

VOLUME IX

NUMBER 3

JULY-AUGUST

**THE
FIELD ARTILLERY
JOURNAL**

EDITED BY

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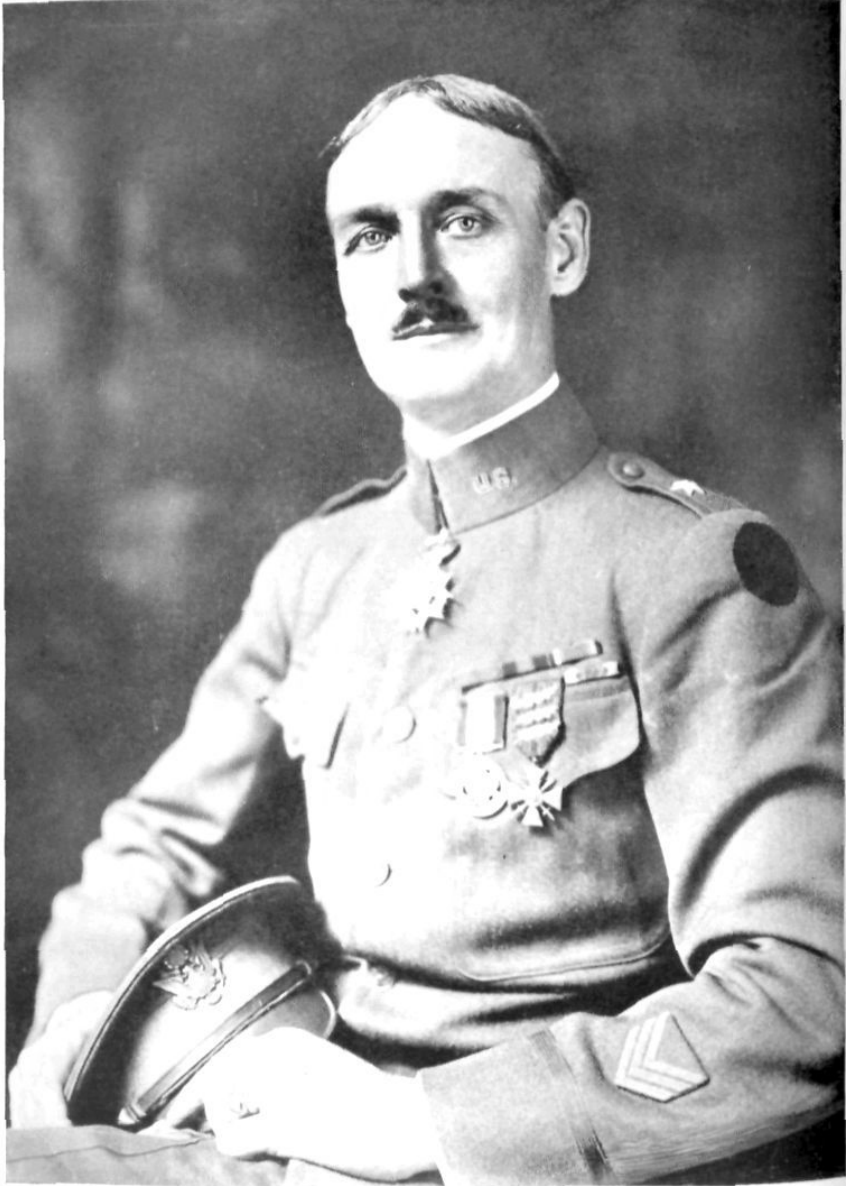
**THE UNITED STATES FIELD ARTILLERY ASSOCIATION
WASHINGTON, D. C.**

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BRIGADIER-GENERAL DWIGHT E. AULTMAN, U. S. ARMY

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THE FIELD ARTILLERY JOURNAL

VOL. IX

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Counter-Battery Work

LECTURE DELIVERED BY BRIGADIER-GENERAL DWIGHT E. AULTMAN, U. S. ARMY, CHIEF OF ARTILLERY, 2ND ARMY, A. E. F., TO THE STUDENTS, ARMY CENTER OF ARTILLERY STUDIES, FRANCE, FEBRUARY 26, 1919.

GENTLEMEN, in taking up my lecture this morning on the subject of counter-battery, I have endeavored to find some literature bearing upon it, but have been unable to do so.

While this rôle of the artillery has long been recognized and became especially prominent during the war, its precepts and principles seem to have been as yet unwritten, further than glittering generalities.

I shall first run over a little of the history of counter-battery. You will all remember that in former days it was the practice that the artillery of one army entered into combat with that of the other in what was termed the artillery duel, after the termination of which the infantry advance commenced. This was the original rôle of counter-battery and was generally regarded as the primary mission of the artillery.

Later it began to be recognized that the only principal mission of the artillery, or, in fact, of any auxiliary arm, was to protect the advance of the infantry, and the counter-battery function came to be recognized as an auxiliary rather than a primary rôle.

The mission of counter-battery was to engage the enemy's batteries, keep their fire off the infantry, and enable the latter to advance, or protect its withdrawal. This mission was confided to the divisional artillery, certain batteries being designated beforehand as counter-batteries.

It was not, however, until the development of trench warfare

that counter-battery came to be regarded as a subject for specialization.

The enormous masses of artillery employed by both sides, together with the production of ammunition in almost unlimited quantities, brought the artillery combat into a prominence that had never before been conceived.

The war was sometimes described as an artillery war, wherein the rôle of the infantry was merely that of occupying the terrain which the fire of the artillery had made untenable for the enemy.

During the period 1916–1917, when an advance of a few hundred metres was heralded as a victory, this was literally true. Either side could by massing a sufficient quantity of artillery, make limited advances and hold the ground gained.

To the importance thus attained by the artillery combat may be attributed the development of counter-battery as a special function, one that has come to be so recognized, and that must be in future provided for even in open warfare.

This rôle was soon assigned to the artillery of the army corps, with which it has since remained. However, the procedure varied in the British and French services.

The British specialized the counter-battery by placing a special staff officer in charge of it. In his office was centralized the information regarding the enemy artillery and he detailed the batteries to fire upon it.

The counter-battery officer was a staff officer of the Chief of Artillery of the army corps, and acted as an intermediary with all other artillery commanders in the counter-battery function. He detailed the batteries from corps artillery or division artillery and was responsible to no one but his chief in the execution of his duties. For offensive purposes he formulated the plan, wherein certain enemy batteries, usually the most dangerous or troublesome, were systematically destroyed a short time before a contemplated operation, leaving only such a remainder as could be effectively neutralized by his own artillery on the day of battle.

His functions and authority naturally interfered to a considerable

COUNTER-BATTERY WORK

extent with those of the heavy artillery commander, and even with the division artilleries, as the counter-battery officer was empowered to call for the services of almost any unit at any time.

However, the British counter-battery system was excellently organized and its defects consequently minimized, which merely emphasizes the aphorism that "Any plan is good provided it is properly carried into execution."

The French from the outset delegated the functions of counter-battery to the corps heavy artillery commander. For the purpose, he commanded all counter-battery guns, and was even authorized to call upon the divisions when it became necessary to augment the fire by that of the divisional 155's.

In the earlier stages of the war, the counter-battery artillery was equipped almost entirely with old type fortress pieces, the 155 long, the 120, the 95 and the 90 millimetre rifles, all slow fire pieces, but with sufficient range and power to effectively neutralize the enemy artillery of corresponding type. These guns, being of inferior mobility, usually remained permanently in a sector.

In the later stages of the war, the 155 long was made more mobile, and the 155 short and 105 long were added to the corps artillery in the more active sectors.

When destruction of batteries was to be undertaken, pieces of heavier calibre: 220 mm. mortars, 240 mm. guns, or 270 mm. mortars, were called in from the R.G.A. (Réserve Général d'Artillerie) or from the A.L.G.P. (Artillerie Lourde de Grande Puissance).

Thus, the functions of counter-battery were centralized in the corps heavy artillery commander.

He directly commanded all the counter-battery matériel. He had first call upon all sources of information, the flash and sound ranging sections, the balloons and the air service. All information from these sources was, however, later compiled in the office of the Corps Chief of Artillery and published periodically in bulletins.

He made all counter-battery plans, both for neutralization

and destruction, and they were put into execution after approval by the Corps Chief of Artillery.

This was substantially the system in effect on the Lorraine front of the 32d French Corps when the 1st Division entered the Toul sector in January, 1918.

Following our entrance, as we were better equipped with heavy artillery than any French division, the functions of counter-battery were turned over to the division, the French heavy artillery commander merely providing for the needs of the adjacent French sector. The heavy artillery regiment of the 1st F. A. Brigade (5th F. A.) thus took over the duty of counter-battery.

Our first counter-battery office was modelled after the office of the 32d Corps Heavy Artillery, modified so as to utilize the regimental staff.

The working equipment consisted of:

1. A chart showing the positions of our own batteries with their sectors of fire.

2. A chart showing in each Lambert square the batteries that could fire thereon.

3. A chart showing by symbol all enemy batteries, with calibre, number of pieces, and the areas usually fired upon. The symbol also indicated whether the location of the batteries had been verified by flash, by sound, or by aerial photography.

4. A sheet showing daily activities of enemy batteries. In the course of a short period, this chart became a graphic of great value in determining which batteries were active, and in thus assisting the counter-battery officer to answer calls for counter-battery in fog or rain, when flashes, etc., were invisible and when the only information available was the area under hostile bombardment.

In addition, a history of all enemy batteries was kept, in which all data regarding each battery was posted. These histories indicated periods of activity and quiescence, changes of position and reinforcement, data of extreme value as indicating enemy policy and intentions.

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Much information was derived from aerial photographs of enemy batteries, and these were usually the final proof of activity.

Direct telephonic liaison was maintained with the flash and sound ranging sections, and with the balloon. With the air service the communication was indirect, through centrals.

Counter-battery calls were always answered, whether from the light artillery or the infantry.

Immediately upon receiving a call, the flash ranging section was called, to report batteries in action, and these were presumed to be the guilty ones and punished at once.

The other information agencies, sound ranging, balloon and aviation, were also called upon when necessary, but no time was lost in answering fire if the flash ranging section could furnish the information.

In fog or rain, the batteries that customarily fired on the bombarded area were taken under fire, and this method frequently proved efficacious.

Counter-battery was not generally used enough. Our infantry, new to front line service, usually called for barrage or retaliation fire when bombarded, whereas what they really wanted was something to stop the enemy's fire, that, is, counter-battery.

Furthermore, they could rarely give definite information as to calibre and direction of hostile fire, two things of material value to the counter-battery officer. With these data and a correct chart of the enemy batteries he could frequently find the offender and silence him forthwith.

Destruction of enemy batteries was frequently undertaken, but in these cases it was necessary to get direct observation, either by an aviator, or by balloon. However, as the destruction of a casemated battery, not in concrete, usually took about 500 rounds of 155 mm. ammunition for complete destruction, it was doubtful whether in the general case these destructions ever really justified the expenditure.

During the Chateau-Thierry (Marne-Vesle) campaign, the

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1st Corps employed a modification of the British system, with a counter-battery officer in the headquarters of the corps heavy artillery commander.

It is believed that the system did not give satisfaction, for later on, in the St. Mihiel drive, the same Chief of Artillery employed the heavy artillery commander as counter-battery officer, with an advanced message centre representing the Corps Chief at the heavy artillery headquarters.

It was apparently becoming evident to all that the corps heavy artillery commander was the logical counter-battery officer, and that the French system was, therefore, the more satisfactory.

On taking over the duties as Chief of Artillery of the 5th Corps, during the Meuse-Argonne operations, I found that system installed, with a corps artillery that was composed entirely of French units under a French commander.

No change was made in the arrangement and it was found to be in every respect satisfactory.

As a result of the experience recited above, I suggest the organization of our counter-battery system along the following lines:

Commander and Staff—

- Commander of the Corps Artillery.
- Adjutant (with functions of Chief of Staff).
- Operations Officer.
- Information Officer.
- Telephone and Radio Officer.
- Administrative Officer.
- Munitions Officer.

Liaison:

The liaison should be as indicated in the diagram. The corps artillery should be divided into as many groups as there are divisions in the front line, and each group should be in direct liaison with the corresponding division artillery commander.

The commander himself maintains direct liaison with his groups, with the Corps Chief, and with the information services,

COUNTER-BATTERY WORK

to wit: flash and sound ranging sections, balloon, and air service.

Liaison with the army artillery will normally be through the Corps Chief of Artillery, but may be direct when convenient.

The counter-battery officer should be empowered to call upon the division or army artillery whenever necessary to supplement his fire. Calls upon the division artillery, however, should be exceptional.

Types of Matériel:

The 155 mm. howitzer has demonstrated itself to be probably the best counter-battery gun that has appeared in the war. It is believed that no better piece could be devised, though motorization, together with improvements in the matériel and ammunition, may give it greater range and consequent effectiveness.

In addition, especially for rapid neutralization, a long gun of about 4 inches calibre, analogous to the French or German 105 mm. guns, is suggested. Both these pieces combine, to a marked degree, mobility and power, and can, therefore, be used in a war of manœuvre.

Heavier calibres, though necessary for destruction on occasion, should not be considered as organic corps artillery. Such pieces, both howitzers and guns, should form part of an army reserve of artillery, to be assigned to corps, or even to divisions, for special missions.

Quantity of Matériel:

To assign a definite amount of artillery to an army corps as the organic artillery thereof is difficult, as the quantity will depend very much upon the mission with which the corps is charged.

