain construction for port of Bassens. (E. S. File 24–10.)

July 5, 1917. Letter of Maj. Wilgus re terminal facilities at port of Bassens. (E. S. File 24–10.)

July 5, 1917. Minutes of conference re railway organization.

July 5, 1917. Maj. Wilgus's report on Bassens port facilities. (E. S. File 24–10.)

July 6, 1917. Report of conference at Paris between British, French, and American officials re transportation problems. (E. S. File 40–6.)

July 6, 1917. Report of Maj. Wilgus re railway and terminal facilities at port of La Martiniere. (E. S. File 24–6 Misc.)

July 6, 1917. Minutes of conference with British and French authorities regarding transportation matters. (E. S. File 40–5.)

July 6, 1917. Letter of Maj. William B. Parsons, re director of railways, line of communications, organization of transportation. (E. S. File 40–5.)

July 7, 1917. Letter from commander-in-chief re port facilities at Bassens. (E. S. File 24–8.)

July 11, 1917. Maj. Wilgus's report on Usinos port facilities. (E. S. File 24–5.)

July 11, 1917. Maj. Wilgus's report on La Martiniere port facilities. (E. S. File 24–6.)

July 12, 1917. Confidential memo by Col. Maurier re agreement allotting space at certain ports. (E. S. File 24–4.)

July 13, 1917. Report of Maj. Wilgus re port facilities in general. Recommends approval of construction of tracks, etc., at La Martiniere, railroad between Paimboeuf and Nantes. (E. S. File 24–7 Misc.)

July 14, 1917. Requisition covering railway tools and materials. Tonnage 157,936. Requisition on Chief of Engineers, Washington, by Maj. Wilgus. (Requisition No. 6.)

July 15, 1917. Letter from chief engineer officer to Maj. Graves re railroad timber requirements for an army of 500,000. (E. S. File 14–3.)

July 20, 1917. Copy of statement of British importations to France, by ports, during May, 1917. (E. S. File 24–22.)

July 22, 1917. Letter of A. Claveille re railway and terminal facilities at Bordeaux. (E. S. File 24–11.)

July 22, 1917. Copy of translation of report by M. Claveille, undersecretary of state for transports, re port of Bordeaux, docks at Bassens. (E. S. File 24–11.)

July 24, 1917. Notes on interview between Gen. Pershing and various officers of the director general of transportation of the British Armies in France. (File 40–10.)

July 27, 1917. Letter from M. Claveille to Col. Taylor re project for base at Talmont. (E. S. File 70–1.)

July 31, 1917. Col. Taylor's reply to M. Claveille in regard to project for base at Talmont. (E. S. File 70–2.)

August 5, 1917. Letter of undersecretary of state for transportation re wharves at Pauillac. (E. S. File 24–18.)

August 5, 1917. Note of M. Claveille re wharves at Pauillac-Trompeloup. (E. S. File 24–18.)

August 6, 1917. Letter of Maj. Wilgus re additional tracks at Pauillac. (E. S. File 24–17.)

August 20, 1917. Letter from the mayor of Meschers recommending the bay of Meschers-Talmont for a port. Col. Taylor's reply. (E. S. File 24–24.)

August 22, 1917. Letter from Maj. Cooper re survey of harbor near Vannes. (E. S. File 24–20.)

Sept. 3, 1917. Letter from Col. Taylor transmitting report on bases (see 35–1–8 above) and Maj. Wilgus's report on British and proposed American port facilities in France, dated July 24. (E. S. File 25–1–9.)

Sept. 9. 1917. Letter of chief engineer, American Expeditionary Forces, with reply attached to assistant director railways re direction of operations. (E. S. File 30–1–13.)

Sept. 14, 1917. Transportation department established. (G. O. 37, 1917, G. H. Q., A. E. F.)

Oct. 9, 1917. Letter of director general of transportation, with reply attached re Engineer services and duties under the provisions of General Orders, No. 37, G. H. Q., A. E. F. (E. S. file 3–1–8.)

Oct. 14, 1917. Memorandum of Col. Youngberg; functions of chief engineer under line of communications. (E. S. File 3–1.)

Oct. 14, 1917. Letter of chief engineer to director general of transportation; director general of transportation functions compared with those of chief engineer officer. (E. S. File 3–1.)

Nov. 1, 1917. 17th, 18th, and 19th Engineers transferred to director general of transportation. (G. O. 24, L. of C.)

Dec. 1, 1917. Gen. Taylor's report on operations to Dec. 1; includes construction and director general of transportation functions. (E. S. File 3–4.)

Dec. 8, 1917. Motor transport service established. (G. O. 70, G. H. Q., A. E. F.)

Dec. 26, 1917. Letter of commander in chief inclosing forms for submission of reports for railways, etc. (E. S. File 3–4–68.)

Dec. 27, 1917. "R. W. C." report. See notes on page 38 of matter written by Capt. McFarren on organization. (E. S. Files.)

Jan. 3, 1918. Memorandum of chief engineer, American Expeditionary Forces, to chief of staff, American Expeditionary Forces, recommending that orders be issued defining more clearly the functions of the Engineer Department, to avoid duplication of duties with the director general of transportation. (E. S. File 3–4–68.)

Jan. 3, 1918. Letter commander-in-chief to commanding general, Line of Communication, and to Chief Engineer, A. E. F., charged with construction except that charged to transportation department. (E. S. Files.)

Jan. 3, 1918. Memorandum of chief engineer, American Expeditionary Forces, inclosing draft of letter to chief engineer, line of communication, director general of transportation and chief engineer, American Expeditionary Forces, defining the duties more clearly re construction as outlined in general orders, headquarters American Expeditionary Forces, 1917. (E. S. File 3–4–68.)

Jan. 3, 1918. Memorandum of Gen. Taylor to chief of staff, American Expeditionary Forces, inclosing draft of letter and recommending it be sent to director general of transportation, and chief engineer, line of communication, defining construction work to be done by the director general of transportation and chief engineer, line of communication, more clearly as outlined in General Orders, No. 8. (E. S. 3–4–68.)

Feb. 2, 1918. Railway construction work is executed by Engineer personnel under direction of director general of transportation. (E. S. File 14–1–14.)

Mar. 27, 1918. Organization of a provisional depot battalion of railway operating troops authorized. (G. O. 5, Hq. S. O. S.)

Apr. 30, 1918. Col. H. C. Smither, chief of staff (G-4), to receive all communications as to transportation. (Memo. 24, Hq. S. O. S.)

May 9, 1918. Organization of 58th, 59th, 64th, and 65th Standard Gauge Operating Battalions and the 67th Standard Gauge Railway Transportation Battalion authorized. (G. O. 15, Hq. S. O. S.)

May 13, 1918. General superintendent of transportation announced, with names of his assistants. (Gen. Notice 3, D. G. T.)

May 25, 1918. Col. Hugh L. Cooper, Engineers, and Maj. J. C. Nutt, R. T. C., N. A., assigned to the office of chief of utilities for duty and station. Technical matters of construction referred to Col. Cooper. Technical matters of transportation referred to Maj. Nutt. (Circ. No. 20, C. of U.)

May 25, 1918. 19th Engineers (railway) to be organized into five battalions and the 35th Engineers (railway) into six battalions and their duties outlined.

May 26, 1918. Officers announced for the organization of the 58th, 59th, 64th, 65th, and 67th Engineers and the battalions assigned to their lines. (G. O. 17, D. G. T.)

June 13, 1918. Railway transportation offices established. (Bull. No. 16, Hq. S. O. S.)

June 16, 1918. Duties of district engineer on changes or new construction being undertaken under control of the French. (G. O. 21, D. G. T.)

July 6, 1918. Report of conference at Paris between British, French, and American officials re transportation problems. (E. S. File 40–6.)

July 11, 1918. Functions of transportation service. (G. O. 114, G. H. Q., A. E. F.)

July 11, 1918. Authority to issue orders involving travel of commissioned officers and soldiers. (Bul. 20, Hq. S. O. S.)

July 24, 1918. Col. W. J. Wilgus, Engineers, National Army, relieved as deputy director general of transportation and announced as assistant director general of transportation. (G. O. 32, Hq. S. O. S.)

Aug. 8, 1918. Port facilities to be developed to fullest extent. New port construction to be started at Bordeaux and the Gironde, St. Nazaire and the Loire, La Pallice, Brest, Marseille, and Talmont. Storage facilities to be pushed on to completion. Question of use of material which requires sea transportation to be carefully studied with view to obtaining as much as possible from French sources. Railroad facilities to be augmented and Service of Supply personnel to be provided. (Memo. 79, S. O. S.)

Sept. 7, 1918. Following Engineer Regiments transferred to the Transportation Corps: 19th, 31st, 35th, 36th, 38th, 39th, 44th, 45th, 46th, 47th, 48th, 49th, 50th, 51st, 52d, 53d, 54th, 57th, 58th, 59th, 60th, 61st, 62d, 63d, 64th, 65th, 66th, 446th, and 449th. (G. O. 42, Hq. S. O. S.)

Sept. 26, 1918. Col. F. Mears, Engineers, announced as general manager, director general of transportation. (G. O. 29, D. G. T.)

Oct. 18, 1918. 68th Engineers transferred to Transportation Corps. (G. O. 47, Hq. S. O. S.)

Nov. 19, 1918. Transportation department, American Expeditionary Forces, charged with carrying out agreements with Allies in reference to the operation, exploitation, and repair of railroads assigned to American Expeditionary Forces; normal gauge railroad construction and repair transferred from Engineer Department to the transportation department. Engineer Department to furnish materials, supplies, tools, and labor. (G. O. 56, Hq. S. O. S.)

Undated. Notes of organization of British transportation facilities. (E. S. File 40–10.)

Undated. Notes on interviews between commander in chief and the director general of transportation, British Expeditionary Forces, re railways. (E. S. File 40–10.)