At the same time the computation of the quantity that may be necessary is simple, when an estimate of the enemy's artillery strength can be made.

I should estimate the requirements for an offensive action to be at least two guns per enemy battery to be neutralized. Thus, for an army corps operating on a front of approximately six kilometres, it is to be supposed that the enemy will normally

oppose with one light gun per 20 metres, or 300 light guns, and one heavy gun per 50 metres, or 120 heavy guns, a total of, roughly, 420 guns, or 105 batteries.

The corps artillery sufficient for counter-battery should, therefore, consist of at least 210 guns, if the division and army artilleries are to be employed exclusively in their own special missions.

For defense, the number of guns should be similarly proportioned to that of the enemy artillery.

As a rule, the number of hostile batteries to be accounted for will be fairly well known through the information service, so that the above estimate must be taken merely as illustrative.

Methods:

Counter-battery is employed for one of the following three purposes:

1. The silencing of hostile batteries that are annoying our infantry or light artillery.

That is the passive defensive rôle that awaits the enemy's action.

2. It may form part of the daily firing schedules in a quiet sector, or there may be a comprehensive plan of neutralization in case of attack. Thus, with a knowledge of the location of all enemy batteries, a regular assignment may be made for normal counter-battery, and each battery may, at a given signal, or automatically in case of a general bombardment, take under fire the hostile batteries assigned to it, with a view to the general neutralization of the enemy artillery and the checking of an attack.

3. Neutralization during offensive operations. This will always be effected in conformity with a general plan of action.

Two phases are to be considered, the preliminary bombardment, and the action during an advance.

Preliminary Bombardment:

For the preliminary bombardment, assignments may be made wherein each battery neutralizes two hostile batteries, using two guns against each of them.

COUNTER-BATTERY WORK

This method has the disadvantage that, in a general bombardment, the centres of impact will not always be accurately placed and in consequence certain of the hostile batteries will be certain to escape and will be able to fire.

The method adopted by the 20th French Corps seems to have given more satisfactory results. In this method either the entire corps artillery or the sub-groups fired heavy concentrations for short periods of time upon the enemy batteries in succession.

The fall of a large number of heavy projectiles in and about each battery was certain to get some hits, while the personnel was pretty well demoralized, and the communications were almost invariably cut, thus putting the battery out of effective action for several hours.

Complete destruction was not contemplated, the object being merely to paralyze the activity of the batteries until the barrage supporting the infantry advance could reach them.

Action During the Advance:

When the infantry advance commenced, every enemy battery was taken under fire by two guns of the counter-battery firing at the maximum hourly rate, with a view of preventing the restoration of communication and the resumption of fire.

The method evolved in the 20th Corps was employed in our 5th Corps during the November operations in the Meuse-Argonne offensive, with very satisfactory results.

Unfortunately, the enemy was already demoralized and we were provided with an overpowering artillery, so that no definite conclusions should be drawn from this experience. However, the method of concentrations followed by neutralization fire has been reported as having been almost uniformly successful.

Counter-battery finds its greatest difficulties in open warfare, as it is largely dependent upon information.

The principles are the same, however, and one may say that success will depend upon the rapidity of installation of the flash ranging sections, and the activity and close liaison of the artillery with the balloon and aviation services.

It is believed that the function definitely belongs to the Army Corps Artillery and is the principal mission of that artillery, though any or all guns, division or army, may at times be called upon for counter-battery.

We have practically decided that preliminary bombardments should be intense and should not last more than five or six hours.

Destructions are of doubtful value, and can be accomplished only with careful and systematic observation, either by balloon or aeroplane.

Concentrations do not destroy; they merely demoralize and break down resistance, and prevent the enemy batteries from resuming action for a short period.

In other words, the object of counter-battery in offensive operations is to keep the enemy artillery out of action for the day. You don't care whether you destroy him or not. If you have performed your functions well the infantry advance may overrun the zone of the batteries and capture the guns.

In any case, if the infantry has been enabled to reach its objectives and establish itself, you have accomplished your mission of counter-battery.

Subsequent Note on the Use of Gas:

No mention of gas was made in the body of the lecture, as the future of poison gases as a means of warfare is now in doubt.

Should these gases be accepted as a legitimate weapon of war, it is in counter-battery that they will find one of their principal uses.

Gas concentrations are very effective in producing casualties, though some high explosive shells should always be used for the destruction of communications. They are especially fruitful of casualties when they are fired as a surprise.

Neutralization by gas is equally effective, as it requires the gun crews to work in their masks and thus diminishes the rate and accuracy of the fire.

The admixture of gas and high explosive shell is even more effective.

Motor Transportation for Artillery

LECTURE DELIVERED AT THE CENTER OF ARTILLERY STUDIES AT TREVES, GERMANY,
APRIL 19, 1919, BY W. R. CONOLLY, LIEUTENANT COLONEL, FIELD ARTILLERY

Introduction.

I AM asked to discuss the subject of Motor Transportation for Artillery under four different headings, as follows:

1. Types in use in A.E.F. with discussion as to performance.
2. Types under manufacture but not in use by A.E.F.
3. Proposed types.
4. To what extent can we expect, in the immediate future, Motor Transportation to supplant the horse for Artillery purposes.

In considering types in use in the A.E.F., with discussion as to performance, we must confront ourselves with the various things that have influenced the design and production, besides the actual usage of the products themselves. It was not only a question of producing something that was adaptable to the horse-drawn artillery matériel, but also of adopting something that could be produced in large quantities and with ease so as not to require the reorganization, readjustment and re-equipment of factories producing automotor vehicles. Engineers were faced with the problem of using as many of the existing patterns and designs as had been used on various types of self-propelled vehicles, in order that the industry might be enabled to expedite production. It was a question of using already established and proven units of self-propelled vehicles such as motors, transmissions, differentials, etc. Therefore, in looking over the motor equipment which was used in the A.E.F., we must not assume that these are final designs for the motorization of Artillery, but must view it merely as an evolutionary step in the substitution of mechanical power for horses.

Also, in considering types under manufacture but not in use

by the A.E.F., we are confronted with the necessity for hasty production. To produce a good motor vehicle requires considerable time, as the experience of various good manufacturing concerns has proven. The Government had some of the best motor engineers in the country working on designs for the use of our Army, and they did much good work toward development. However, before they had completed their experiments, calls came from the A.E.F. to put into production what they had already, as it was necessary at that time to substitute mechanical power for horses, the supply of the latter having been completely exhausted. This perhaps may account for certain mechanical defects, such as faulty track roller brackets on the 2½-ton tractor, poor material in the track rollers of the Ford¹ tank, etc.

In proposed types which may be used in the Artillery in the future, greater experience will eliminate these mechanical defects and we should have the maximum efficiency to be expected of motor equipment. An example of this may be had in the new Ordnance four-wheel drive truck, known as the Militor type.² Exhaustive tests and experiments have been made with this truck, and it has stood them admirably well. The engineers have worked on this truck almost since we entered the war, taking it through different stages of development.

As regards types for immediate use, we are more or less restricted to some form of motor vehicle to pull the artillery matériel which we now have on hand. As to future developments, other types such as the gun or howitzer mounted directly on the carriage containing the motor power plant can be considered.

Types in Use in the A.E.F. with Discussion as to Performance.

It must be realized that motor equipment can not be made foolproof, and criticism is sometimes unfair when the motor vehicles have been in the hands of untrained personnel. In the A.E.F. we more or less put the cart before the horse in that we

¹ Officially designated as the Ordnance 3-Ton Tank.

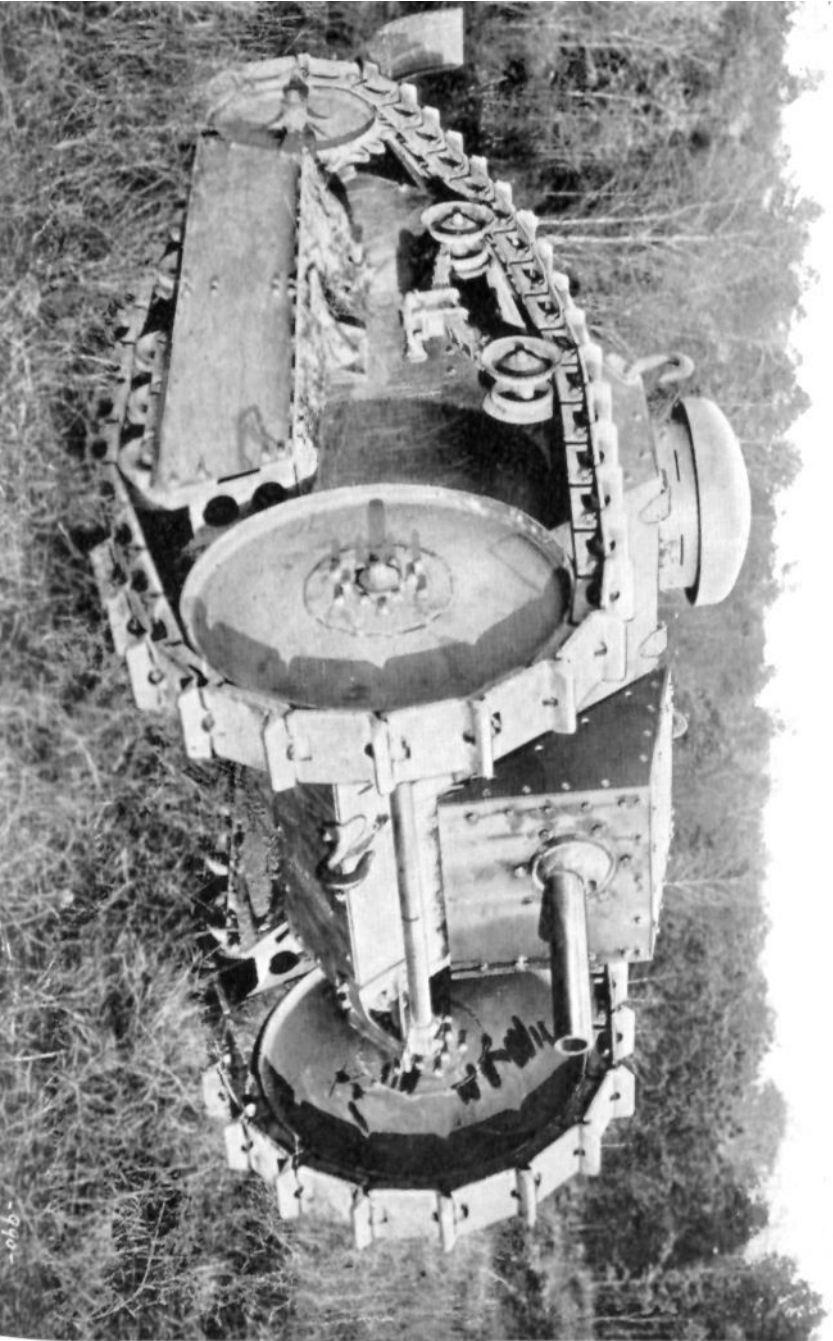
² Officially designated as Truck 3-Ton Model 1918 Ordnance Department.

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delivered our motor equipment to organizations before their personnel was sufficiently trained to receive and handle it. We were restricted to the men who had had experience driving motor equipment in civil life and to the product of our motor schools, such as those conducted by the Ordnance Department in the States, the Organization and Training Centers of the Heavy Artillery, and the Field Artillery Motor Training Center at LeBlanc. Those coming from civil life were limited and often wholly unqualified, as was shown by their ignorance of motor equipment, while the students graduated from the various motor schools were trained in a very short time, such as a course of three weeks for instance, and consequently were not seasoned drivers. To illustrate how the necessity for having skilled drivers is appreciated in civil life, the large farm organizations in the west pay their tractor engineers a salary of seven dollars per day and board. They have found that it is decided economy to have an expert man in charge of each machine. To prove the absence of this expert knowledge among the drivers of the A.E.F., I will quote from a report by Captain Peterson of the Ordnance Department in which he states that of 350 tractors which are issued to regiments and inspected by him only 37 had the correct steering clutch adjustment. This is only one particular fault among the many that were found and neglects of this kind cause serious damages to the machine. Not only this training is lacking, but it is also necessary to build up among the personnel handling motor equipment, a spirit of love for the vehicle such as the railroad engineer has for his locomotive, or the field artilleryman of the old army has for his horse.

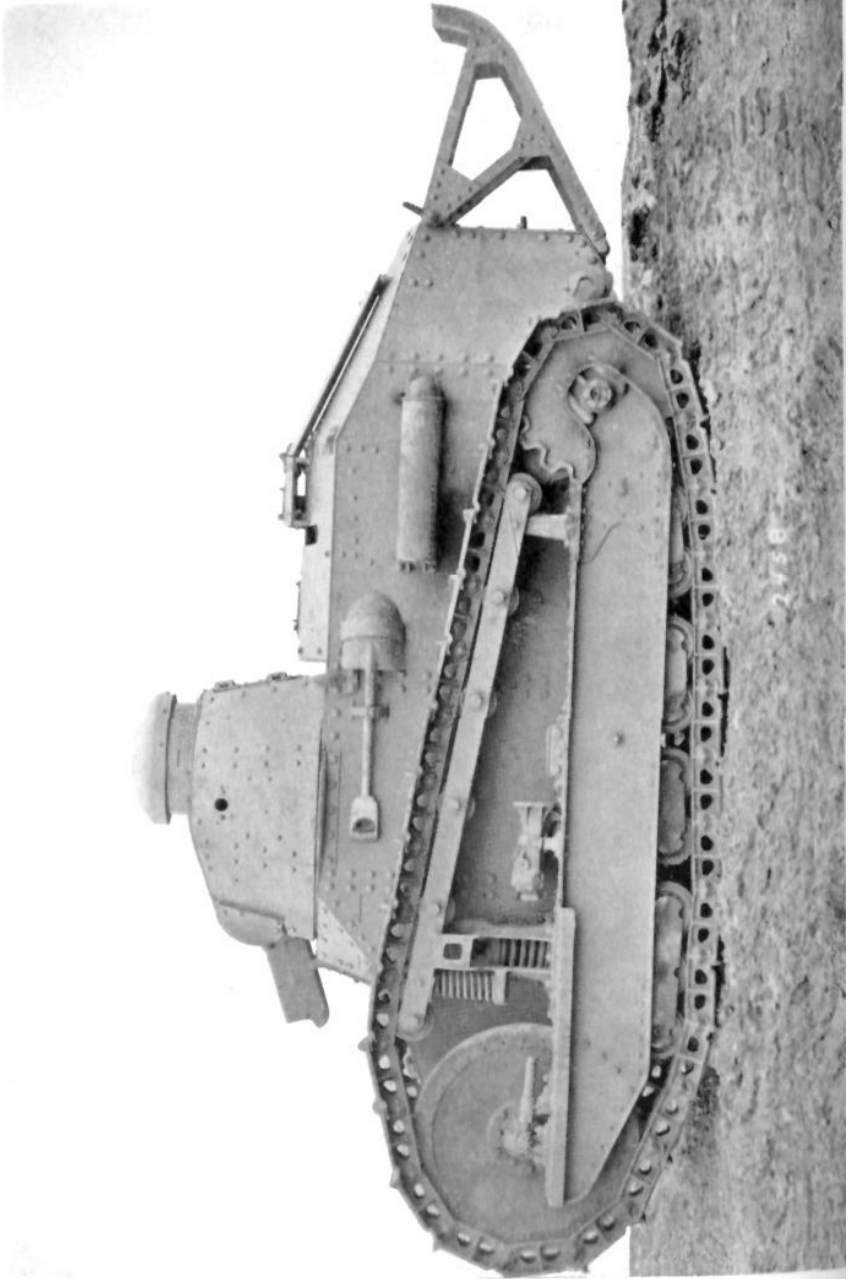
In the hands of trained personnel, the present tractor with its so-called caterpillar tread, that is being universally adopted, will prove itself very efficient in its rôle. It is a complete redesign of the Holt commercial job, and is the only American tractor for moving Artillery in our Army. It differs greatly from the original machine, except in the principle of the track and final drive. The necessity for speedy production resulted in certain errors of design such as the track roller support and

fan belt assembly on the 10-ton tractor. These errors became apparent in the field and could easily be corrected for future production. On the whole, however, these machines are doing all that could be expected of them when we consider the manner of their production and the speed of their design. They have sufficient power to enable them to negotiate practically all terrain encountered, and their ease of operation facilitates manœuver. Although often handled by partly trained personnel, the ruggedness of this design has been appreciated, and many are convinced of the mechanical possibilities for the movement of Artillery. The machine is in no way an enlargement or a change of a truck for the purpose of drawing some vehicle behind it, but is an original design, the primary object of which is the moving of a trailing vehicle, and it was so developed by commercial interests before the war. It is believed that the tractive power for artillery in the future will follow closely this design. It is not necessary to go into minute discussion of the different types of the caterpillar tractor, as they are largely similar in design, differing principally as to weight, strength of parts, and power. The 15 and 20-ton machines are the commercial Holt products, while the 5 and 10-ton jobs were evolved out of the Holt commercial tractor by the Ordnance Department. The 5-ton differs mainly in its power plant, the motor being the quartermaster B trucks L head type converted into an I head to secure more power and better adaptability for tractor use. The design of the caterpillar tractor is probably very well known, and it will not be necessary to go into detail. Primarily, it is a tractor with a great deal of tractive surface in contact with the ground, thus giving great adhesion, which is to be desired in such a machine. The endless tracks receive their power directly from a standard type of sliding gear transmission, and to this point the principle is the same as that found in any standard self-propelled vehicle. From the transmission, the power, instead of going through a differential to the final points of drive, is delivered to the tracks through intervening clutches, thus



3-TON ORDNANCE DEPARTMENT TANK

-970-



6-TON ORDNANCE DEPARTMENT TANK

MOTOR TRANSPORTATION FOR ARTILLERY

enabling the operator to permit the power to flow to both tracks simultaneously, or to deliver all of the power to one track, thereby pivoting the other. It is this feature which accomplishes steering. In such a vehicle the large area of the track in contact with the road has two great advantages. It reduces the pressure per square inch of the vehicle upon the ground, and gives great adhesion to the road. This accomplishes the two most necessary things for a tractor, namely: tractive power, and the ease of manœuver.

Although the caterpillar type of tractor was considered the best for Artillery, on account of being unable to purchase them in sufficient numbers, some of the Artillery was equipped with French tractors of the Latil and Renault type. These tractors are merely a revision of the four-wheel drive truck such that they deliver a marked drawbar pull, and mounting a capstan which permits certain maneuvers of the Artillery over ground that the tractor itself can not negotiate. This type requires a great amount of training for the personnel, and is not sufficiently mobile in soft ground to meet the requirements of field conditions for artillery. The Renault and Schneider Companies also produce a caterpillar tractor similar to ours.

The trucks issued to the Artillery are largely of the four-wheel drive design. This type of truck has never been produced in large numbers for commercial use. If we consider the primary object for which trucks are built for commercial purposes, it will be found that the great market is the cities where they are used on paved streets. The four-wheel drive is not required for such work, and therefore has received very little recognition as a commercial product, with the resultant fact that experiment with this machine was limited. However, some of them were produced, so when the Mexican trouble arose in 1916 necessitating motor transportation for freight in the field, this truck was bought in considerable quantity by the government, and, under the conditions of the field as they exist along the border, the four-wheel drive principle proved itself superior to the two-wheel drive design when it was necessary to maneuver trucks

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over very difficult roads. Most of the four-wheel drive trucks bought at that time were from the Thomas B. Jeffrey Co., the trucks being known as the Jeffrey Quad. While it was admitted by those having the most experience with this type of truck that the four-wheel drive principle was correct, it was found that the Jeffrey Company had put very poor material and workmanship in the machine. As a result of this fact, we had much difficulty with this truck, and the principle itself received some criticism because a comparison was made between the Jeffrey Quad, which was constantly getting out of order, and the other makes of trucks which were of the two-wheel drive, but good machines of long commercial standing. But when it was necessary to maneuver loaded trucks over very bad roads, or to haul rock for road work across fields, it was found that the only truck that could successfully maneuver the soft, muddy ground was the four-wheel drive. Officers then came to the conclusion that if the four-wheel drive principle was embodied in a well-made truck of good material and workmanship, it would be superior to the two-wheel drive for maneuver over difficult terrain. When it became necessary to adopt a form of truck for issue to the Artillery in France, exhaustive tests were made comparing the different designs of trucks, the engineers coming to the conclusion that for long hauls over good roads the two-wheel drive truck was best adapted, but for the difficult terrain conditions which would be met by artillery in the zone of the advance, the four-wheel drive type was best suited. The only companies equipped to turn out these four-wheel drive trucks in quantity were the Nash Motors Company, and the Four Wheel Drive Auto Company, consequently large orders were placed with these firms and other companies subsidized to work on auxiliary contracts, using the Nash and F. W. D. design. Neither the Nash nor the F.W.D. has the refinement of design or construction that would warrant their adoption, even at the present time. It is a fact, however, that during the war rapid changes were being made in both of these vehicles, and this spring would have seen machines of the same name quite different

MOTOR TRANSPORTATION FOR ARTILLERY

in design. It is a fact beyond doubt that, when trucks operate on any ground except smooth, hard roads, four-wheel drive is to be desired. It has the advantage of giving traction at both ends of the machine, thus enabling it not only to push but also to pull itself over difficult terrain. Under the normal condition of trench warfare, roads over which ammunition and supplies were hauled were generally in such good condition that the standard two-wheel drive truck functioned very satisfactorily. However, when it developed into open warfare, considerable difficulty was experienced by two-wheel drive trucks in getting through on bad roads which four-wheel drives negotiated without outside assistance. Experience has proven, however, that the four-wheel steer is entirely unnecessary, and, in reality, is a disadvantage. In the later contracts this feature of the Nash was eliminated, but in doing this, to prevent the slowing up of production, the steer on the front wheels was not materially changed, thereby necessitating a very long turning radius when the steer was accomplished on two wheels only. The steering arms on the Nash are also being made of a material which does not crystallize so easily, thereby preventing the great trouble which was experienced with these arms. It is thought that the mechanical performance of the F. W. D. has been successful.

The four-wheel drive truck chassis was produced in very large quantities, and on these chassis were mounted different bodies for special use. Among these are:

| | |
|-------------------|------------------------------------|
| Ammunition, | Winch Truck, |
| Artillery Supply, | Heavy Mobile Ordnance Repair Shop, |
| Artillery Repair, | 240 Trench Mortar. |
| Equipment Repair, | |

The ammunition bodies are not suited to the needs of the Artillery, due to lack of volumetric capacity. With the supply body, the chests are too heavy and are not suited to receive specified loads, and in addition, the whole body has insufficient volumetric capacity. The Artillery Repair Truck has proven universally satisfactory. It is equipped to perform operations such

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as pneumatic riveting, oxy-acetylene welding and cutting, small lathe work, drilling, and bench work. Supplementing this is the Heavy Mobile Ordnance Repair Shop, which is rather elaborate, consisting of sixty-one vehicles, including facilities for carrying raw matériel, spare parts, wood-working machinery, milling machine, shaper, drill press, lathes, blacksmith shop, and a very complete set of hand tools for bench work. Facilities for oxy-acetylene welding and cutting, electric welding, and a tire press for applying solid rubber tires, are also included. The latter shop, however, is not assigned to divisions. The Equipment Repair Truck has fulfilled its function satisfactorily, but it is thought that provision should be made whereby the bins could be removed from the body and set up in a workshop. In addition to the repair facilities mentioned above, a Dodge light repair truck has been supplied, the purpose of which is to dispatch repair kits, personnel, and supplies necessary for making emergency repairs. The reports indicate that it has proven quite serviceable and satisfactory.

The commercial automobiles that have given the best satisfaction are the Cadillac, Dodge, and Ford,³ and it is with these cars, together with the special reconnaissance and staff observation machines, that the Artillery has been equipped. It is thought that the reconnaissance and staff observation cars are very efficient and practical for their use, and it is believed that the future Artillery will see many vehicles built on a chassis which is similar to the one used for the reconnaissance and staff observation cars, this chassis being a reinforced 1-ton White with overpowered engine and pneumatic 36 × 6 tires. It is about the right size and strength necessary for the mounting of different styles of body for the transportation of personnel, fire control equipment, maps, charts, and other paraphernalia necessary to accompany Artillery. Ambulance bodies could be mounted on the same chassis.

³ The speed of an artillery convoy is usually low. The Ford has only two speeds forward and must frequently operate in low gear for considerable periods when in a convoy. Under these conditions the engine overheats seriously. For this reason this type of automobile is not suitable for artillery use.

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The motorcycles issued have been mostly of the Harley-Davidson and Indian types, the former proving more satisfactory.

Types Under Manufacture, But Not in Use by the A. E. F.