Dec. 18, 1918. 518th, 538th, 701st, and 702d Engineers formed into stevedore companies as follows: 518th will form Companies 846, 847, 848, and 855, Transportation Corps; 538th will form Companies 856, 858, 859, and 860, Transportation Corps; 701st will form Companies 861, 862, 863, and 864, Transportation Corps; 702d will form Companies 865, 866, 867, and 868, Transportation Corps. The 69th, 81st, 93d, and 118th Engineers will be formed into railway companies as follows: 69th Engineers will be formed into Companies 134 to 136, Transportation Corps; 81st Engineers (1 company) will be formed into Company 137, Transportation Corps; 93d Engineers (1 company) will be formed into Company 138, Transportation Corps; 118th Engineers will be formed into Companies 139 to 150, Transportation Corps.

CONSTRUCTION.

May 31, 1917. Letter of adjutant general, American Expeditionary Forces (on board S. S. *Baltic*), appointing board to report on ports. Report of board attached. (E. S. File 35–1–8.)

June 7, 1917. Military and commercial exploitation of French maritime ports. Communication from undersecretary of state, French republic, to Maj. W. B. Parsons. (E. S. File 24–3.)

June 7, 1917. Letter of undersecretary of state for transportation reconstruction at various ports in France. (E. S. File 24–2.)

July 9, 1917. Letter of Maj. Wilgus recommending certain construction for port of Bassens. (E. S. File 24–10.)

July 7, 1917. Letter from commander in chief re port facilities at Bassens. 24–5.)

July 11, 1917. Maj. Wilgus's report on Usines Brules port facilities. (E. S. File 24–5.)

July 11, 1917. Maj. Wilgus's report on La Martiniere port facilities. (E. S. File 24–6.)

July 12, 1917. Confidential memo by Col. Maurier re agreement allotting space at certain ports. (E. S. File 24–4.)

July 13, 1917. Maj. Wilgus's report on port facilities in general. (E. S. File 24–7.)

July 22, 1917. Copy of translation of report by M. Claveille, undersecretary of state for transports, re port of Bordeau-Bassens docks.

July 27, 1917. Letter from M. Claveille to Col. Taylor re project for base at Talmont. (E. S. File 70–1.)

July 31, 1917. Col. Taylor's reply to M. Claveille in re project for base at Talmont. (E. S. File 70–2.)

August 5, 1917. Note of M. Claveille re wharves at Pauillac-Trompeloup. (E. S. File 24–18.)

August 6, 1917. Requisition covering construction tools requisition on Chief of Engineers, Washington, by Maj. Cooper. (Requisition No. 8.)

Aug. 20, 1917. Letter from the mayor of Meschers recommending the bay of Meschers-Talmont for a port. Col. Taylor's reply. (E. S. File 24–24.)

Aug. 22, 1917. Letter from Maj. Cooper re survey of harbor near Vannes. (E. S. File 24–20.)

Sept. 3, 1917. Letter from Col. Taylor transmitting report on bases (see 35–1–8 above) and Maj. Wilgus's report on British and proposed American port facilities in France, dated July 24. (E. S. File 25–1–9.)

Oct. 10, 1917. Scarcity of construction material. (G. O. No. 46, G. H. Q., A. E. F.)

Dec. 1, 1917. Gen. Taylor's report on operations to Dec. 1, includes construction and director general of transportation functions. (E. S. File 3–4.)

Dec. 26, 1917. Commander in chief directs submission of reports covering construction under the Engineer Department and reports showing supplies in hand in depots. (E. S. File 3–4–68.)

Jan. 3, 1918. Letter commander in chief to commanding general, line of communications, and to chief engineer, Engineer Department, charged with construction except that charged to transportation department. (E. C.)

Jan. 3, 1918. Memorandum of chief engineer, American Expeditionary Forces, inclosing draft of letter to chief engineer, line of communications, director general of transportation, defining the duties more clearly re construction as outlined in general orders, headquarters American Expeditionary Forces, 1917. (E. S. File 3–4–68.)

Jan. 21, 1918. Lieut. Col. Harold S. Hetrick, Corps of Engineers; Lieut. Col. Lewis H. Watkins, Corps of Engineers, and Maj. Charles F. Williams, Corps of Engineers, announced as general staff officers. Engineers to install portable shower baths. (G. O. 13, G. H. Q., A. E. F.)

Jan. 31, 1918. Chief engineer, line of communications, charged with construction, etc., of engineer depots, etc. (Circ. 8, O. C. E.)

Feb. 2, 1918. Railway construction work is executed by Engineer personnel under direction of director general of transportation. (E. S. File 14–1–14.)

Feb. 6, 1918. General construction work is executed by Engineer personnel. In line of communications it is under chief engineer, line of communications. In Army and corps areas it will be supervised by chief engineer of Army or corps. (E. S. File 14–1–14.)

Feb. 18, 1918. Construction and repairs by Engineers. (G. O. 32, G. H. Q., A. E. F.)

March, 1918. All road work in base sections and intermediate sections to be done under direction of the director of construction and forestry. (G. O. 1, Hq. S. O. S., S. O. U.)

Apr. 10, 1918. Requisition for engineer and construction material will be made upon the chief engineer officer. Capt. R. T. Frazier, jr., Engineer Officers' Reserve Corps, appointed supply officer, Service of Utilities. (Circ. No. 9, C. of U.)

Apr. 30, 1918. Procedure for handling communications at headquarters, Service of Supply. The fourth section to be under Col. H. C. Smither, chief of staff (G–4), to receive communications as to supply, construction, and transportation. (Memo. 24, S. O. S.)

May 25, 1918. Col. Hugh L. Cooper, Engineers, and Maj. J. C. Nutt, R. T. C., N. A., assigned to the office of chief of utilities for duty and station. Technical matters of construction referred to Col. Cooper. (Circ. 20, C. of U.)

June 16, 1918. Duties of district engineer on changes or new construction being undertaken under control of the French. (G. O. 21, D. G. T.)

June 20, 1918. District engineers' duties outlined as representatives of the engineer of construction. (G. O. 20, D. G. T.)

July 11, 1918. Construction and forestry and light railways and roads added to functions of the Engineer Corps. Maj. Gen. William C. Langfitt, National Army, appointed chief engineer, American Expeditionary Forces, relieving Brig. Gen. Harry Taylor. (G. O. 114, G. H. Q., A. E. F.)

July 12, 1918. Under provisions of order announcing Maj. Gen. Langfitt, National Army, as chief engineer, American Expeditionary Forces, the following subdivisions of the office of chief engineer, with their respective heads, announced: Division of military engineering and engineer supplies, Brig. Gen. Harry Taylor, National Army; division of construction and forestry, Brig. Gen. Edgar Jadwin, National Army, director; division of light railways and roads, Brig. Gen. Charles H. McKinstry, director. Personnel and material assigned to these agencies transferred to Engineer Department. (G. O. 29, Hq. S. O. S.)

July 24, 1918. Notes on interview between Gen. Pershing and various officers of the director general of transportation of the British Armies in France. (E. S. File 40–10.)

July 24, 1918. Maj. Wilgus to Col. Taylor, report on British and proposed American port facilities in France. (This document is also included in data on ports.) (E. S. File 40–11.)

Aug. 6, 1918. Purchase of standing timber to be made through division of construction and forestry. (G. O. 130, G. H. Q., A. E. F.)

Aug. 8, 1918. Port facilities to be developed to fullest extent. New port construction to be started at Bordeaux and the Gironde, St. Nazaire, and the Loire, La Pallice, Brest, Marseille, and Talmont. Storage facilities to be pushed on to completion. Question of use of material which requires sea transportation to be carefully studied with view to obtaining as much as possible from French sources. Railroad facilities to be augmented and Service of Supply personnel to be provided. (Memo. 79, S. O. S.)

Sept. 19, 1918. Division of Construction and Forestry to conduct all negotiations for acquisition of standing timber to exceed 5,000 francs. (G. O. 159, G. H. Q., A. E. F.)

Oct. 30, 1918. Section V, paragraph 1, General Orders, No. 32, Headquarters Chief of Staff, revoked and table published showing sources of materials and responsibility for repairs for buildings and their equipment. (G. O. 191, G. H. Q., A. E. F.)

Nov. 14, 1918. Cancellation of numerous projects and orders for supplies, following signing of the armistice. (G. O. 54, Hq. S. O. S.)

Mar. 24, 1919. In camps at Marseille, Bordeaux, St. Nazaire, Brest, Le Mans, and St. Aignan the chief engineer will take steps to screen kitchens, mess halls, bakeries, and hospitals, and provide traps for these camps. Screening of kitchens to be given priority. (Bul. 15, Hq. S. O. S.)

FORESTRY.

June 22, 1917. Report of conference held in office of chief engineer, American Expeditionary Forces, on timber supply. (E. S. File 14–2 Misc.)

June 22, 1917. Minutes of conference on timber supply between Col. Taylor et al. and Col. Sutherland, British Army. (E. S. File 14–2.)

June 27, 1917. Report of Maj. H. S. Graves on forestry supplies, American requirements, etc. Cooperation with British, purchase of timber, etc. (E. S. File 26–1.)

June 27, 1917. Report on forest supplies by Maj. H. S. Graves. (E. S. File 26–1 Misc.)

June 29, 1917. Letter of Comite Franco-Brittanique des Bois de Guerre (Col. Sutherland) inclosing copies of minutes of conferences between Gen. Lord Lovat and Col. Taylor on June 28, 1917, and between Gen. Lord Lovat, Col. Taylor, and Lieut. Sebastian relative to forestry matters. (E. S. File 26–3 Misc.)

June 29, 1917. Report of conference with British forestry officers re forestry troops for Britain. Report of conference with Lieut. Sebastian re France furnishing lumber for first American Expeditionary Forces troops attached. (E. S. File 26–3 Misc.)