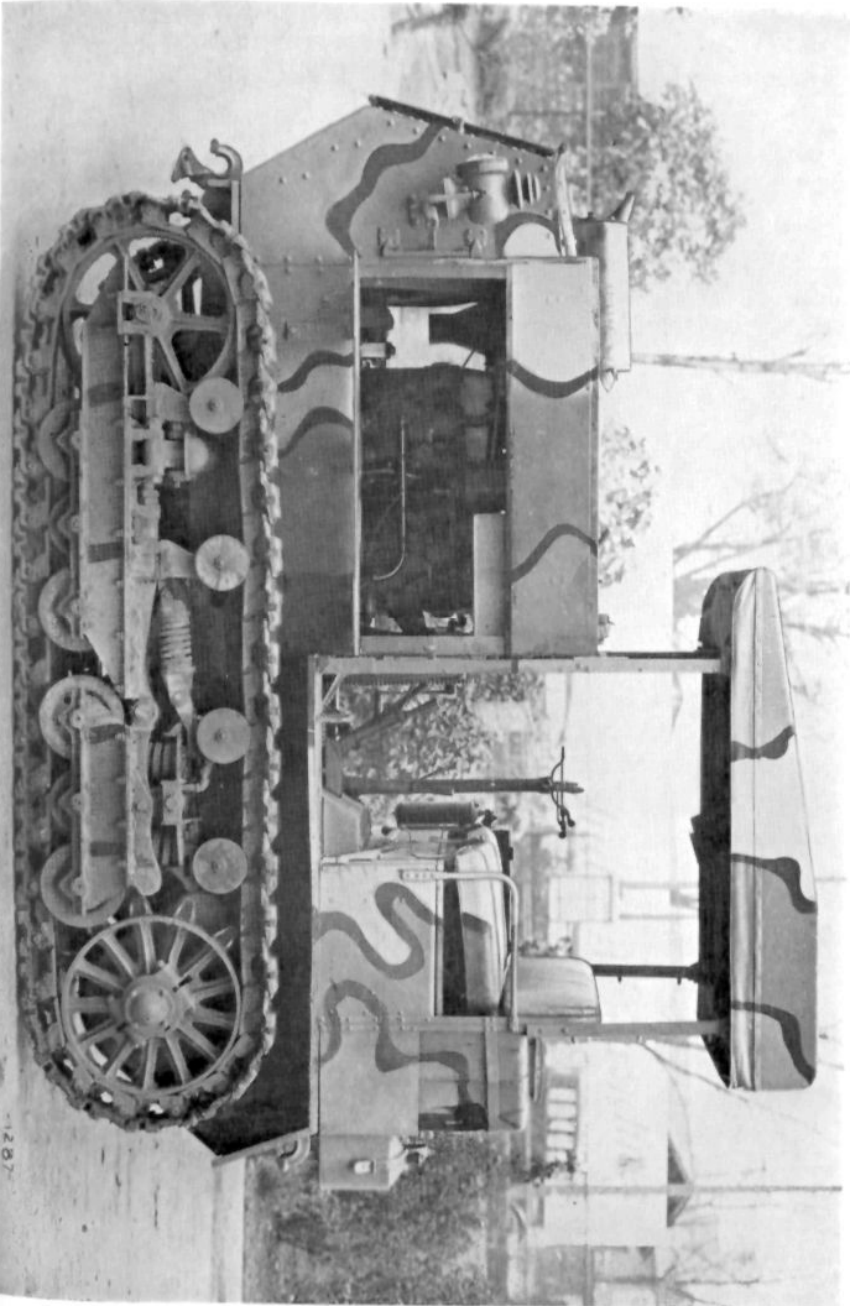
At the close of hostilities, there were in process of construction in the States several special vehicles for Artillery service which had not yet been delivered in the A. E. F. in quantity. Among these was the Ordnance three-ton truck tractor, known as the wheeled Artillery tractor, which is used primarily for service with the tank corps, embodying the four-wheel steer feature for maneuver purposes, together with a power-driven winch, and incorporates the ideas of the truck engineers in the States most experienced in the construction and design of four-wheel drive vehicles. Work on this model was started in January, 1918, and the first experimental models placed on the road in the Spring of the same year. Quantity orders had been placed and production started on a large scale at the time of the closing of hostilities. A sample vehicle was delivered to the A. E. F. in the Summer of 1918. I have seen tests of this machine at Is-sur-Tille, and its performance is wonderful.⁴ From the experiments made, it appears that the difficulties met with in the commercial types, such as the Nash and F. W. D., have been overcome, and in addition, it has the good points of the French construction, such as the Renault and Latil wheel tractors. It has a Wisconsin motor similar to the F. W. D., whereas the drive to the fore wheels is taken from a differential mounted on the dead axles in a similar manner to the Nash Quad. However, this drive was so designed that the universal action is greater, giving the truck a shorter turning radius and it steers with greater ease. The transmission, steering gear, cab and control are adoptions of those members used in the B type truck. The radiator is mounted behind the motor like the Renault type. The differential is an automatic locking design, and this, together with its four-wheel drive and two-wheel steer, enables it to go

⁴ This vehicle with the two-wheel steer feature, and without a winch, has been adopted as the standard quad for use of the Army.

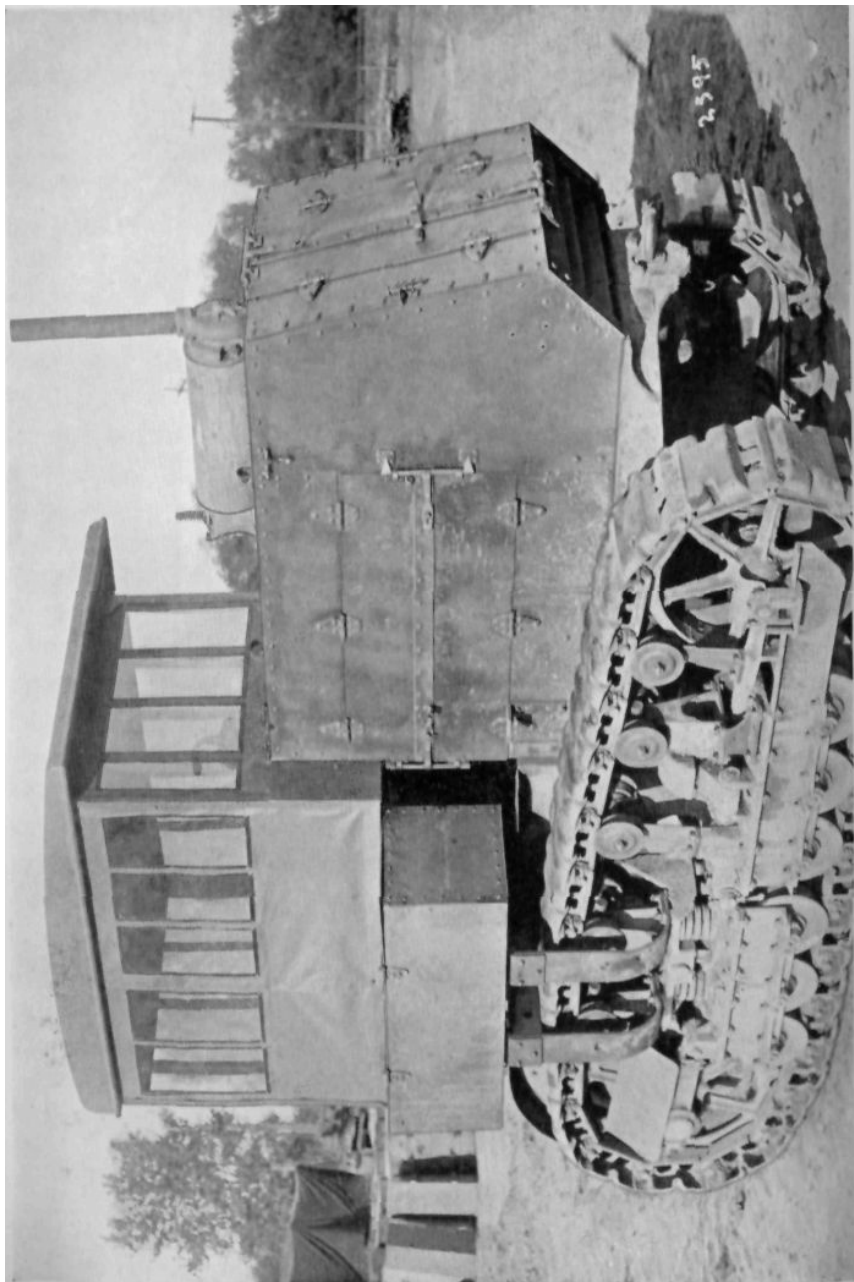
through very heavy terrain. It is only stalled when all four of the wheels have gone down so deep that the axles are resting on the ground.

There was also in production a three-ton rubber-tired trailer, which was intended to be used in motorizing certain 75 mm. batteries to be used for reinforcement purposes. The idea was to roll the present 75 upon this trailer, thus enabling the unit to be transported at great speed over good roads, and at the same time relieve the gun mechanism and axles of the 75 from the severe road shocks. This plan was used by the French, and apparently it worked quite successfully. There was also under construction in quantity a ten-ton rubber-tired trailer, which was designed to carry tanks and tractors. The tanks and tractors would mount the platform of the trailer under their own power, and in case road conditions were encountered which were too severe for the towing truck to pass through, the tank or tractor would be dismounted from the trailer, pulled through the bad road on its own power, and then be put back on the trailer for more rapid transportation over the good roads. A similar trailer had mounted upon it a four-ton crane, which was to be used in connection with the Heavy Mobile Ordnance Repair Shop.

The factories in America were producing a two-and-one-half-ton tractor which was a modification of the other caterpillars, but using the standard Cadillac power plant. It is questionable whether or not the high-speed motor is adaptable to the heavy duty work of a tractor,—and the track seems to be rather narrow. There is also a tendency for the machine to rear up in front when the tractor is pulling a load, thus allowing but a small surface of the track to be in contact with the ground. This is due to the fact that the roller frame is too high for the length of the track. It has the advantage of high speed and quick maneuver, and it was intended at first to use it for moving reel carts, but later it was decided to utilize it in motorizing the 75 mm. batteries. The Ford tank was also to be used for this purpose, it having become absolutely necessary to motorize the Divisional Artillery on account of the lack of horses. This tank



5-TON ARTILLERY TRACTOR



10-TON ARTILLERY TRACTOR

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is purely an American idea, emanating from the Ordnance Department, and is built along the lines of the British "whippet" type. It mounts two standard Ford motors, and the whole job has a very cheap construction. However, it must be taken into account that they were not designed to pull Artillery, but were built as tanks, and were supposed to have a short life. They would have been used to motorize the 75 mm. regiments as an emergency measure. I have seen these tanks pulling 75 mm. guns through difficult terrain at LeValdahon, and their maneuvers were very successful, taking the matériel where it would be impossible to carry it if horse-drawn.

There were in production in the States caterpillar gun mounts for the eight-inch howitzer, 155 G. P. F. gun, and two caterpillar mounts of slightly different design for the 240 mm. howitzer. This is a scheme of mounting the gun directly upon a modified form of the present ten-ton tractor, thus making a single unit of the gun and its source of mobility. This was the first step by us in consolidating the two units into one.

On the standard one-ton White chassis were being mounted anti-aircraft guns with high angles of elevation. It is thought this machine would have been too light for such work; perhaps it would have been necessary to use a heavier chassis. However, it has the desired mobility and may have proven successful.

Proposed Types.

With reference to probable future types for the Artillery, a Board of Officers, of which General Westervelt is President, has been convened, and has been working for some time studying different types of motor vehicles and matériel for Artillery.* They have interviewed many of the General officers who have had most experience with Artillery at the front, and have investigated matériel in use and proposed by France, England and Italy. They will conduct exhaustive experiments in the States, and their recommendations will probably determine what matériel our Artillery will have in the future.

* See report of this board in this number.—EDITOR.

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A consideration of the development of motor vehicles for army use may be interesting. When motor equipment first appeared in the Army, it was used almost exclusively for carrying personnel in automobiles and motorcycles, together with hauling supplies in trucks. The superiority of motor equipment was demonstrated to a certain extent in our service in Mexico and on the Mexican Border. Also progress in engineering has brought forward more improved types of motor transportation. The early part of the last war developed the fact that it was necessary to utilize to a very large extent motor transportation, and not only were the lighter types, such as automobiles, motorcycles, and trucks, employed, but the heavy wheel tractors, equipped with power winches for hauling guns, were put into use to maneuver the guns not only on the roads, but over difficult terrain to gun positions. The American caterpillar tractor was another development over the wheel type used in Europe, and it was found that this machine could haul its load over soft ground and under conditions which would have been absolutely impossible to negotiate with horses. Recent experiments have brought out the idea of mounting the gun and ammunition on caterpillar treads, thereby eliminating the trouble of having the wheels of these carriages sink into the mud. The advantage of combining the tractor and gun carriage in one vehicle is apparent, due to the fact that there would result a reduction in the number of parts required, the wheeled gun carriages being eliminated and no new problem as to the upkeep of the gun mount introduced. Also by reducing the number of carriages, the road space occupied by a unit will be materially reduced. The plan may develop discussion as to whether or not the caterpillar will have as long life as the gun itself. Even if it should not, it would be rather simple to mount the tube, with its traversing and elevating mechanism, on a new caterpillar. However, tests in the United States have been made in which ten-ton tractors ran for a distance of 1800 miles on a single trip and without difficulty or appreciable delay. Having the gun always with its means of transportation would undoubtedly be an advantage in rapid

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movements at the front, as it would eliminate the necessity of bringing up horses and limbers from the rear, or, if caterpillars are substituted for horses, of bringing up the caterpillars to tow the guns. It is thought that with such a self-contained tractor and gun mount there would never be any question as to whether or not the Artillery could maintain a rapid advance. This disadvantage might be advanced of the vulnerability of the caterpillar when left in the battery position. This will exist, of course, so far as direct hits are concerned, but the machine can easily be armored so that shrapnel, machine-gun fire, or fragments, will not affect it. The French have given considerable study to this question of self-contained gun mounts, and reports indicate that they will adopt some form of caterpillar on which will be mounted the guns and howitzers directly. The St. Chamond firm has produced such a caterpillar, and according to their scheme, the caterpillars are to be driven by electrical current. On one machine is mounted a gasoline motor which drives a generator, and this generator supplies current for propelling not only the machine carrying the gasoline motor, but through a cable, the caterpillar in rear which mounts the gun or howitzer. Also, provision is made for carrying on the first vehicle several tons of ammunition. I saw this type at St. Chamond, and its maneuver seems to be quite successful. I was also very much impressed with the stability of the carriage while firing. The gun, or howitzer, has what might be called a double recoil, in that it not only recoils in the regular recoil cylinders, but the whole firing mechanism recoils on an inclined plane, the gun or howitzer travelling up this plane when it is fired and returning to its original position by gravity. The steadiness of the whole caterpillar is maintained by means of supports which are let down to the ground in rear of the caterpillar and operate more or less like an automobile jack. They have a large base, and by means of a screw can correct for the unevenness of the ground. As these jacks are set at an angle of about 60° to the horizontal, the whole caterpillar is extremely steady. Traverse is accomplished by moving the caterpillar, a large hand wheel with great

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gear reduction being provided for the purpose on each side of the vehicle, for movements through large angles the power plant is employed, the carriage can therefore be traversed through an angle of 360° if necessary. In reading a report of General St. Clair Deville, Inspector General of all French Artillery, I find that he is very much in favor of this means of mounting the larger calibers of guns and howitzers. He also discusses the possibility of motorizing the Divisional Artillery with similar equipment, stating that such a thing is entirely possible, and the only reason why horses are to be considered is the possible shortage of gasoline. However, he also points out most definitely that in the future any army which has a material shortage of gasoline, or other substitute, is destined to sure defeat.

If any type of tractor with self-contained gun or howitzer mount is adopted in our service, it probably will be a caterpillar tread, with each carriage propelled by its own gasoline motor.

The question now comes up as to how ammunition and supplies are to be furnished. Along the same plan as that outlined above, there have been developed tractor caissons which are self-propelled, cargo-carrying caterpillars, one of three and of five tons capacity. These can be loaded with ammunition or any other supplies desired. There was also in the experimental stage a caterpillar trailer which consisted of an ammunition body mounted on caterpillar tread. This trailer could be pulled by the caterpillar caisson, thus having all the carriages bringing the guns and ammunition to the battery position equipped with caterpillar tread, enabling them to maneuver terrain which is not only impossible for horses, but also for vehicles equipped with wheels. The two-wheel drive truck seems to solve the transportation of ammunition and supplies on good roads. For operation in divisional area, where the roads will not be so good, the Ordnance four-wheel-drive Militor truck should be used to haul to the regimental or perhaps battalion dumps. From these dumps the ammunition will be transported to the battery position by the caterpillar caisson and trailers. I see

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no reason why this scheme should not work for all of the artillery below the caliber of Railway Artillery.

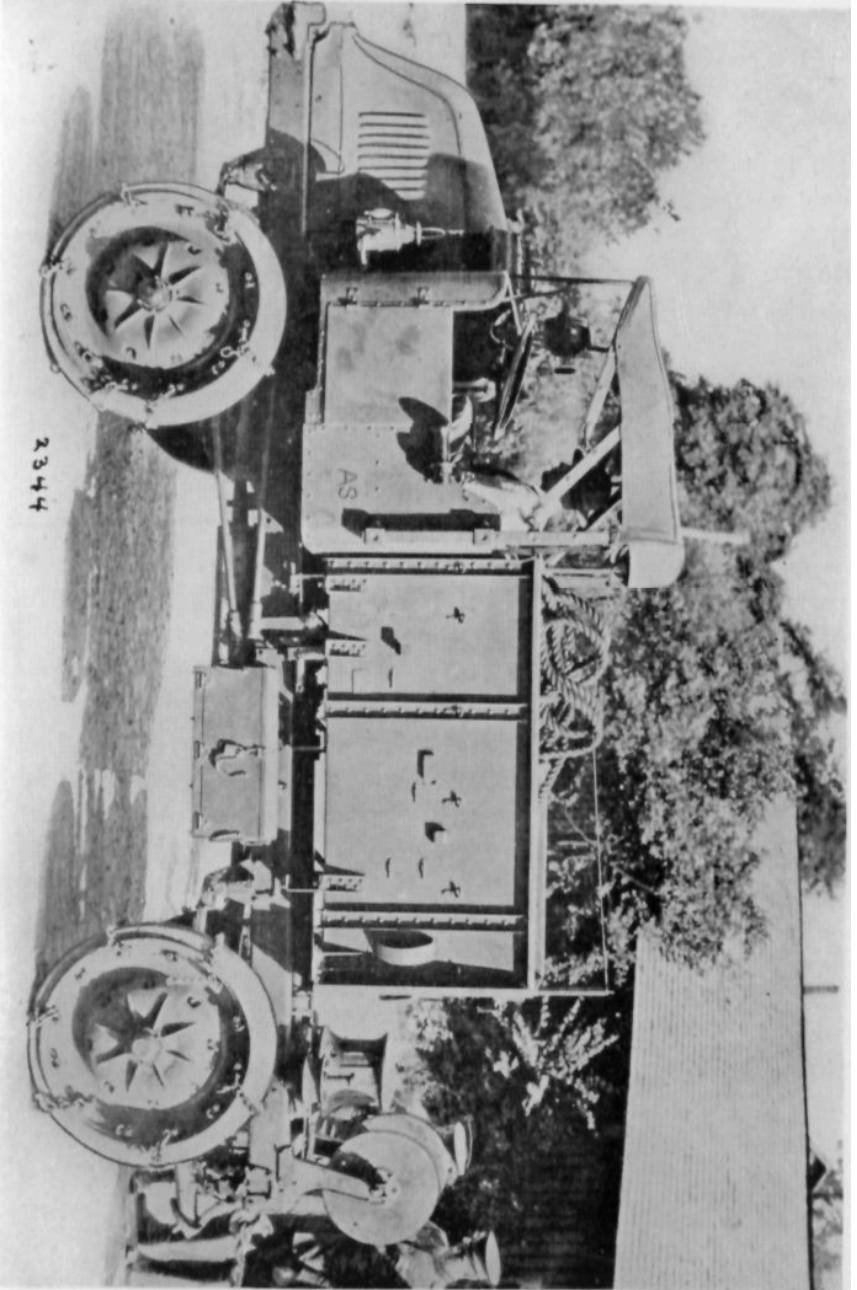
As for the automobiles that are to be used, it is thought that the one-ton chassis is not only perfectly adaptable to such special cars as the reconnaissance and staff observation cars, but it is also quite feasible to mount regular automobile bodies or limousines on this same chassis. For the lighter automobile transportation, it is believed that the Dodge or Ford chassis should be used. It would be used for messenger and courier work together with taking individual officers to places along the front, where it would not be desirable to use the heavier vehicle, as the one-ton chassis. On this lighter chassis can be mounted different styles of body, and it is entirely practicable to use a small body of somewhat racer design for messenger work to replace the motorcycle. Experience at the front has proven beyond a doubt that motorcycles are very undependable. No design has ever been produced which will stand the rough usage to which they are subjected at the front. I have seen it demonstrated that a light automobile such as the Dodge or Ford will maneuver over terrain where the motorcycle, following the same machine, would be completely stuck and impossible to move under its own power. In addition to this, the use of motorcycles involves more spare parts to be maintained, thereby taking us away from what we must have, namely: standardization and as few models of motor vehicles as possible. The only use that would be recommended for motorcycles is perhaps a very few solo machines which would ordinarily be carried in trucks and only used for emergency messenger work when the traffic was very congested or the trail very narrow such that it would not be practicable to use the light automobile chassis.

The greatest difficulty that has been encountered in the whole A.E.F. as regards motor transportation has been the supply of spare parts. It is true that we have been handicaped on account of the lack of spare parts, but this will always result where there are so many different types, makes, and designs of motor equipment as we have employed in the A.E.F. It is

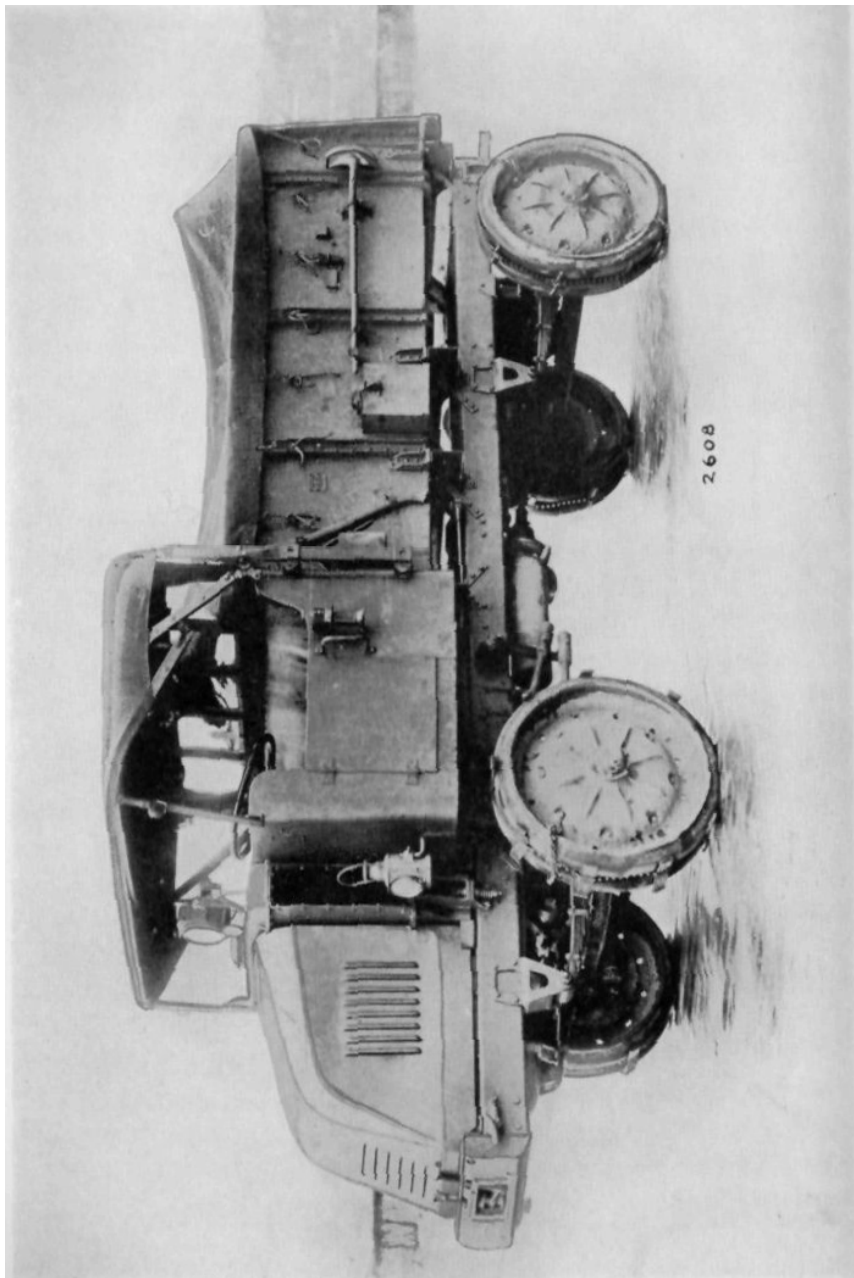
thought that this will be eliminated by adopting standard equipment. To give a resumé of what is recommended above, we would have for the Divisional Artillery the five-ton caterpillar, with trailer having interchangeable tracks with the caterpillar; the three-ton Ordnance four-wheel drive Militor truck; the one-ton chassis, and the light chassis of either the Dodge or Ford type. For the service of the rear we would employ a two-wheel drive truck of the quartermaster B type. In the regiments of Heavy Artillery, it would be necessary to employ a larger tractor. However, this machine can be of the same make and design, only larger and of more capacity.

To What Extent Can We Expect, in the Immediate Future, Motor Transportation to Supplant the Horse for Artillery Purposes?

As noted above, the extent to which we may expect motor transportation to supplant the horse for Artillery, in the immediate future, will probably depend largely upon the recommendations of the Westervelt Board. However, it may be interesting to discuss the main considerations which will probably influence the Board in making its decision. As mentioned before, the motor equipment of the Artillery in the immediate future will depend to a certain extent upon the necessity of adopting types suitable for utilizing the present artillery matériel as it now exists. We have large numbers of 75-mm. guns made to be horse drawn, together with much equipment, such as harness, etc. To immediately motorize all of the Divisional Artillery would necessitate junking much of this equipment, and remodelling the carriages so that they may be motor drawn. Also, even if it is decided to motorize all of the Artillery immediately, the type of motor equipment adopted to handle the Artillery matériel will probably be a small tractor which will be used in towing the guns and caissons. The adoption of caterpillar carriages with self-contained gun mounts and ammunition carriers will be a thing to be considered for future production, but, due to the sweeping changes that would be necessary



ARTILLERY WHEEL TRUCK, ORDNANCE DEPARTMENT MODEL 1918, 4-WHEEL DRIVE, 4-WHEEL STEER



3-TON ORDNANCE DEPARTMENT TRUCK. MODEL 1918. 4-WHEEL DRIVE, 2-WHEEL STEER, MENTIONED IN FOOTNOTE NO. 2

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if it be adopted immediately, we probably can not expect them at once. As to whether or not motor equipment will supplant the horse depends largely on a comparison of horse-drawn Artillery to motorized matériel.

It is realized that there still exists among some of our officers a considerable opposition against entirely supplanting the horse with motor equipment, particularly in the Divisional Artillery and more especially for the 75's. In this connection I will quote from a report by St. Clair Deville on this subject: "Technical progress during the war has always brought about new complications, and these complications have always raised *a priori* considerable opposition, but experience has shown that the progress was a matter of necessity, and it has been found impossible to reject because of the complications." One of the principal complications which we have encountered in the development of motorization has been certain mechanical defects which were occasioned by the necessity for haste in production before the new designs could be thoroughly tested and tried. These defects quickly developed in the field and have caused much annoyance. For the same reason we have in the A. E. F. practically every type of motor equipment in existence, thereby necessitating an enormous number of different spare parts. Both of these difficulties can be remedied in the future by perfecting the designs and standardization of all equipment. In order for motorization to be a success, however, standardization is absolutely necessary.