June 29, 1917. Another report of conference between Lord Lovat and Col. Taylor re forestry regiment for use by British. (E. S. File 26–3.)

July, 1917. Note on lumber requirements for an army of 500,000 men. (E. S. File 14–1.)

July 5, 1917. Memorandum of conference at Ministere de la Guerre relative to engineering and wood supplies. (E. S. File 26–6 Misc.)

July 5, 1917. Memorandum of conference between Col. Taylor et al. and Gen. Julien, Col. Germain, and Lieut. Sebastian, French Army, on engineering and wood supplies. (E. S. File 26–6.)

July 15, 1917. Letter from chief engineer officer to Maj. Graves re railroad timber requirements for an army of 500,000. (E. S. File 14–3.)

July 22, 1917. Letter chief engineer officer to commander in chief re wood supply. (E. S. File 14–4.)

July 22, 1917. Letter of chief engineer, American Expeditionary Forces, to commander in chief re critical need of wood supplies by the American Expeditionary Forces, recommending matter be called to attention of French. (E. S. File 14–4.)

July 26, 1917. Letter of commander in chief to French minister of war, re critical situation regarding lumber and wood supplies needed by the American Expeditionary Forces. (E. S. File 14–8.)

July 26, 1917. Letter of commander in chief to minister of war re requisitioning of timber. (E. S. File 14–8.)

Aug. 1, 1917. Letter from Maj. H. S. Graves to chief engineering officer re wood supplies. (E. S. File 14–10.)

Aug. 1, 1917. Letter of Maj. H. S. Graves requesting authority to arrange with M. L. Petit for furnishing wood. (E. S. File 14–10.)

Aug. 1, 1917. Letter Capt. B. Moore re boxes and lumber. (E. S. File 14–11.)

Aug. 3, 1917. Letter from Maj. H. S. Graves to chief engineer officer re forestry situation. (E. S. File 14–17.)

Aug. 3, 1917. Letter from Young Men's Christian Association secretary to adjutant general, American Expeditionary Forces, re timber for Young Men's Christian Association. (E. S. File 14–13.)

Aug. 3, 1917. Letter Maj. H. S. Graves relative to conference at office of minister of war with regard to selection of forests for the American Expeditionary Forces to operate in, said conference being attended by Gen. Pershing. (E. S. File 14–17.)

Aug. 6, 1917. Letter of chief engineer, American Expeditionary Forces, to Gen. Chevalier relative to acquisition of forests for American use. (E. S. File 14–14.)

Aug. 6, 1917. Letter of chief engineer, American Expeditionary Forces, to M. Claveile re timber at La Gavre and Camors. (E. S. File 14–15.)

Aug. 17, 1917. Report of Maj. H. S. Graves on his field examination for production of forest supplies. (E. S. File 14–21.)

Aug. 17, 1917. Memorandum of Maj. H. S. Graves relative to forest situation in France, location of first troops to arrive in France, and production of forest supplies. (E. S. File 14–21.)

Aug. 25, 1917. Letter of Maj. H. S. Graves re personnel for forest division, office of chief engineer, line of communications. (E. S. File 14–23.)

Aug. 25, 1917. Memorandum of Capt. B. Moore, re conference with Gen. Lord Lovat re forestry troops for the British. (E. S. File 26–14.)

Aug. 25, 1917. Maj. Graves to Lieut. Col. Jackson, extract of memorandum 70, headquarters American Expeditionary Forces, re personnel to be retained for duty in Paris. (E. S. File 14–23.)

Aug. 28, 1917. Conference with Lord Lovat re forestry troops for British. (E. S. File 26–14.)

Dec. 28, 1917. Report of Gen. Taylor to chief of engineers. Forestry troops now operating: One regiment of two battalions, total about 2,700 men, now cutting 50,000 feet of lumber per day. Within two months will increase to 400,000 feet per day. (E. S. File.)

Feb. 6, 1918. Meeting of Allies in England on lumber question. (E. S. File 3–40.)

Feb. 6, 1918. Wood-cutting regulations. (G. O. 21, G. H. Q., A. E. F.)

July 11, 1918. Construction and forestry added to functions of Engineers. (G. O. 114, G. H. Q., A. E. F.)

July 12, 1918. Division of construction and forestry announced. Brig. Gen. Edwin Jadwin appointed director. (G. O. 29, Hq. S. O. S.)

Aug. 6, 1918. Purchase of standing timber to be made through division of construction and forestry. (G. O. 130, G. H. Q., A. E. F.)

Sept. 19, 1918. Division of construction and forestry to conduct all negotiations for acquisition of standing timber to exceed 5,000 francs. (G. O. 159, G. H. Q., A. E. F.)

Oct. 10, 1918. Engineer forestry troops to be organized into one regiment, the 20th Engineers, and attached Engineer service companies. (G. O. 47 Hq. S. O. S.)

Oct. 18, 1918. 20th Engineers organized. To consist of 1 regimental headquarters, 29 battalion headquarters, and 145 Engineer companies. Absorbs 10th, 41st, 42d, 43d, 503d, 507th, 517th, 519th, 523d, and 531st Engineers. (G. O. 47, S. O. S.)

Undated. All road work in base sections and intermediate sections to be done under direction of the director of construction and forestry. (G. O. 1, Hq. S. O. S., S. of U.)

LIGHT RAILWAYS AND ROADS.

July 10, 1917. Requisition covering road-making equipment, including steam roller, rock crushing and quarrying machines, etc., for special road troops. Requisition on Chief of Engineers, Washington, by Maj. Barber. (Requisition No. 5.)

Aug. 18, 1917. Requisition covering trench track and appliances. Narrow gauge. Requisition on Chief of Engineers, Washington, by Maj. Cooper. Tonnage not indicated. (Requisition No. 9.)

Sept. 22, 1917. Letter of Col. W. H. Adams re organization of American light railways. (E. S. File 3–4.)

Nov. 14, 1917. Lieut. Col. Hodge, Corps of Engineers, National Army, made manager of roads. (G. O. 61, G. H. Q., A. E. F.)

Dec. 19, 1917. Artillery depends on railroads and tramways. (E. S. File 14–2–66.)

July 11, 1918. Light railways and roads added to functions of Engineers. (G. O. 114, G. H. Q., A. E. F.)

July 12, 1918. Division of light railways and roads announced. Brig. Gen. Charles H. McKinstry, National Army, appointed director. (G. O. 29, Hq. S. O. S.)

Sept. 4, 1918. 12th and 14th Engineers assigned to division of light railways and roads. (G. O. 149, G. H. Q., A. E. F.)

Nov. 11, 1918. Headquarters division of light railways and roads moved to Neufchateau. (Memorandum.)

Undated. Reports of railway operations (proposed organization of railway regiment attached) of the 11th, 12th, and 14th regiments. (E. S. File 3–4–15.)

Nov. 19, 1918. 12th, 14th, 21st, and 22d Engineer (light railway) regiments, and 11th, 15th, and 16th railroad construction regiments, assigned to duty with the transportation department. (G. O. 36, Hq. S. O. S.)

Dec. 11, 1918. Commanding general of base section involved through chief engineer officer responsible that suitable action is taken to have roads cleared of snow. (Bul. 101, G. H. Q., A. E. F.)

Jan. 2, 1919. Road repair and maintenance placed under department of construction and forestry. Engineer troops will be furnished to carry out instructions of director of construction and forestry. (G. O. 2, G. H. Q., A. E. F.)

Mar. 15, 1919. Division of light railways abolished. All light railway supplies, shops, depots, and personnel transferred to the Engineer purchasing officer, who will exercise the necessary supervision and control under the chief engineer, American Expeditionary Forces. (G. O. 16, Hq. S. O. S.)

Apr. 10, 1919. One route only maintained by American troops from American area in eastern France to Luxemburg and occupied Germany. (Bul. 30, G. H. Q., A. E. F.)

ENGINEER SUPPLIES.

May 21, 1917. Letter of Col. Taylor to Capt. Graves re supplying of troops in France. (E. S. File 12–4, Misc.)

May 28, 1917. Letter of Engineer purchasing office, Paris, re organization of that office. (E. S. File 16–1–207.)

June 20, 1917. Requesting clerical help and suggesting establishment of purchasing agency for Engineers in New York City. (Cable No. 12–S, E. S.)

June 23, 1917. Letter of chief engineer, American Expeditionary Forces, to Chief of Engineers, re purchasing and disbursing officers. Urges appointment of same at an early date. (E. S. File 80–5.)

June 24, 1917. Letter of Ernest Graves re organization of mining troops. (E. S. File.)

July 2, 1917. Letter from Col. McCarthy (C. Q. M.) re Engineer regiments to arrive in France, inquiring whether those to be assigned to British and French would be fed and clothed by those Governments.

July 5, 1917. Memorandum of conference at Ministere de la Guerre relative to engineering and wood supplies. (File 26–6 Misc.)

July 10, 1917. Requisition covering road-making equipment, including steam rollers, rock crushing and quarrying machines, etc., for special road troops. Requisition on Chief of Engineers, Washington, by Maj. Barber. (Requisition No. 5.)

July 10, 1917. Electric lighting plant and equipment. Requisition on Chief of Engineers, Washington, by Maj. Barber. Aggregate tonnage, 395. (Requisition No. 3.)

July 10, 1917. Material for water supply projects. Requisition on Chief of Engineers, Washington, by Maj. Barber. Aggregate tonnage, 6,133. (Requisition No. 2.)

July 10, 1917. Covering camouflage materials. Aggregate tonnage, 22,806. Requisition of Maj. Barber on Chief of Engineers, Washington. (Requisition No. 1.)

July 10, 1917. Requisition covering "equipment and supplies," i. e., tools, portable forges, wheelbarrows, equipment and supplies for Infantry Division, for troop operations in the field. Total tonnage, 14,509. (Requisition No. 4.)

July 14, 1917. Requisition covering railway tools and materials. Tonnage, 157,936. (Requisition No. 6.)

July 14, 1917. Requisition covering special mining stores. Tonnage, 1,848. (Requisition No. 7.)

July 19, 1917. Cable No. 53–S; mining service. (E. S. File.)

Aug. 6, 1917. Requisition covering construction tools. Tonnage not given. (Requisition No. 8.)

Aug. 18, 1917. Requisition covering trench track and appliances. Narrow gauge. Tonnage not indicated. (Requisition No. 9.)

Aug. 19, 1917. Memorandum of chief engineer, American Expeditionary Forces, to commanding general, American Expeditionary Forces, stating Col. Taylor is only Engineer disbursing officer in France, but that Col. T. H. Jackson, chief of engineers, will open account in a few days. (E. S. File 80–2.)

Aug. 20, 1917. General purchasing board established. (G. O. 23, G. H. Q., A. E. F.)

Aug. 21, 1917. Letter of Chief of Engineers, United States Army, stating funds have been placed to credit of Col. T. H. Jackson. Circular letter attached re instructions for Engineer supply officers. (E. S. File 27–1–9.)

Aug. 23, 1917. Lieut. Col. Charles G. Dawes appointed general purchasing agent. G. O. 28, G. H. Q., A. E. F.)

Aug. 23, 1917. Detail of Maj. T. H. Jackson to purchasing board. (E. S. File 29–35.)

Sept. 17, 1917. Changes in Engineer depots. (G. O. 3, L. of C.)

Sept. 19, 1917. Engineer purchasing officer, London, Maj. R. G. Powell, states he reported to Gen. Lassiter, Sept. 21, and was assigned office space (3 rooms) in the embassy. (E. S. File 3–4–24.)

Sept. 21, 1917. Letter of commanding officer, camouflage section, requesting that all units of the American Expeditionary Forces be advised to call on the camouflage section for camouflage supplies. (E. S. File 13–2–15.)

Sept. 27, 1917. Report of Maj. Powell on organization of Engineer purchasing office at London. (E. S. Files.)

Sept. 30, 1917. Supplies; depots; requisitions. (G. O. 43, G. H. Q., A. E. F.)

Oct. 6, 1917. Report of Maj. R. G. Powell on limited supply of material. (E. S. File 3–40.)

Oct. 8, 1917. Letter of Capt. J. A. Sargent re his assignment as officer in charge of Engineer depot, Gievres. (File 210–4–s, Depot Section.)

Oct. 18, 1917. Personal letter Gen. Taylor to Gen. Patrick re establishment of Engineer depots. Letter of Gen. Patrick, dated Oct. 21, 1917, attached, stating that large amount of supplies are being stored at Is-sur-Tille. (E. S. File 1–1a–28.)

Oct. 20, 1917. Requisition for material for working parties and storage. (Requisition No. 10.)

Oct. 25, 1917. Letter of Capt. J. C. Gotwals re anti-aircraft searchlights with notes on trip of British front attached, covering searchlight organization and supply. (E. S. File 14–2–19.)

Oct. 30, 1917. Report of Col. Youngberg on British shop system at front. (E. S. File 3–4.)

Nov. 3, 1917. Coordination of purchase. (E. S. Files.)

Nov. 21, 1917. Letter of Engineer supply officer relative to establishing of dumps. Submits remarks relative to "reissuing points" which were established, one at Demange for the First Division, and one at Neufchateau for divisional areas previous to establishment of intermediate depots. E. S. (File 340, Dumps.)

Nov. 24, 1917. Letter of Engineer purchasing officer, London, re cement. Total of 4,000,000 barrels. (E. S. File 3–40.)

Nov. 27, 1917. Gen. Patrick relieved as commanding general, line of communications. New base sections established. Requisitions of French Government. (G. O. 66, G. H. Q., A. E. F.)

Nov. 27, 1917. Requisition for stores required for machine repair shops, electric generating outfits, etc. Requisition on Chief of Engineers, Washington. (Requisition No 11.)

Nov. 30, 1917. Report of Col. Youngberg on British supply system. (E. S. File 3–4.)

Dec. 8, 1917. Letter of chief engineer, line of communications, re officer to be sent to the United States to represent the needs of the Engineer Department. (E. S. File 16–2–356.)

Dec. 12, 1917. Supply service, procurement and care, etc. Transportation of supplies. (G. O. 73, G. H. Q., A. E. F.)

Dec. 15, 1917. Letter of Col. Jackson to general purchasing agent re large quantities of supplies procurable in Europe effecting a saving in tonnage. (E. S. File 3–4a.)

Dec. 26, 1917. Commander in chief directs submission of reports covering construction under the Engineer Department and reports showing supplies on hand in depots. (E. S. File 3–4–68.)

Dec. 28, 1917. Money accounts and supply officers. (Buls. 18 and 19, Hq. S. O. S.)

Jan. 5, 1918. Report on electrical and mechanical section for 1917. (E. S. File 3–4.)

Jan. 9, 1918. Memorandum coordination section, general staff, re responsibility of technical staff officers for procurement and distribution of supplies. (E. S. File 25–1–104.)

Jan. 15, 1918. Engineer property, instruction relating to. (Bul. 5, Hq. A. E. F.)

Jan. 15, 1918. Organization of First Army Corps. Supply functions per General Orders, No. 73, 1917. (G. O. 9, G. H. Q., A. E. F.)

Jan. 16, 1918. Salvage service, American Expeditionary Forces, established. Chief of salvage service to have, among others, one representative from the Corps of Engineers attached to his office as assistant. (G. O. 10, G. H. Q., A. E. F.)

Jan. 19, 1918. Engineer property for station, etc. (G. O. 12, G. H. Q., A. E. F.)

Jan. 23, 1918. Letter of chief engineer, American Expeditionary Forces, to chief engineer, line of communications, submitting definition of duties and responsibilities in connection with Engineer supplies. (E. S. File S–3538.)

Jan. 31, 1918. Chief engineer, line of communication, charged with construction, etc., of Engineer depots. (Circ. 8, Office of Chief Engineer.)

Feb. 5, 1918. Letter of commanding officer, camouflage section, re commutation of rations for soldiers at Nancy workshop. (E. S. File 13–1–70.)

Feb. 6, 1918. Translation of general order issued by French authorities in dealing with the American services. (Bul. 11, Hq. L. of C.)

Feb. 13, 1918. Memorandum of chief engineer to chief of staff. Department has obtained about 200,000 tons of stores in Europe. Saving of tonnage at this time is important. (E. S. File 3–40.)

Feb. 18, 1918. Local purchases of supplies. Local engagement of services. Construction and repairs by Engineers. (G. O. 32, G. H. Q., A. E. F.)

Mar. 7, 1918. Drafting instruments to be furnished by the Chief of Engineers. (G. O. 37, G. H. Q., A. E. F.)

Mar. 23, 1918. Commanding general, Service of Supply, responsible for procurement of supplies, material, equipment, plants, and establishments necessary for the American troops in France; also for care and storage. (G. O. 44, G. H. Q., A. E. F.)

Mar. 25, 1918. Functions of commanding general, Service of Supply, in the supply of troops. Regulations in the matter of the requisitions and issue of supplies. Articles 27–35 particularly apply to Engineer Department. (G. O. 45, G. H. Q., A. E. F.)

Mar. 29, 1918. Articles of Engineer property subject to issue to intelligence service, Infantry regiments, and topographical section. (G. O. 49, G. H. Q., A. E. F.)

Mar. 30, 1918. All shop troops and others who have no possible chance of being ordered to join combatant units to be equipped with trousers and canvas leggins in place of breeches and puttees. (G. O. 7, Hq. S. O. S.)

Apr. 8, 1918. Letter of Gen. Taylor to Gen. Pershing. (E. S. File 3–4.)

Apr. 9, 1918. Chief engineer responsible for supply of cement in Service of Supply. (Bulletin 8, S. O. S.)

Apr. 10, 1918. Requisition for engineering and construction material will be made upon the chief engineer officer. Capt. R. T. Frazier, jr., Engineer Officers' Reserve Corps, appointed supply officer, Service of Utilities. (Circ. 9, C. of U.)

Apr. 30, 1918. Procedure for handling communications at headquarters, Service of Supply. The fourth section to be under Col. H. C. Smither, chief of staff (G–4), to receive communications as to supply, construction, and transportation. (Memo. 24, S. O. S.)

Apr. 30, 1918. Letter of chief engineer to commander in chief, re cement mill at Bordeaux turned over to United States. (E. S. File 3–4.)

May 10, 1918. Salvaged Engineer property to be repaired by the salvage service. (G. O. 73, G. H. Q., A. E. F.)

May 10, 1918. All chiefs of supply and technical departments of Service of Supply to make frequent personal inspections of their projects. (Memo. 30, S. O. S.)

June 19, 1918. Allowance, material, and personnel for Engineer regiment. (G. O. 99, G. H. Q., A. E. F.)

June 20, 1918. Col. Charles G. Dawes announced as representative of American Expeditionary Forces on military board for allied supply. (G. O. 100, G. H. Q., A. E. F.)

June 21, 1918. Letter of commanding officer, 24th Engineers, inclosing report of board on shop layouts. (E. S. File 24–4.)

July 12, 1918. Under provisions of order announcing Maj. Gen. Langfitt as chief engineer, American Expeditionary Forces, the division of military engineering and engineer supplies, is announced, with Brig. Gen. Harry Taylor director. (G. O. 29, Hq. S. O. S.)

Aug. 8, 1918. In port construction, question of use of material which requires sea transportation to be carefully studied with view to obtaining as much as possible from French sources. Railroad facilities to be augmented and Service of Supply personnel to be provided. (Memo. 79, S. O. S.)

Sept. 2, 1918. Category of supplies to be furnished by each branch of service, including Engineer Corps. (G. O. 41, Hq. S. O. S.)