As a basis of comparison between horse and motorized Artillery, figures have been drawn on a regiment of 155's horsed as compared to the same regiment motorized. These establish the fact that compared on the basis of freight cars of French type, the horsed regiment requires 308, whereas the motorized regiment will need only 128. On a basis of ship tonnage, the horsed regiment will require 13,010 ship tons, whereas the motorized regiment will need only 3767 ship tons. It is also estimated that in marching, the motorized regiment could probably cover three times the distance per day as would be traveled

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if horse drawn. This may be specifically illustrated by the motorized regiments of our Artillery which functioned at the front. These regiments were equipped with the smallest possible amount of motor equipment and still function. For instance, in the entire regiment there were only 24 tractors, leaving not a single spare tractor to replace any that became disabled. Yet these regiments maneuvered very successfully, not only keeping themselves supplied and moving their own equipment, but assisting in clearing road blocks and helping horse-drawn matériel which had become stuck in difficult terrain and on bad roads. On one occasion that I happen to know of, one of these regiments made a march of 50 miles in one day, bringing in all the matériel, personnel, and equipment in good shape. The possibilities of maneuver and of maintaining the advance with motorized equipment are almost unlimited.

The question of mobility of Artillery motorized is established beyond a doubt. Artillery, no matter of what caliber, having proper mechanical power, is able to negotiate every terrain encountered. It is not a question of a motorized battery occupying every position that horses can negotiate, but of occupying any position which might be designated. I have seen this demonstrated with the 75, 155 mm., 155 G.P.F. and 8-inch howitzer. At LeValdahon I saw 75's drawn by 2½-ton tractors and Ford tanks maneuver terrain that could not have been crossed if the matériel had been horse drawn. I have seen 155 howitzers drawn by five-ton tractors do the same. At Is-sur-Tille an eight-inch howitzer and a G.P.F. negotiated swampy terrain that a horse could not have crossed. If absolutely alone and unencumbered, he simply could not have walked across the ground without miring in.

As to the supply of motor matériel, the manufacturing facilities of the U. S. are practically unlimited. We are essentially a mechanical nation. It is true that we had considerable delays in getting motor matériel for the army in the desired quantities. However, it must be remembered that we were not only unprepared for the equipment of a large army such

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as we put in the field, as regards artillery, ammunition, etc., but our factories were all equipped to turn out commercial products, many of which were not adaptable to army use. Nevertheless, at the time of the cessation of hostilities, the plants in the U. S. were turning out on an average of one thousand five-ton tractors and approximately nine hundred ten-ton tractors per month. In addition, there were being produced 2½-ton tractors at the rate of nine hundred per month, and Ford tanks at the rate of three thousand per month. Truck production had been expedited in the same way, and the factories were prepared to turn out enormous quantities of all machines suitable for army use. Production of mechanical vehicles is flexible and practically unlimited as to quantity. On the other hand, the supply of horses and, to a certain extent, forage, is limited. For some time previous to the signing of the armistice, the Allied Governments had searched practically the entire world, except the enemy country, trying to corral sufficient horses for their armies. As stated above, the supply had simply been exhausted.

As regards concealment, I have been particularly impressed with the small amount of display exhibited by bringing a battery of motorized artillery into a position. To bring up four sections instead of having eight teams with their drivers showing up in the position, there are only these small tractors which disappear to the rear with practically no display. Also it is certainly true that a tractor can be more easily camouflaged than a team of horses. Another thing that may be considered in favor of motorization is the manufacture and supply of harness. For a howitzer regiment 358 sets of harness are required to ordinarily equip the regiment and after that, of course, it will be necessary to maintain supplies and facilities for making repairs in addition to having to supply new sets after a time. Of course, set against this is the necessity of supplying spare parts to the motor equipment. However, the initial cost of the motor equipment would not be more than the cost of horses, harness, etc., and, it is established beyond any doubt in the world that

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the supply of gasoline, oils, spare parts, etc., will nothing like equal the supplies necessary to maintain a horse-drawn regiment. In addition, the personnel required in a motorized regiment can be considerably reduced. Again, a tractor, though put out of action, may still be salvaged and many valuable parts retained in the organization. The machine may also be hit with rifle and machine gun fire, or with shell fragments, and still be quite serviceable. A horse, once wounded, is an incumbrance to the organization. Also, during gas attacks, there is nothing more annoying or that caused greater anxiety than the protection of the animals against gas. The horse has become so thoroughly domesticated until he requires much care to keep him in service. He will contract many forms of diseases and requires constant care of trained personnel to keep him serviceable. When horses are to be cared for in an organization, the Commanding Officer can never give a complete holiday to his command on account of the necessity of caring for the horses. One regimental commander, who is now in command of a motorized regiment, spoke of the desirability of being allowed to give his men a complete day off on Sunday. The motor equipment requires practically no care when not in use. Personally, I think to serve with horses is very pleasant and I am very fond of them, so I should say that from the standpoint of sentiment they are greatly to be desired, but from the standpoint of utility in the Artillery they are doomed in favor of motor equipment.

Recapitulation.

To recapitulate I have tried to bring out briefly the following points:

- (a) The necessity for trained personnel to handle motor equipment.
- (b) That the caterpillar tractor, with the exception of a few mechanical defects, has proven successful.
- (c) That some type of the four-wheel drive truck chassis has the most utility for Divisional Artillery in the theater of operations.

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- (d) That a two-wheel drive truck is sufficient on good roads.
- (e) That the one-ton chassis has proven successful and is ample for mounting not only the special Ordnance bodies but automobile and ambulance bodies as well.
- (f) That a light chassis, such as the Dodge or Ford, is desired and should replace the motorcycle, mounting different desired bodies.
- (g) That the 2½-ton and Ford tractors, together with the special Ordnance four-wheel drive truck and other motor matériel, would have been supplied in large quantities if the war had not ended.
- (h) That for future production of Artillery matériel, some form of self-contained caterpillar and gun mount, together with caterpillar ammunition carriers, will be adopted.
- (i) That it is feasible to motorize all Artillery below the caliber of Railway Artillery.
- (j) All motor equipment and spare parts must be standardized.
- (k) That motor equipment is superior to horses.

The Munitions Problem

BY COLONEL J. H. BURNS, ORDNANCE DEPARTMENT, U. S. ARMY

ONE of the principal lessons taught us by the recent World War is the great importance and size of the munitions or ordnance problem and the absolute necessity of a constant and very thorough study of it in times of peace by the interested branches of the service and their best minds, so that comprehensive means or policies will be always available to maintain munitions in step with man power. Military authorities should have been fully aware of this problem and of the fact that a modern army is practically useless without a sufficient supply of up-to-date guns and ammunition, or fighting equipment, and a logical solution should have been developed so that personnel and supplies and particularly munitions would have been maintained in balance. But neither the problem nor a solution thereof had been laid down before our entry into the war, and it is desired here to outline briefly the conditions that existed at our entry into the war, the reasons therefore, the developments during the war, and to discuss steps that should be taken to insure proper future action.

Importance of Problem

It is first desired to point out the reason why the munitions problem is one of constantly increasing importance:

As we trace the history of man we find that his progress is really measured by his scientific development, which manifests itself by his ability to put to his use, in constantly increasing quantity, the forces and materials of nature.

And the progress of army development is measured by the same foot-rule. In the earliest days of history we find that man was able to use only clubs and stones or materials of nature requiring a minimum of change. Later on, he developed the use of metal weapons—the spear, the tomahawk, etc. But these could be effective only within throwing distance, and in

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order to increase his range he invented the sling, the bow and arrow, etc. All these were essentially mechanical developments and covered several centuries of human history.

No further material progress occurred until mankind broke into the realm of chemistry, which first showed itself in war in the use of gun powder. Chemical development was at first slow, but gradually increased until to-day, the strength of an army is not measured by its man power alone, but in great measure by its power to inflict damage through the intelligent and up-to-date use of munitions.

Man power is, of course, and always will be, paramount, but this power is greatest when utilized for unloosening on the enemy the power stored in chemicals through the aid of mechanical and electrical equipment. And this condition will be more pronounced as time goes on.

Napoleon is credited with saying that "God is on the side of the army having the best artillery." How much truer is that statement to-day! And it must be remembered that the artillery's real strength is all stored in its *munitions*.

We have in this war seen all sorts of new chemical and mechanical schemes used, and in some cases the use of one of them has nearly gained the victory. The lesson to be drawn is that we must, in our munitions departments, keep thoroughly up-to-date with all scientific developments, including chemical, mechanical, and electrical engineering, and see to it that these developments are adapted to our munitions designs.

Situation When We Entered the War

I. FIELD ARTILLERY.—(a) *Quality*.—The designs of guns and ammunition had not kept pace with the developments that had been brought about by the great war in Europe. In fact, practically no knowledge existed of these developments. This was, in great measure, due to the very great difficulties encountered in getting proper representatives at the various sources of information in Europe.

Furthermore, adopted and proven designs of the heavier

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types of guns and ammunition which were part of the mobile artillery program did not exist, due principally to the fact that this country had not realized at a sufficiently early date the necessity for the heavier armament.

(b) *Quantity*.—There were, of course, no stocks of guns or ammunition of the calibres which had not been adopted or proven. Furthermore, there were hardly enough guns of the adopted calibres to supply the then existing army, and the stocks of ammunition were practically negligible. Practically no facilities for the manufacture thereof existed in the country, outside of government arsenals, which were hardly able to supply the then existing army, much less develop reasonable reserves, or keep pace with even a modest increase in our fighting forces. This condition was due, in great measure, to lack of funds.

II. COAST ARTILLERY.—(a) *Quality*.—The design situation for this service was in much better shape than for the Field Artillery. It was quite well established both for guns and ammunition, although there were, of course, many elements still not thoroughly developed.

(b) *Quantity*.—Reasonably satisfactory stocks of fighting materials existed at the various forts, although in some cases one or more of the essential components were not at hand. It is recalled in particular that a serious shortage of smokeless powder for 12-inch guns existed. The consumption program of this type of munitions, even in war, is small, and it is thought that even the small arsenal system in effect before the war might have kept reasonable pace with requirements.

III. AIR SERVICE.—No designs, stocks, or manufacturing facilities existed.

IV. TRENCH WARFARE.—No designs, stocks, or manufacturing facilities existed.

V. INFANTRY AND CAVALRY.—The principal munitions therefore are the small arms, group, or .30-calibre rifle, pistol, and machine gun, and their ammunition.

(a) *Quality*.—Rifle: An excellent design, both of gun

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and ammunition, had been accepted. Pistol: A satisfactory design, both of gun and ammunition, had been developed and adopted. Machine Guns: No satisfactory design had been adopted.

(b) *Quantity*.—Rifle: Small stocks, both of guns and ammunition, existed and good arsenal facilities had also been developed for their manufacture. This work is also handled by commercial firms even in peace time and commercial capacity had been greatly augmented by allied purchases. Serious shortage existed, however, in the necessary jigs, fixtures, tools and gauges to transform commercial plants for the manufacture of our type of rifle. Pistol: Stocks of pistols and ammunition either existed or were quite readily procurable from commercial firms. Machine Guns: Manufacturing facilities were, of course, lacking, as designs had not been perfected.

VI. GENERAL.—(a) *Quality*.—Designs were not in a satisfactory state, and had been built up in many cases along more or less theoretical lines of thought—with no real attention having been paid to the raw material supplies necessary to produce the munitions. As an example, T.N.T. was the adopted shell-filler for mobile artillery ammunition in spite of the fact that at the time practically no toluol was produced in America. No comprehensive quality-developing organization or facilities existed.

(b) *Quantity*.—Demand: No office had been set up, either in the General Staff, the Ordnance Department, or elsewhere, which constantly considered the quantity of munitions that should be in stock, nor that would be required, nor the amount of time, facilities, raw materials, etc., that would be necessary for the development of war quantities. And, as a consequence, when we entered the war it was impossible to ascertain the quantity of materials that were necessary during any particular period of time to maintain pace with man power.

Supply: Practically no stocks of munitions existed. The Ordnance Arsenal system, on which we practically depended for production, was, in general, small, and in most cases absolutely

incapable of being expanded into real quantity-producing plants. Practically no reserve plants, equipment, or facilities of special kinds, existed. For many items of the munitions program, there were no commercial firms with any knowledge or experience except, fortunately, what a few had picked up through the purchases of the Allies, prior to our entry into the war. No comprehensive study was at hand of the amount of raw materials, manufacturing facilities, personnel, etc., that were available in the country for use in meeting the munitions demands, nor of the possibilities of expanding these resources.

Reasons for the Munitions Situation as it Existed at Our Entry into the War

(a) *The Ordnance Department* for many years had been in almost complete control of all duties pertaining to the design, manufacture, and issue of munitions. The work was in the hands of entirely *too few* officers, most of whom had no real idea of the problems connected with the use thereof. Proper coördination with the General Staff and with *the users of munitions* was not developed and maintained. Proper information was not available of the developments of foreign governments in munitions. No real conception of the munitions problem existed in the Ordnance Department, either from the standpoint of quality or quantity nor of the effect of a large program on the industries and raw material resources of the country. Solutions had not been laid down before our entry into the war as to how munitions would be produced, assembled, issued, etc., in large quantities. Development of both types and stocks was slow, due to the lack of a comprehensive quality and quantity organization and arsenal system, as well as to constant shortage of funds.

(b) *The various users of munitions* had practically no conception of their munitions problems, either from quality or quantity standpoints. In general they maintained no means of thoroughly educating their personnel in the general problem of design, care, and use of munitions. They also had developed

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no friendly coördination with the Ordnance Department covering questions of design, manufacture, and issue of their fighting materials. They had developed no organization that could lay down for the Ordnance Department or General Staff the general policy of design of their fighting materials nor of the quantity they would need per division per day, etc.