Sept. 27, 1918. Disposition of surplus supplies, also extravagant use of power and light. (Bul. 34, Hq. S. O. S.)

Sept. 30, 1918. Articles supplied by Engineer Corps. (Bul. 35, Hq. S. O. S.)

Oct. 15, 1918. Brig. Gen. J. F. McIndoe assigned as director of military engineering and engineer supplies. (G. O. 1, O. C. E.)

Oct. 28, 1918. Maj. J. H. Wickersham, Engineers, appointed deputy engineer supply officer at general headquarters. (G. O. 2, O. C. E.)

Oct. 30, 1918. Table showing sources of materials and responsibility for repairs for buildings and their equipment. (G. O. 191, G. H. Q., A. E. F.)

Nov. 2, 1918. Bills to be submitted for supplies furnished to French Army. (G. O. 198, G. H. Q., A. E. F.)

Nov. 5, 1918. Map section established in office of director of military engineering and engineer supplies. (Bul. 41, Hq. S. O. S.)

Nov. 8, 1918. Organization of 227th Engineers (shop and supply) and 228th Engineers (water supply) authorized. (G. O. 199, G. H. Q., A. E. F.)

Nov. 14, 1918. Cancellation of numerous projects and orders for supplies, following signing of the armistice. (G. O. 54, Hq. S. O. S.)

Nov. 19, 1918. Transportation Department, American Expeditionary Forces, charged with carrying out agreements with Allies in reference to the operation, exploitation, and repair on railroads assigned to American Expeditionary Forces. Normal gauge railroad construction and repair transferred from Engineer Department to the Transportation Department. Engineer Department to furnish materials, supplies, tools, and labor. (G. O. 56, Hq. S. O. S.)

Mar. 3, 1919. Care and disposition of Engineer equipment. (Bul. 18, G. H. Q., A. E. F., Par. III.)

MILITARY ENGINEERING.

June 24, 1917. Letter of Maj. Ernest Graves re organization of mining troops. (E. S. Files.)

June 25, 1917. Cable 13–S. First mention of gas service. (E. S. Files.)

July 10, 1917. Requisition covering camouflage materials. Aggregate, 22,806 tons. (Requisition No. 1.)

July 10, 1917. Requisition covering "equipment and supplies," i. e., tools, portable forges, wheelbarrows, equipment, and supplies for Infantry Division, for troop operations in the field. Total tonnage, 14,509. (Requisition No. 4.)

July 10, 1917. Requisition for electric lighting plant and equipment. Aggregate tonnage, 395. (Requisition No. 3.)

July 10, 1917. Requisition for material for water supply projects. Aggregate tonnage, 6,133. (Requisition No. 2.)

July 14, 1917. Requisition covering special mining stores. Tonnage, 1,848. (Requisition No. 7.)

July 19, 1917. Cable 53–S. Mining service. (E. S. Files.)

Aug. 15, 1917. Letter of Maj. Graves on English Tunneling School at Chatham, England. (E. S. File 9–2.)

Aug. 17, 1917. Letter of Col. Taylor to chief of staff recommending organization of gas and flame service and that Col. Fries be placed in charge. (E. S. File 10–2–1.)

Aug. 17, 1917. Memorandum of chief engineer, American Expeditionary Forces, to chief of staff, American Expeditionary Forces, appointing Lieut. Col. A. A. Fries as officer in charge of gas and flame service. (E. S. File 10–2–1.)

Aug. 25, 1917. Memorandum on location of Engineer regiments. (E. S. Files.)

Sept. 3, 1917. Gas service established. See Cable 122–S. (G. O. 31, G. H. Q., A. E. F.)

Sept. 5, 1917. Report on German gas attack by Lieut. A. McQueen, of First Canadian Division. (E. S. File 10–2–2.)

Sept. 21, 1917. Letter of commanding officer, camouflage section, states specialists needed for camouflage workshop. Forwarded to commander in chief requesting cable be sent to United States re sailing date of camouflage troops. (E. S. File 13–2–3.)

Sept. 22, 1917. Letter of commanding officer, camouflage section, re sending men to British camouflage section to study methods. (E. S. File 13–2–4.)

Oct. 8, 1917. First Corps center of instruction established. (G. O. 45, G. H. Q., A. E. F.)

Oct. 10, 1917. Army schools at Langres. (G. O. 46, G. H. Q., A. E. F.)

Oct. 10, 1917. Letter of commanding officer, First Division Engineer Train, re searchlight training and equipment. (E. S. File 14–2–25.)

Oct. 13, 1917. Letter of chief engineer, American Expeditionary Forces, to Engineer supply officer, Paris, re sites for camouflage workshop. Dijon suggested. (E. S. File 13–1–11.)

Oct. 13, 1917. Report of Col. Youngberg on British water supply. (E. S. File 3–4.)

Oct. 13, 1917. Report on searchlights. (E. S. File 14–2–25.)

Oct. 20, 1917. Requisition for material for working parties and storage. (Requisition No. 10.)

Oct. 22, 1917. Allotment of textbooks per regiment for noncommissioned officers' schools. (Bul. 6, G. H. Q., A. E. F.)

Oct. 25, 1917. Letter of Maj. H. S. Bennion re camouflage troops. (E. S. File 13–1–16.)

Oct. 25, 1917. Notes of Capt. Gotwals on searchlights at British front. Searchlight organization and data. (E. S. File 14–2–19.)

Oct. 30, 1917. Report on engineer service, British Army, by Col. G. A. Youngberg. (E. S. File 3–4–45.)

Oct. 30, 1917. Report of Col. Youngberg on British shop system at front. (E. S. File 3–4.)

Nov. 6, 1917. Capt. Gotwals's report on searchlights at French front. (E. S. File 14–2–22.)

Nov. 15, 1917. Topographical engineers; two companies with intelligence section, G. S. (E. S. File 6–1.)

Nov. 18, 1917. Memorandum to chief of staff re searchlights. (E. S. File 14–2–37.)

Nov. 22, 1917. Memorandum of Capt. Gotwals, re notes on trip to French Eighth Army. (E. S. File 14–2–22.)

Dec. 3, 1917. Memorandum of chief engineer, American Expeditionary Forces, with copy of study made of memorandum from operations section, General staff, re searchlight service. (E. S. File 14–2–27.)

Dec. 17, 1917. Divisional area work in charge of Engineer officer, advance section, line of communications. (Circ. 12, Adv. Sec. L. of C.)

Dec. 19, 1917. Capt. Gotwals's report on second trip to British front. (E. S. File 14–2–66.)

Dec. 19, 1917. Letter of commanding officer, searchlight depot, submitting report of trip to British front relative to searchlights. (E. S. File 14–2–66.)

Dec. 22, 1917. Letter of commanding officer, camouflage section, submitting project for camouflage factory at Dijon. Papers attached re advance camouflage workshop at Nancy and re sites for factories. (E. S. File 13–1–9.)

Dec. 29, 1917. Letter chief engineer, American Expeditionary Forces, to chief of staff re authorization for preparation, publication, and distribution of "Engineer Field Notes." (E. S. File 23–4–306.)

Jan. 1, 1918. Letter of chief engineer, American Expeditionary Forces, to commanding officer, camouflage section, with report of operations for the year of 1917 re camouflage. (E. S. File 13–4–61.)

Jan. 1, 1918. Letter of First Lieut. R. W. Lewis, re searchlight investigative trip to England. (E. S. File 14–2–66.)

Jan. 9, 1918. Weekly status report No. 1, on searchlight material being supplied to American Expeditionary Forces by General Engineer Depot, United States Army. (E. S. File 14–2a.)

Jan. 9, 1918. Report on searchlight service for 1917. (E. S. File 14–2–66.)

Jan. 10, 1918. Letter of chief engineer, American Expeditionary Forces, with special reports attached on digest of camouflage experiences; report on French camouflage and principles and practice of camouflage, to January, 1918. (E. S. File 13–1–60.)

Jan. 11, 1918. Report on camouflage service for 1917. (E. S. File 3–4.)

Jan. 15, 1918. Organization of First Army Corps. Supply functions per General Orders, No. 73, 1917. (G. O. 9, G. H. Q., A. E. F.)

Jan. 16, 1918. Letter, chief engineer, American Expeditionary Forces, to chief of camouflage. (E. S. File 13–1–67 and 13–1–70.)

Jan. 21, 1918. Letter of chief engineer, American Expeditionary Forces, to Chief of Engineers, United States Army re searchlight personnel and equipment. (E. S. File 14–2–66.)

Jan. 23, 1918. Letter of commanding officer, camouflage section, requesting authority to attach men to French camouflage section for instruction. (E. S. File 13–2–12.)

Jan. 23, 1918. Second Corps schools organized. Engineer School. Maj. J. W. Stewart, director. (G. O. 14, G. H. Q., A. E. F.)

Jan. 25, 1918. Engineer Department charged with technical photography of Engineer operations. (G. O. 15, G. H. Q., A. E. F.)

Jan. 29, 1918. Letter on camouflage service, quoting Gen. Winslow. (E. S. File 13–1–60.)

Jan. 29, 1918. Indorsement to Maj. Bennion's letter re camouflage personnel. (E. S. File 13–1–60.)

Feb., 1918. Report of Capt. Hazeltine (camouflage) on visit to French front. (E. S. File 13–1–59.)

Feb. 5, 1918. Letter of commanding officer, camouflage section, re commutation of rations for soldiers at Nancy workshop. (E. S. File 13–1–70.)

Feb. 10, 1918. Tabulated report of camouflage services. (Camouflage folder, E. S. Files.)

Feb. 14, 1918. Letter chief engineer to chief of camouflage service re duties in field on water supply, electrical and mechanical, and camouflage; will devolve on chief engineer in tactical or geographical jurisdiction, etc. (E. S. Files.)