The one exception to the above was the Coast Artillery,* which had an organization and did appreciate to a great extent its munitions problem and, as a consequence, had effected liaison with the Ordnance Department and had assisted very materially in bringing its ordnance situation to a reasonably satisfactory state.

(c) *The General Staff* did not include among its numbers a single representative of the Ordnance Department, had no real conception of the munitions problem, either from the quality or quantity standpoint, and was unable to satisfactorily lay down or approve a definite program for the guidance of all concerned so that munitions would keep pace with man power.

(d) *Congress* (and the nation) did not appreciate the size of the problem and had constantly refused to provide money in sufficient quantities to satisfactorily develop personnel to handle the problem and to develop types and stocks of munitions and facilities for their manufacture.†

(e) *General*.—Practically all officials on whom the responsibility for the supply of munitions rested were either ignorant of or materially under-estimated the problem and, as a consequence, neither the problem nor a comprehensive solution had been laid down.

Developments of the War

They emphasize the fact that the task of munitions design, manufacture, and supply is one of the greatest problems of war. The results achieved show that it is much easier to develop

* Showing the absolute necessity for the establishment of a permanent office of Chief of Field Artillery.

[† This was but a repetition of a condition of affairs which had existed throughout the history of our country from the beginning. (See *Military Policy of the United States*, Upton). Editor.]

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an army of trained men than it is to supply this army, and that of supplies the most difficult group is munitions. Practically all other supplies, such as food, clothing, transportation, medicines, etc., are used in times of peace and must only be slightly changed in time of war. But this is not true of munitions. They must be exact in every detail—especially guns and ammunition. Practically no capacity except that at arsenals exists in time of peace, and in war commercial industries must be materially transformed in order to produce them.

It should not for a moment be lost sight of that we could not, in the recent war, have waged even a day's battle with our armies if we had been able to utilize *only* the munitions furnished by our factories. It was only because of the fact that we could procure from France and England, from their reserve stocks of munitions, the necessary fighting materials that we were able to engage our men. It is true that the Ordnance Department had built up a tremendous organization from practically nothing and that this organization was solving its problems to such an extent that munitions of all descriptions were beginning to flow during the fall of 1918, and that this flow would probably have been of sufficient volume to have supplied, to a reasonable extent, during the spring of 1919, the man power that would have been able to operate on the various fronts. In other words, it took us practically two years to develop munitions to such an extent that we could begin to supply our armies. And, expressed in another way, munitions of our own manufacture were practically one year behind man power.

During the entire war, the program of requirements was most uncertain and generally excessive, and gradually increased in size until it reached a point where it would undoubtedly have been absolutely impossible of fulfillment, even though the entire resources of the country were utilized for nothing else. As a consequence, the program became unbalanced because some of the items could be procured and others could not, and, of course, labor, materials, and time were wasted in constructing useless facilities and fabricating valueless products. It is not felt that

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the value and absolute necessity of a definite and logical program is any too well realized, even now.

The British Government faced practically the same problems with reference to munitions at their entry into the war, and after approximately two years of unsuccessful effort to keep their man power satisfactorily supplied with munitions, evolved the organization known as the British Ministry of Munitions. The great strength of this organization lay principally in the fact that it focussed proper attention by all the higher officials and the people of England on the size and importance of the munitions problem.

Briefly, the British munitions scheme was about as follows:

The program of requirements was always considered of paramount importance and was worked out as long in advance as possible by representatives of General Headquarters in France and other countries, the Ministry of Munitions, and the War Office in England. These representatives were, in general, from among the highest officials and the best minds in the organization concerned. The representatives of the General Headquarters indicated requirements from the standpoint of the military plans on their particular front, the number of men available and campaigns to be fought, the armament to be maintained, and the rate of fire per gun per day to be used. The representatives of the Ministry, who had thorough knowledge of the capacity of their country and the available capacity of the allied countries, studied the desired program from the standpoint of whether or not *it could be met* and gave their opinions as to the balanced program that could be produced. Compromises were then effected between the three organizations, and military plans and munitions requirements balanced up with a munitions program that *could be produced*. This program was laid down and approved, it is believed, by the Supreme War Council, as the official munitions program and generally covered about a year's future activity, although, of course, minor changes were being constantly made.

The quality of munitions was essentially under the Ministry

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of Munitions, with the important exception that the users of munitions, through General Headquarters in the Field and the War Office in England, outlined for the Ministry the general specifications to be met, and the War Office finally approved or disapproved the type submitted.

The quantity of munitions produced was completely in charge of the Ministry of Munitions. All types were under its control, including gas and other chemical munitions.

Accepted munitions were turned over by the Ministry to the representatives of the War Office for storage and shipment to the various fronts.

The Ministry itself was organized in general under a Minister of Munitions, who, in turn, worked through a munitions council of which he himself was president. The other members of the council were chiefs of the various groups in which the work was subdivided, namely:

Secretariat—covering Requirements and Statistics, Administration, etc.

Finance—covering finance, contracts, etc.

Design—covering design, inspection, etc.

Steel and Iron—covering iron and steel raw materials.

Materials—covering non-ferrous raw materials in general.

Explosives—covering powder, explosives, chemicals, etc.

Projectiles—covering projectile manufacture and assembly into ammunition.

Guns—covering gun and carriage manufacture and assembly.

Engines—covering aircraft production, tanks, motors, tractors, etc.

Labor—covering labor regulations and supply.

Allies—covering liaison with Allies.

After eighteen months of war our own Ordnance Department developed an organization which corresponds in large degree to that of the British Ministry.

Another development of the war has been the creation of the Office of the Chief of Field Artillery. This office is becoming

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thoroughly cognizant of the main problems of its branch—namely, man power and supplies. And it is beginning to appreciate the importance of its munitions, and of the fact that its entire power is stored therein.

Steps Necessary to Insure Proper Future Munitions Preparedness

It is, of course, fundamental that such a logical organization be laid down in time of peace for the handling of the task that expansion only is necessary in time of war, and it is essential that this be done at once so that the experiences of this war will be utilized to maximum advantage.

A recent projected reorganization chart of the Army abolished, to a great extent, the Ordnance Department and placed in great measure the responsibility for the design and manufacture of munitions on the branch of the service using them, under, of course, control of the General Staff. In other words, the task was taken, *in toto*, from the Ordnance Department, who previously had all of it, and given to the users, who previously had none of it.

This scheme has advantages and disadvantages. Its principal advantage is that it makes the users more fully alive to their munitions situation, and this is of very great importance. Its principal disadvantage is that it forces the creation of several organizations to design and manufacture practically the same materials. This also is of very great importance, for the experiences of both the British and ourselves in the recent war indicate the absolute necessity of having the design and procurement of similar materials for government use in the hands of the same individuals in the Government organization. The reasons for this are obvious, and any radical violation of this principle would be most unjustified.

The proper solution, it is felt, lies in a combination of the two schemes embodying the following principles:

(a) Each of the principal users of munitions should develop and maintain an organization or representation which is

thoroughly aware of its munitions problem. This includes up-to-date knowledge of the *quality* and *quantity* of munitions needed to supply man power, and the status thereof. It should be required to lay down for the Ordnance Department just what it is desired that the munitions accomplish and should be capable and be required to accept or reject the types offered by the Ordnance Department to meet these specifications. It should have representation with the Ordnance Department to assist the latter in its developments and work and to keep the branch of the service concerned thoroughly acquainted with the status of its munitions. In the schools pertaining to each branch particular emphasis should be paid to the munitions problem and special courses of instruction given thereon covering not only care and use, but also design, manufacture, and methods of issue. If possible, the branch should have representatives at such foreign countries as appear in any way progressive in munitions development.

(b) The Ordnance Department should be called upon to make and develop satisfactory designs to meet the general specifications submitted by the various branches, and should be responsible that definite and comprehensive arsenal and proving ground facilities and commercial liaison exist not only for this development of quality, but also for the satisfactory fulfillment of quantity demands. It should be required to have available at all times approved designs for fighting equipment for all the users thereof, satisfactory stocks thereof, and definite solutions as to the manner in which these stocks could be always maintained within reason ahead of man power, covering the problem from the elementary raw materials through manufacture and assembly to finished issue articles.

The Ordnance Department should realize that it is really a servant of the various branches of the line of the Army, and must effect the closest liaison therewith in order to ascertain their demands. It should have representatives take special courses at the schools of the various branches in order to get the details of the use of munitions and the point of view of the

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users. It should develop (and is doing so) a comprehensive school system for the thorough instruction of its officers in the art. It should also have representatives, if possible, in foreign countries, to ascertain the status therein. It should, and is, organizing an Ordnance Committee to be made up of representatives of the various branches of the Army, as well as special representatives of the Ordnance Department, to pass upon designs of munitions and make sure that they not only are satisfactory to the Ordnance Department itself but that they also meet the demands of the users, and with the further object of keeping the Ordnance Department and the users of munitions in close touch as to developments. Emphasis must be laid on the fact that too much change in design in the effort to reach perfection is perhaps more fatal than ultra-conservatism.

(c) The General Staff should lay down and keep up to date an Ordnance Program or "Tables of Munitions Requirements" setting forth what quantities of the various types of munitions should be maintained in stock and what quantities would be required by the various users in case of war in order that munitions could always maintain pace with man power. This program would, of course, be developed through consideration of the desired requirements of the users per unit of army, the General Staff's knowledge as to the number of units that could be raised and the time required to do so, and the possibility of the country's producing these requirements as indicated by Ordnance studies. This program should be checked at periodic intervals by the General Staff, and at such times the Ordnance Department should be required to submit its solutions of the problem in detail, showing that it has designs for all types of munitions satisfactory not only to itself but also the users, required stocks, and schemes for keeping these stocks in step with man power. The General Staff must also develop better knowledge of munitions and must number among its force representatives not only of the users but also of the Ordnance.

As already pointed out, we were forced to fight this war

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with munitions purchased from the Allies. Our main object was to win the war, and it was our duty to supply our armies with munitions from all possible sources in order to accomplish this task. Reports indicate that our armies were properly supplied with munitions. *The war was won.* This is the best answer to all criticisms concerning conditions prior to the war and the developments of the war.

But who wants the United States to be dependent upon purchased munitions for the next war? Universal training and schemes for raising man power in case of emergency can only be successful when all other links in the chain of preparedness are kept in step with man power. Munitions preparedness is of paramount importance in this chain, and while it is a tremendous problem, the problem can be solved, and without the expenditure of tremendous amounts of money. What it requires most is knowledge and coöperation. Knowledge and cooperation on the part of the users, knowledge and coöperation on the part of the manufacturers or Ordnance Department, knowledge and coöperation on the part of the General Staff, and knowledge and coöperation on the part of Congress.

Study of the Armament and Types of Artillery Matériel to be Assigned to a Field Army

1. Report of a Board of Officers convened pursuant to the following order:

WAR DEPARTMENT,

Special Orders
No. 289-0

Washington, December 11, 1918.

Confidential

EXTRACT

Par. 142. A board of officers to consist of:
Brigadier General William I. Westervelt, U. S. Army;
Brigadier General Robert E. Callan, U. S. Army;
Brigadier General William P. Ennis, U. S. Army;
Colonel James B. Dillard, U. S. Army;
Colonel Ralph McT. Pennell, U. S. Army;
Lieutenant Colonel Webster A. Capron, U. S. Army;
Lieutenant Colonel Walter P. Boatwright, U. S. Army;
is appointed to meet at A. P. O. 706, France, at the earliest practicable date, to make a study of the armament, calibers, and types of matériel, kinds and proportion of ammunition, and methods of transport of the artillery to be assigned to a Field Army.

* * * * *

After completing its investigations abroad, the board will return to the United States to finish its work at such ordnance and other plants in the United States as may be necessary.

334.2 (Field Artillery Equipment).

The travel directed is necessary in the military service.

By order of the Secretary of War:

PEYTON C. MARCH,
General, Chief of Staff.

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Official:

P. C. HARRIS,
The Adjutant General.

Washington, D. C., May 5, 1919.

The Board met January 12, 1919, at Chaumont, France, and, after organization, arranged for the accumulation of such artillery data as were available in France, visited manufacturing plants, and had conferences with the French and American artillery officers. It visited Italy, had conferences with the higher technical and artillery officers, visited manufacturing plants, and had a conference on types and tactical uses of artillery at the Italian Great Headquarters. Similar opportunities were afforded the Board by the British at their Great Headquarters in France and at their War Ministry in England.

2. In making up its report, the Board has adopted the following general scheme of discussing and developing the subject:

- I. The artillery of a field army: its functions (Par. 3–5 incl.).
 - (a) Division artillery missions (Par. 6–9).
 - (b) Corps artillery mission (Par. 10).
 - (c) Army artillery missions (Par. 11–13).
- II. Discussion of types of artillery.
 - (a) Light field gun (Par. 14).
 - (b) Light field howitzer (Par. 15).
 - (c) Medium field gun (Par. 16).
 - (d) Medium field howitzer (Par. 17).
 - (e) Heavy field gun (Par. 18).
 - (f) Heavy field howitzer (Par. 19).
 - (g) Super guns and howitzers (Par. 20).
- III. Improvement in design and construction of projectiles (Par. 21–28).
- IV. Types of artillery recommended: ideal and practical. Light field artillery.
 - (a) Gun (Par. 29–32).
 - (b) Howitzer (Par. 33–35).

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Medium field artillery.

(c) Gun (Par. 36–38).

(d) Howitzer (Par. 39–40).

Heavy field artillery.

(e) Gun (Par. 41–43).