Feb. 14, 1918. Instruction made regarding observations to be made by officers visiting or serving with the French or British or Americans at front. (G. O. 29, G. H. Q., A. E. F.)

Feb. 15, 1918. Camouflage in First Division. (E. S. File 13–1–62.)

Feb. 15, 1918. Letter chief engineer, American Expeditionary Forces, with papers attached relative to organization of camouflage. (E. S. File 13–1–67.)

Feb. 24, 1918. Letter of chief engineer, American Expeditionary Forces, to commander in chief. Camouflage section attacked re faulty camouflaging in First Division. (E. S. File 13–1–92.)

Feb. 25, 1918. Water supply in Army zone. (G. O. 34, G. H. Q., A. E. F.)

March, 1918 Camouflage to be under Engineer Corps and duties of camouflage service outlined. (Bul. 17, G. H. Q., A. E. F.)

Mar. 5, 1918. Instruction covering Army schools. (G. O. 35, G. H. Q., A. E. F.)

Mar. 11, 1918. Camouflage service proposed organization. (E. S. File 13–1–86 and 13–1a.)

May 20, 1918. Troop baths to be erected by Engineer Department. (Bul. 12, Hq. S. O. S.)

May 24, 1918. Amendment to General Orders, No. 35, paragraph 9, relating to Engineer instruction at corps schools. (G. O. 77, G. H. Q., A. E. F.)

June 1, 1918. Battalion headquarters of 29th Engineers, organized at Langres. Companys A and H assigned to battalion and Company B attached. (G. O. 84, G. H. Q., A. E. F.)

June 18, 1918. Duties of chief engineer of Army and chief engineer of Army corps. (G. O. 98, G. H. Q., A. E. F.)

June 19, 1918. Allowance material and personnel for each Engineer regiment. (G. O. 99, G. H. Q., A. E. F.)

June 21, 1918. Letter of commanding officers, 24th Engineers, inclosing report of board on shop layouts. (E. S. File 24–4.)

June 25, 1918. Second, Third, and Fourth Army Corps established and chief engineer of each announced. (G. O. 102, G. H. Q., A. E. F.)

July 12, 1918. Under provisions of order announcing Maj. Gen. Langfitt, as chief engineer, American Expeditionary Forces, division of military engineering and engineer supplies established, and Brig. Gen. Harry Taylor announced as director. (G. O. 29, Hq. S. O. S.)

July 24, 1918. Brig. Gen. Jay J. Morrow designated as chief engineer, First Army.

Aug. 7, 1918. Engineer Department's responsibility in connection with water supplies. (G. O. 131, G. H. Q., A. E. F.)

Aug. 9, 1918. 30th Engineers transferred to chemical warfare service as 1st Gas Regiment. (G. O. 133, G. H. Q., A. E. F.)

Aug. 27, 1918. Base printing plant of the 29th Engineers, A. P. O. 714, designated as map depot for American Expeditionary Forces. (G. O. 142, G. H. Q., A. E. F.)

Oct. 15, 1918. Brig. Gen. J. F. McIndoe assigned as director of military engineering and engineer supplies. (G. O. 1, O. C. E.)

Nov. 5, 1918. Map section established in office of director of military engineering and engineer supplies. (Bul. 41, Hq. S. O. S.)

Undated, 1918. Duties of Army Engineer Corps and duties of chief engineer. (Bul. 65, G. H. Q., A. E. F.)

June 14, 1918. Requests for camouflage to be sent to division engineers. (Bul. 37, G. H. Q., A. E. F.)

Undated, 1918. Organization of water supply service under the Engineer Corps. (Bul. No. 55, G. H. Q., A. E. F.)

APPENDICES.

Organization.

1. Organization charts, Engineer Department.
2. General orders, general headquarters.
3. General orders, headquarters, Service of Supply.
4. Bulletins, general headquarters.
5. Bulletins, headquarters, Service of Supply.
6. Index and extracts, general orders, and bulletins, general headquarters, line of communication, and Service of Supply.

Military Engineering—Staff Operations.

7. Report—Assistant to the chief engineer, American Expeditionary Forces, at general headquarters. (With appendix reports on board of military engineering and geologic section.)

Special Engineer Services.

WATER SUPPLY.

8. Report (3 volumes)—Activities of water supply section, division of military engineering and engineer supplies, office of chief engineer, American Expeditionary Forces, August, 1917, to January, 1919, by Col. F. F. Longley.
9. Report (2 volumes)—Engineer research material (water supply), by Capt. Benjamin M. Hall, jr.
10. Report—Water supply in Ninth Corps, British Expeditionary Forces, by Capt. E. C. Wilson, Engineers, water supply officer, Second American Corps.
11. Report—Water service (French) during battle of Verdun, by Maj. Bunau Varilla. (Translation by Maj. J. N. Hazelhurst.)
12. Notes on military water supply, by Capt. Paul Hansen.
13. Report—Activities of water analysis laboratories to January, 1919, by Lieut. Col. Edward Bartow.

ELECTRICAL-MECHANICAL.

14. Report—Activities of electrical-mechanical section, office of chief engineer, American Expeditionary Forces, by Maj. George W. Semmes.

CAMOUFLAGE.

(*See* Reports, chief engineers, First Army; chief engineer, Second Army; 40th Engineers.)

SEARCHLIGHTS.

14b. Report—Searchlight section. (*See* Reports, chief engineer, First Army; chief engineer, Second Army; 50th Engineers.)

BRIDGING.

(*See* Reports, chief engineer, First Army; chief engineer, Second Army; chief engineer, Third Army; assistant to the chief engineer, American Expeditionary Forces, at general headquarters; 27th Engineers and other regimental historical-technical reports.)

TOPOGRAPHICAL AND RANGING.

15. Report—Ranging in American Expeditionary Forces, by Lieut. Col. A. Trowbridge.

LIGHT RAILWAYS.

16. Report—Director of division of light railways, office of chief engineer, by Col. A. T. Perkins.

ROADS AND QUARRIES.

17. Report—Department of roads, division of light railways and roads, office of chief engineer, by Col. A. T. Perkins.

ENGINEER RESEARCH—REPORTS, ENGINEER RESEARCH PARTY.

18. Organization of the ground, by Capt. J. W. Gavett.
19. Military bridges, by Capt. M. W. McDonald.
20. Dugouts and concrete shelters, by Capt. G. R. De Beque.
21. German tank mines, by Capt. G. R. De Beque.
22. Mine warfare, by Capt. G. R. De Beque.
23. Standard-gauge railroads, by Maj. R. M. Lawton.
24. Roads, by Capt. T. R. Beeman.

BOARD ON MILITARY ENGINEERING.

25. Engineer Field Notes. (*See* also Report—Assistant to chief engineer at general headquarters.)

GEOLOGY.

26. Report—Organization and duties of geologic officers, by Lieut. Col. A. H. Brooks. (*See* also Report—Assistant to chief engineer, at general headquarters.)

ENGINEER SCHOOLS.

27. Reports—Army Engineer School.
28. Reports—First Corps School.
29. Reports—Second Corps School.
30. Reports—Third Corps School.

(*See also* Report—116th Engineers) (replacement regiment).

TRAINING OF DIVISIONAL ENGINEERS.

31. Program of training (first phase) for 6th Division; No. 1307–G–5, general headquarters, July 22, 1918.
32. Memorandum for corps and division commanders, subject, "Training," August 5, 1918.
33. Program for training for divisions in the United States.

Engineer Supply and Construction.

ENGINEER SUPPLY.

34. Report, January 20, 1919, officer in charge, supplies section, division of military engineering and engineer supplies, by Col. F. A. Molitor.
35. History of operations of shop section, division of military engineering and engineer supplies, December 31, 1918, by Maj. C. E. Whipple.
36. Report, January 29, 1919, of Engineer purchasing officer, by Col. T. H. Jackson.
37. Report, May, 1919, Engineer purchasing officer, by Col. T. H. Jackson.
38. Report—Cement supply, by Capt. E. C. Eckels.

CONSTRUCTION.

39. Report, December 23, 1918, director of construction and forestry to chief engineer, American Expeditionary Forces.
40. Report, chief engineer, American Expeditionary Forces, to commanding officer, Service of Supply, March 10, 1919, with appendix report, March 12, 1919, director of construction and forestry to commanding general, Service of Supply, through chief engineer, American Expeditionary Forces.
41. Notes on electrical installations, Service of Supply.
42. Report, March 11, 1919, Engineer valuation board.

42a. Report—Townsend Board.

Reports on Projects, by Section Engineers.

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43. Base section No. 1.
44. Base section No. 2.
45. Base section No. 3.
46. Base section No. 4.
47. Base section No. 5.
48. Base section No. 6.
49. Base section No. 7.
50. Intermediate section (west).
51. Intermediate section (east).
52. Advance section.
53. Type plans, hospitals.
54. Types of hospital ward and troop barracks.

Forestry.

55. Report on technical equipment of forestry section, division of construction and forestry, by Capt. Ralph C. Staebner.
56. Report (5 volumes) on individual operations of forestry section, division of construction and forestry, by Capt. C. E. Dunston.
57. Report—History of forestry section, division of construction and forestry.

Miscellaneous.

58. Report of technical board, by Maj. Dugald C. Jackson.
59. Report of personnel section, office chief engineer, American Expeditionary Forces, by Lieut. Col. C. Van Deventer.
60. Report—Historical-technical section, office of chief engineer.

61. Narrative Report—"From base port to Army zone with the Engineers."
62. Report on organization and equipment of railway construction troops, by Col. W. B. Parsons.
63. Condensed report of war damages board, by Brig. Gen. C. H. McKinstry.
64. Experience reports of Engineer officers.
65. Photographs of engineer activities with the Armies and in the Service of Supply.

REPORTS ON PROJECTS BY SECTION ENGINEERS.

43. Base section No. 1:
    St. Nazaire, basin improvements.
    Montoir, Montoir yards.
    Montoir, dock.
    St. Nazaire, water supply improvements.
    St. Nazaire, camps.
    St. Luce, storage yards.
    Saumur, engine terminals.
    Savenay, hospital center.
    Savenay, dam and waterworks.
    Base section No. 1, roads.
44. Base section No. 2:
    Bassens, refrigeration plant.
    Bassens, Bassens camp.
    Bassens, warehouse, French docks, etc.
    Bassens, rec. and depart. yards, etc.
    Bassens, dock and classification sheds.
    Bassens, open storage, French docks.
    Blaye, oil storage tanks.
    Beau Desert, Beau Desert Hospital.
    Beau Desert, Beau Desert Railway.
    Talence-Bordeaux, Base hospital No. 6.
    Le Courneau, work at Camp Le Hunt.
    Furt (Gironde), gasoline storage tank.
    Le Courneau (Gironde), work at Camp Le Hunt.
    Lormont, Genicart Camp.
    Lormont, Grange Neuve Camp.
    Carbon Blanc, base veterinary hospital.
    Pauillac, naval storage yard.
    Perigueux, Perigueux engine terminal.
    La Bastide, Bordeaux. Aucanne warehouse.
    Souge, Camp de Souge.
    St. Loubes, gasoline storage tank.
    St. Loubes, St. Loubes ammunition depot.
    St. Sulpice, St. Sulpice storage project.
    La Bastide, Bordeaux. Barracks at Sursol.
    Perigueux, Perigueux Hospital project.
    Base section No. 2, road construction.
    Base section No. 2, well-drilling operation.
    La Bastide, Bordeaux. Motor operation park.
    Bordeaux, Marignac remount station.
    Bordeaux, Casino des Lilas.
    Talmont, dock facilities and railroad tracks.
    Bayonne, Bayonne remount station.

44. Base section No. 2—Continued.

Talmont, railroad, Talmont to La Traverserie.
Hendaye, Hendaye Corral.
Carbon Blanc, Carbon Blanc remount.
St. Jean de Luz, St. Jean de Luz rest camp.
Bassens, German prison camp.
Limoges, convalescent camp No. 5.
Bassens, Baranquine Camp (stevedore).
Bassens, James Stewart Barge Con.
Dax, camp infirmary.
Bordeaux, new postoffice building No. 705, etc.
Bassens, fire protection.
Limoges, 6,000-bed laundry.
Bassens, mechanical bakery.
St. Pardon, St. Pardon lighterage wharf, Chantiers and Ateliers de la Gironde, Bordeaux.
Houelles, forestry siding.
Beau Desert, Second Aerial Artillery Observation School.
Talmont, material yard and lighterage dock.
Limoges, ordnance repair shop.
Nexon, Nexon engine terminal.
Vauclaire, Vauclaire Hospital.
Limoges, Route de Lyon Hospital.
Limoges, Champ de Juillet.
Limoges, Mas Loubier Hospital.
Limoges, Bel Air Seminary Hospital.
Bordeaux, new base headquarters.
Bordeaux, Aquitane warehouse.
Bordeaux, barracks for French women.
Bordeaux, degreasing plant.
Lormont, motor reception park.
Bassens, A. T. S. Camp.
Bassens, 65th Engineers Hill Camp.
Coutras, railway water supply.
Mussidan, railway water supply.
Nexon, railway water supply.
Ambazac, railway water supply.
La Souterraine, railway water supply.
Base section No. 2, electrical work.
Cenon, Cenon pumping station.
Section Engineers. Unattached officers and organization engaged in work in base section No. 2.

45. Base section No. 3:

Slough, Engineer stores depot.
Portsmouth, Base Hospital No. 33.
Hursley Park, U. S. Base Hospital No. 204.
Salisbury Court, U. S. Base Hospital No. 40.
Liverpool, A. R. C. Military Hospital No. 4.
Liverpool, U. S. Rest Camp and Camp Hospital No. 40.
Plymouth, U. S. Base Hospital (no number).
Romsey, U. S. Camp Hospital No. 34.
Winchester, U. S. Camp Hospital No. 35.
Southampton, U. S. Rest Camp and Camp Hospital No. 36.
Winchester, kitchen, washhouses, latrines, and bathhouses for camp.

45. Base section No. 3—Continued.
    Winchester, prison camp.
    Romsey, bathhouses, laundry, latrines, and ablutions for camp.
    Southampton, officers' bathhouse (canceled).
    Romsey, permanent staff quarters (canceled).
    Winchester, officers' mess.
    Winchester, Quartermaster stores and shoe repair shop.
    Winchester, headquarters building for surgeon.
    Winchester, replanning construction, Flower Down Camp.
    Winchester, officers' bathhouse, Flower Down Camp.
    Winchester, Transient Officers' Club, Flower Down Camp (canceled).
    Dartford, U. S. Base Hospital No. 37.
    Winchester, district laboratory.
    Portsmouth, quartermaster and medical stores.
    Tottenham, U. S. Base Hospital No. 29.
    Liverpool, quartermaster stores at Knotty Ash Camp.
    Liverpool, cell and garage.
    Portsmouth, alterations to operating and X-ray rooms.
    Harling Road, mess hall and bathing facilities for camp (canceled).
    Bircham-Newton, kitchen for camp (canceled).
    Swanscomb, heating facilities for shower baths.
    Winchester, delousing plant.
    Romsey, delousing plant.
    Southampton, delousing plant (canceled).
    Winchester, A. R. C. Canteen.
    Hursley Park, A. R. C. Theater (canceled).
    Romsey, A. R. C. Recreation Building (canceled).
    Southampton, Officers' bathhouse (canceled).
    Hursley Park, delousing plant.
    Winchester, office for resident engineer.
    Winchester, Young Men's Christian Association Theater.
    Didcot, Engineer stores depot.
    Southampton, North Stonham Rest Camp (canceled).
    Winchester, railway platform.
    Paignton, A. R. C. Military Hospital No. 21.
    Romsey, extension to cook houses.
    Liverpool, garage (canceled).
    Southampton, garage for embarkation office.
    Codford, Camp Hospital (no number).
46. Base section No. 4:
    Le Havre, Quai de Maree warehouse and yard.
    Le Havre, Tancarville Canal warehouse.
    Le Havre, barracks, warehouses, motor parks, and office buildings.
    Rouen, wharf and warehouse construction.
    Rouen, Grande Couronne ammunition dock and storage.
    Rouen, Stevedore Camp Barracks.
47. Base section No. 5:
    Brest, Port de Commerce. Cover ramp for Pier No. 3.
    Brest, Permor station. Remodeling stables into barracks.
    Brest, new motor reception parks.
    Brest, pumping station at Casemates Fautras.
    Brest, Fort Guelmeur and old English remount station.
    Brest, latrine at quartermaster sorting yards.
    Brest, American Expeditionary Forces entraining yard.

47. Base section No. 5—Continued.
    Brest, freight classification shed, Port de Commerce.
    Brest, Stevedore Barracks and camp sewer, Port de Commerce.
    Brest and Pontanezen, Penfeld water supply.
    Brest, remodeling Pontanezen Barracks.
    Brest, Port de Commerce, Storage buildings for quartermaster department.
    Brest and vicinity, repair of roads and highways.
    Brest, Port de Commerce water supply.
    Brest, Port de Commerce, Jettee de l'Est.
    Landerneau, hospital.
    Brest, Port de Commerce, Erection of warehouse for Worm & Co.
    Brest, remodeling private residence for Laboratory.
    Brest, Port de Commerce, West Jettee refrigerator plant.
    Brest, remodeling base headquarters building.
    Brest, railroad work, Port de Commerce.
    Brest, installing balcony floor at Casemates Fortress.
    Brest, pipe line from French navy yard to wharves.
    Brest, Kermor Station. Gas distributing station.
    Fort Bouguen, prisoner-of-war inclosure.
    Brest, Forestou Creis, Stevedore Barracks.
    Brest, rest camp at Pontenezen Barracks.
    Brest, Troop Barracks.
    Brest, small mechanical bakery.
    Kerhuon, base hospital.
    Brest, Pontanezen Barracks, Contagious Disease Hospital.
    Quatre Pompes, driving piles for Navy at water dock.
    Brest, Port de Commerce. Derricks on Pier No. 5.
    Brest, Port de Commerce. South Jettee.
    Base section No. 5, operation of stone quarries.
    Brest, Fort Penfeld Prison Camp.
    Brest and vicinity, miscellaneous electrical work.
    Fort du Portzic, La Trinite water supply.
    Base section No. 5, standard disinfectors.
    Rennes, Rennes Hospital.
    Brest, Port de Commerce. Baggage sheds.
48. Base section No. 6:
    Marseille, camp for troops and personnel.
    Marseille, motor reception park.
    Toulon-Milhaud, storage yard and docking facilities.
    Miramas, storage depot.
49. Base section No. 7:
    La Pallice, track work at dockyard.
    La Pallice, oil tanks, pipe line, and trackage in Bedford Petroleum Co.'s yard.
    La Pallice, Dumet storage yard and Engineer warehouse.
    La Pallice, phospho-guano trackage.
    La Pallice, camp construction.
    La Pallice, construction of Motor Transport Corps park.
    La Pallice, Camp Hospital No. 39.
    La Pallice, remount depot.
    Pa Pallice, wiring docks and sheds.
    La Pallice, completion of refrigeration plant.
    La Pallice, prisoner-of-war inclosure.

49. Base section No. 7—Continued.
La Pallice, A. T. S. office building and warehouses at docks.
La Rochelle, R. T. O. office building.
La Rochelle, construction of two barracks for headquarters detachment.
La Rochelle, camp construction.
Base section No. 7, road work.
Aigrefeuille, storage project.

51. Intermediate section (east):
Allerey, hospital center.
Mars, hospital center.
Mesves, hospital center.
Vichy, hospital center.
Nevers, Cut-off.
Nevers, car repair facilities.
Marcy, engine terminal.
Sougy, remount depot and veterinary hospital.
Clermont-Ferrand, seventh aviation instruction center.

50. Intermediate section (west):
Gievres, historical-technical reports, 55th Engineers.
General.
Orleans, Base Hospital 202.
La Courtine, historical report of camp.
Le Mans, construction for second depot division.
Blois, standard disinfector construction.
Blois, construction of baggage room.
Blois, remodeling of grain hall.
Blois, operation of municipal water works.
Blois, gasoline distributing station.
Blois, remodeling of Caserne Maurice de Saxe.
Blois, prisoner-of-war inclosure.
Blois, spur track for wood-storage yard.
Blois, construction of 3,000-man recuperation camp.
Blois, Base Hospital No. 43.
Cour-Cheverny, construction of Signal Corps replacement depot.
La Suze, construction of base hospital.
Alencon, construction of base hospital.
Avoine, construction of base hospital.
Montierchaume and Chateauroux—
Engineer terminal and car repair facilities, Montierchaume.
Cold-storage depot, Montierchaume.
Gas mask repair depot, Chateauroux.
Siding facilities at Anglo-American tank center, Neuvy-Pailloux.
Convalescent hospital camp, Chateauroux.
Prisoner-of-war inclosure, Montierchaume.
Gasoline distributing station, Montierchaume.
Gasoline distributing station, Le Blanc.
Gasoline distributing station, Chateauroux.
Gasoline distributing station, Poitiers.
Base Hospital No. 9, Chateauroux.
Sewers, light, and water, camp hospital at Poitiers.
Power transmission line, Chateauroux to Neuvy-Pailloux.
Motor Artillery Training Camp, Le Blanc.
Barrack addition at Ecole Normal Hospital, Chateauroux.
Observation towers for artillery ranges, Montmorrillon.

50. Intermediate section (west)—Continued.

Vierzon-Forges, loading cars with sand and gravel.
Vierzon, rearrangement in track and engine facilities.
Tours-Le Mans, double tracking P. & O. R. R.
Noyers, fencing cemetery.
Noyers, construction of Camp Hospital No. 26.
Noyers, construction of classification camp, first depot division.
Noyers, gasoline distributing station.
Noyers, motor transport machine shop.
Noyers, installation of railroad water-supply station.
Argenton-sur-Creuse, installation of railroad water-supply station.
Bourges, construction of two additional tracks, Pont-Vert to Bourges.
Bourges, ordnance proving grounds.
Bourges, remodeling of French Artillery barracks for use of central records office.
Bourges, laying additional track and rearranging freight facilities.
Chateau-du-Loir, installation of railroad water-supply pump station.
Chateau-du-Loir, quartermaster casual camp.
Chatenay, construction air service spares depot.
Chelles, construction of prison camp.
Claye-Souilly, Veterinary Hospital No. 8.
Conlie, installation of railroad water supply station.
Corbeil, construction of track and turntables.
Dierre, installation of railroad water supply station.
Dourdan, construction of base hospital.
Epone, electrical installation.
Gievres, construction of general intermediate storage depot, including—
- General storage depot, warehouses.
- Track facilities and coal storage.
- Refrigerating plant.
- Remount depot, Selles-sur-Cher.
- Veterinary hospital, Gievres.
- Remount depot, Gievres.
- Gasoline distributing station, Gievres.
- Coffee roasting and grinding plant.
- Electric lighting in bakery.
- Office for R. T. O., Villefranche-sur-Cher.
- Rest and coffee station.

Grigny, barge terminal.
Issoudun, construction of ammunition depot at Camp Cheneviere.
Issoudun, construction of third aviation instruction center.
La Belle Epine, construction of telephone exchange for Signal Corps.
Langeais, installation of railroad water supply station.
Laval, installation of railroad water supply station.
Le Cors (La Chappelle), bomb and grenade depot.
Mehere, orthopaedic camp.
Mehun, construction of intermediate ordnance ammunition depot No. 4, including—
- Power line, Bourges to Mehun.
- Additional track siding at Mehun.
- Ordnance repair shops.
- Construction of warehouses.
- Installation camp water supply.
- Camp construction.
- Road work.

50. Intermediate section (west)—Continued.
- Montoire-sur-Le-loir, construction of hospital.
- Orly, aviation acceptance park, No. 1.
- Paris—
  - Base Hospital No. 85.
  - Base Hospital No. 57.
  - Base Hospital No. 212.
  - Prophylactic station.
- Reignac, hospital.
- Richelieu, prisoner-of-war officers' inclosure.
- Romarantin, air service production center.
- St. Denis, overhaul park for Motor Transport Corps.
- St. Florent, installation of railroad water supply station.
- St. Germain du Puy, engine terminal.
- Thezee, training school for sanitary troops.
- Tours, second aviation instruction center.
- Tours district, including—
  - Miscellaneous construction and maintenance at Tours.
  - Quartermaster salvage depot No. 8, St. Pierre des Corps.
  - Camp de Grasse.
  - Beaumont Barracks.
  - Central prisoner-of-war inclosure.
  - Gasoline distributing station.
  - Headquarters camp.
  - Service park and garage.
  - Sick and wounded records department.
  - Camp Hospital No. 27.
  - Quarters for sick and wounded officers and men.
  - Quarters for female employees of the American Expeditionary Forces.
  - Building for Postal Express Service.
  - Prisoner-of-war inclosure (1 company).
- Trembley, convalescent camp hospital.
- Villeneuve-le-Roi, track connections.

52. Advance section:
- Liffol-le-Grand, regulating station "H."
- Advance section, report of activities.

Regimental Histories and Monthly Reports.

Appendix No.	Organization.	Appendix No.	Organization.
R-1	1st Engineers.	R-313	313th Engineers.
R-2	2d Engineers.	R-314	314th Engineers.
R-4	4th Engineers.	R-315	315th Engineers.
R-5	5th Engineers.	R-316	316th Engineers.
R-6	6th Engineers.	R-317	317th Engineers.
R-7	7th Engineers.	R-318	318th Engineers.
R-11	11th Engineers.	R-319	319th Engineers.
R-12	12th Engineers.	R-401	401st Engineers.
R-13	13th Engineers.	R-464	464th Engineers.
R-14	14th Engineers.	R-465	465th Engineers.
R-15	15th Engineers.	R-466	466th Engineers.
R-16	16th Engineers.	R-467	467th Engineers.
R-17	17th Engineers.	R-501	501st Engineers.
R-18	18th Engineers.	R-502	502d Engineers.
R-20	20th Engineers.	R-504	504th Engineers.
R-21	21st Engineers.	R-505	505th Engineers.
R-22	22d Engineers.	R-506	506th Engineers.
R-23	23d Engineers.	R-508	508th Engineers.
R-24	24th Engineers.	R-509	509th Engineers.
R-25	25th Engineers.	R-510	510th Engineers.
R-26	26th Engineers.	R-511	511th Engineers.
R-27	27th Engineers.	R-512	512th Engineers.
R-28	28th Engineers.	R-513	513th Engineers.
R-29	29th Engineers.	R-514	514th Engineers.
R-32	32d Engineers.	R-515	515th Engineers.
R-33	33d Engineers.	R-516	516th Engineers.
R-34	34th Engineers.	R-520	520th Engineers.
R-37	37th Engineers.	R-521	521st Engineers.
R-40	40th Engineers.	R-522	522d Engineers.
R-55	55th Engineers.	R-524	524th Engineers.
R-56	56th Engineers.	R-525	525th Engineers.
R-72	72d Engineers.	R-526	526th Engineers.
R-74	74th Engineers.	R-527	527th Engineers.
R-101	101st Engineers.	R-528	528th Engineers.
R-102	102d Engineers.	R-529	529th Engineers.
R-103	103d Engineers.	R-530	530th Engineers.
R-104	104th Engineers.	R-532	532d Engineers.
R-105	105th Engineers.	R-534	534th Engineers.
R-106	106th Engineers.	R-535	535th Engineers.
R-107	107th Engineers.	R-536	536th Engineers.
R-108	108th Engineers.	R-537	537th Engineers.
R-109	109th Engineers.	R-539	539th Engineers.
R-110	110th Engineers.	R-540	540th Engineers.
R-111	111th Engineers.	R-541	541st Engineers.
R-112	112th Engineers.	R-542	542d Engineers.
R-113	113th Engineers.	R-543	543d Engineers.
R-114	114th Engineers.	R-545	545th Engineers.
R-115	115th Engineers.	R-546	546th Engineers.
R-116	116th Engineers.	R-547	547th Engineers.
R-117	117th Engineers.	R-548	548th Engineers.
R-121	121st Engineers.	R-549	549th Engineers.
R-122	122d Engineers.	R-550	550th Engineers.
R-126	126th Engineers.	R-601	601st Engineers.
R-127	127th Engineers.	R-602	602d Engineers.
R-129	129th Engineers.	R-603	603d Engineers.
R-132	132d Engineers.	R-604	604th Engineers.
R-137	137th Engineers.	R-605	605th Engineers.
R-301	301st Engineers.	A-1	First Army.
R-302	302d Engineers.	A-2	Second Army.
R-303	303d Engineers.	A-3	Third Army.
R-304	304th Engineers.	C-1	First Army Corps.
R-305	305th Engineers.	C-3	Third Army Corps.
R-306	306th Engineers.	C-4	Fourth Army Corps.
R-307	307th Engineers.	C-5	Fifth Army Corps.
R-308	308th Engineers.	C-2	Second Army Corps.
R-309	309th Engineers.	C-6	Sixth Army Corps.
R-310	310th Engineers.	C-7	Seventh Army Corps.
R-310-NR	310th Engineers.	C-8	Eighth Army Corps.
R-311	311th Engineers.	C-9	Ninth Army Corps.
R-312	312th Engineers.		

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