(f) Howitzer (Par. 44–46).

Weapons of greater power.

(g) Heavy gun (Par. 47).

(h) Heavy howitzer (Par. 48–50).

(i) Super guns (Par. 51–56).

(j) Super howitzers (Par. 57–62).

Other artillery.

(k) Anti-aircraft; light gun, heavy gun (Par. 63–69).

(l) Pack artillery (Par. 70–71).

(m) Infantry accompanying gun (Par. 72–74).

(n) Trench artillery (Par. 75).

(o) Anti-tank gun (Par. 76).

V. Artillery transport.

General discussion (Par. 77–84).

Gasoline-propelled vehicles (Par. 85).

Motor cars (Par. 86).

Motor trucks (Par. 87–89).

Caterpillars (Par. 90).

History of artillery motorization in the United States (Par. 91–97).

Types produced by the Ordnance Department (Par. 98).

Types recommended to be developed (Par. 99–101).

Tractors (Par. 102–103).

Trucks (Par. 104).

Trailers (Par. 105).

Tractor caissons (Par. 106).

Self-propelled gun mounts (Par. 107–110).

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Complete plan of artillery motorization (Par. 111–112).

Immediate application of the above plan (Par. 113).

Special recommendations (Par. 114).

I. THE ARTILLERY OF A FIELD ARMY: ITS FUNCTIONS

3. The artillery assigned to a Field Army should be of such mobility, power, variety and number as to insure the success of the mission involved and to enable this success to be gained with the minimum of casualties. The latter point must receive careful consideration in studies of organization, for without adequate artillery preparation and support the successes of the most gallant infantry can, in a series of actions, become little more than pyrrhic victories. While it is not within the province of this board to discuss this question, it may be well not to leave it without stating that many actions of our divisions in France resulted in casualties whose numbers were a decreasing function of the number of guns with which divisions were supported. The proportion of guns per thousand gross strength to infantry, cavalry and machine guns adopted by the armies of the first-class powers before the opening of the present European War in 1914 was:

| | |
|----------------|--------------------|
| British | 6.8 |
| French | 4.6 |
| German | 6.4 |
| American | 3.2 (Gruble Board) |

During the war this proportion was constantly increased until at the close under conditions of position warfare it was between 8 and 12 per thousand; this varied, of course, with the activity in different sectors. In quiet sectors and under conditions of maneuver warfare which necessitated leaving much artillery behind it was about 6 per thousand.

4. A study of the types of artillery actually employed by the field armies in Europe might lead to some errors in drawing

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conclusions as to what should constitute a proper armament, for the reason that the various countries involved had to use existing types which they had at the beginning of the war, whether satisfactory or not, and build new and supplementary types, not always the ideal, even from their own standpoint, but such as the manufacturing facilities of their countries permitted. The development of types due to the emergency and the use of antiquated matériel multiplied the types for which ammunition had to be supplied; the war in turn also multiplied the types of ammunition which had to be supplied to a particular type of artillery. Such a condition of artillery matériel could only produce a limited degree of artillery efficiency, a mass of types of questionable value and great expenditure of money and industrial effort.

5. An artillery program should be founded on the object and the means—that is, the destruction of the target and the projectile to accomplish this. It should also admit of a proper series of ranges that would fulfill all the tactical requirements that could reasonably be expected of a series of types. In the study of an artillery program there are two methods of approaching the subject. First, by starting with a minimum weight of projectile and working up to a reasonable maximum according to some law and taking the corresponding calibers, a theoretical series of guns and howitzers can be expressed. For instance, if the law be doubling the weight of projectile the series could be:

| | | | |
|---------------|------|-----------------|-----|
| Projectile of | 13 | pounds, caliber | 3" |
| Projectile of | 26 | pounds, caliber | 4" |
| Projectile of | 52 | pounds, caliber | 5" |
| Projectile of | 104 | pounds, caliber | 6" |
| Projectile of | 208 | pounds, caliber | 8" |
| Projectile of | 416 | pounds, caliber | 10" |
| Projectile of | 832 | pounds, caliber | 12" |
| Projectile of | 1664 | pounds, caliber | 14" |

The second and more logical method, and the one followed by the board, is to consider the artillery missions and determine the

types best suited irrespective of any theoretical series. However, in the discussions of artillery missions and the proper types for their fulfillment which the board had with our own and foreign officers, there was a remarkable degree of unanimity of thought on these subjects; and the above table actually contains, with slight variations, the types that were most strongly recommended. While granting the great variety of artillery missions that often shade into each other, it is believed that they can best be considered in three great classes that follow the tactical composition of a field army; those of division, corps and army artillery.

(a) *Division Artillery Missions*

6. The division artillery, first of all, must have the mobility that will permit it to accompany the infantry of a division and the maximum power consistent with this mobility; its objective must be primarily the infantry of the opposing division. It is, therefore, bound to its own infantry with the closest bonds and its tactical use cannot be separated from that of the infantry. The division artillery must fire accurately a man-killing projectile and be prepared for quick changes of objective; it must have great range because of echelonment in depth, both of its own and the opposing division; it must continually harass the enemy, prevent his movement and force him into cover or protected trenches. On the defensive it must break up the opposing infantry formations by counter-offensive preparation and by annihilating fire on points from which the attacks emerge; and, failing in these, be prepared to use the barrage and the close-range shrapnel fire. In the offensive the division artillery must play its part in the complex scheme of artillery preparation by cutting wire, destroying machine gun nests, gassing areas, concentrating on infantry positions and taking the principal part in the deep barrage that should precede the infantry attack. Its fire, accompanying the infantry movement, requires its own movement by echelons; and by its mobility it often becomes for

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some time the sole artillery protection in the consolidation of a position which has been taken.

7. It would be ideal if one type of weapon could accomplish all the requirements that the division artillery should fulfill, and some artillery officers in one of the foreign armies have made a study of a gun-howitzer with this in mind. The objections to such a gun-howitzer are:

(a) That it would require the use of a projectile of about 30 lbs., which is about twice that of the normal field gun ammunition, thereby greatly increasing the tonnage of ammunition supply for the same volume of fire.

(b) That it would require a complication of the ammunition supply to individual batteries in that both fixed and semifixed ammunition would have to be supplied if the double function of the piece was to be taken advantage of at any time. To meet this by having all the ammunition semi-fixed would result in a decreased rate of fire when the piece was used as a gun.

(c) That to obtain fairly good gun characteristics the weight of the piece and carriage would be increased and, therefore, the mobility decreased.

(d) That in any case the piece would not be the best type of either field gun or field howitzer.

8. The consensus of opinion of artillery officers is that the division artillery missions are best fulfilled by a light field gun and a light field howitzer having a range of at least 11,000 yards. While differing in mechanical features the field guns of the different European countries are practically of the same type and, though constant effort is being made to improve details, they can be stated generally as satisfactory to their own governments and not liable to any radical changes. This general type of field gun, while capable of fulfilling most of the division artillery missions, must be supplemented by a proper howitzer. There are many instances where the terrain offers such protection to infantry that the field gun cannot bring an effective fire. The howitzer has the great advantage that with a proper set of propelling charges and, therefore, a choice of trajectories

for the same range, protected positions can be chosen for howitzers that guns could not use, and angles of fall on objectives obtained that the normal ammunition of guns would not give. The low muzzle velocity of howitzers admits of their almost continuous use in harassing fire and allows the use of a projectile double the weight of that of the field gun. Such a howitzer renders excellent service in wire cutting and is a useful projector of gas shells. To insure the mobility required of all divisional artillery the weight of the howitzer and carriage should not exceed that of the field gun and carriage, or about 4500 lbs.

9. In connection with the support of the division infantry by the division artillery the war has intensified the old question of accompanying guns for infantry. A solution of this question by the assignment of batteries of field artillery has been tried but the general opinion is that the field artillery gun is not satisfactory for this purpose; it is too vulnerable a target in motion; the ammunition supply is difficult; it is not sufficiently mobile because it cannot be man-handled; and from the division artillery standpoint the loss of the control of these batteries breaks down the power of the division artillery. One of the most serious obstacles to the advance of infantry is the enemy's machine guns. If the machine gun nest is isolated it is relatively simple to maneuver in such a way as to neutralize it. If, however, there is a line of machine gun nests it becomes necessary to destroy a certain number in order to outmaneuver the others. The infantry rifles, machine guns and 37 mm. guns are not sufficient for the latter mission. It is not always easy to obtain promptly the action of the division artillery, usually some distance in the rear, and it is difficult to indicate to the artillery the exact location of the machine gun nests. For the above reasons it seems proper that a special gun, designed for the destruction of machine gun nests and other light forms of enemy resistance, should be provided. This gun should have such mobility that it can be man-handled as a unit, that is, dragged along on a low-wheeled mount; it should be accurate for its

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purpose up to 2500 yards and use a large capacity high explosive shell. Its carriage should also admit of ready adaptation for use in trenches.

(b) *Corps Artillery Missions*

10. It will be noted above that the division artillery missions did not include their own protection against enemy artillery. This counter-battery work is the principal mission of the corps artillery. There are American officers who advance the idea that, because their actual experience is not receiving proper corps artillery support, the division should be supplied with counter-battery artillery; the matter is complicated because the 155 mm. howitzer which formed part of our division artillery brigades is an ideal counter-battery weapon, and further by the fact that these howitzers did not form a part of our corps artillery, which organically consisted of guns alone. This should not divert us from the fact that the mission of counter-battering the enemy's gun belongs to the corps which has the proper agencies for determining the position of enemy guns and for coördinating this work so as to fit in with the plans of the corps commander. The corps artillery has also the missions of extensive harassing and interdicting fire along the corps front and to a greater depth than the capabilities of the division artillery; also of destructive fire on strong points as well as on railroad facilities and points of supply. For the accomplishment of these corps artillery missions there are two distinct types of artillery necessary, a gun and a howitzer, each having about 16,000 yards range and each weighing with carriage about 11,000 lbs.

There is another class of artillery called anti-aircraft artillery to be considered. This is used first in providing anti-aircraft defense to troops engaged in combat and, second, in providing anti-aircraft defense for army zones, for certain areas in rear of armies or along certain line of anti-aircraft defense.

The first class gives protection from low flying air-planes to troops engaged in combat; it should, therefore, form part of

the field army. The second class is part of the general anti-aircraft defense and works in coördination with the air service, balloon defense, searchlights and anti-aircraft machine guns, thus forming the anti-aircraft defense service.

(c) *Army Artillery Missions*

11. In addition to the division and corps artillery fulfilling the missions outlined above there must be additional artillery available; there are missions of interdiction, neutralization and destruction which fall beyond the activities or capabilities of the normal corps or medium field types; there must exist a surplus of divisions or corps types, properly transported, for strategic reinforcement of divisions and corps during such times as the normal allotment to such units is insufficient; there must be artillery of special purpose—pack artillery, trench artillery and super-guns and howitzers.

Of the above additional artillery, a type of heavy field gun and a type of heavy field howitzer are considered normally necessary in the armament of a field army; the gun should have a range of approximately 25,000 yards, and the howitzer a range of about 18,000 yards. These weapons, more powerful than the medium field types, add range to the interdiction and harassing, and to the neutralization and destruction possible with the corps types.

12. Considering paragraphs 3–11, inclusive, it will be seen that the normal artillery missions of a field army can be accomplished by an assignment of six calibers, *i.e.*, two light weapons, two medium weapons and two heavy weapons—a gun and a howitzer in each class—and a satisfactory anti-aircraft gun.

13. The surplus of field army types for strategic reinforcement of their respective units, the artillery of special purpose—pack artillery, trench artillery, obsolescent types, and superguns and howitzers—are believed to be outside of the normal assignment of armament to a Field Army. At times all or any of the special types are necessary in field army missions; these types have no continuing purpose and should, therefore, be

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looked upon and organized as available reinforcement or reserve for the artillery of field armies.

II. DISCUSSION OF TYPES OF ARTILLERY

(a) *The Light Field Gun*

14. The consensus of opinion of all artillery officers—French, Italian, English and American—is that the 75 mm. gun, or approximately this caliber, firing a 15-pound projectile or a projectile of approximately this weight, and having a range of not less than 11,000 yards, is a satisfactory weapon at the present time for use with division artillery. The projectile in question, whether a shrapnel or high explosive shell, satisfies adequately the criterion of man-killing.

At the close of the war the nations were not entirely in accord with respect to their conception of an up-to-date carriage for the light field gun. All the nations whose tendencies have been considered in this report have experimented to a varying degree with field gun carriages, particularly in a desire to design a carriage permitting a greater angle of elevation and a greater movement of the gun in traverse. The Italians have expressed themselves in the modified Deport carriage; this vehicle is of the split-trail type and permits an elevation in excess of 75 degrees, and a traverse on each side of the carriage axis of about 20 degrees.

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Up to the time that the board left France it was not possible to learn the French decision in the matter of a split-trail carriage for their light field gun. It is known, however, that several types of this carriage have been designed and tested; it is known, also, that considerable favor has been found with the American 1916, which type has been tested under the auspices of the French Government. In England, however, the board was not able to develop any enthusiasm for the split-trail type, although the matter had been seriously considered. In that country the up-to-date field gun carriage appears to be adequately

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expressed in their new 18-pdr. The vehicle upon which this gun is mounted permits an elevation of 37 degrees and an axle traverse of $4\frac{1}{2}$ degrees on each side. The trail is a box trail and the carriage is simple and steady in its construction and lends itself to rapid production.

* * * * *

The split-trail carriage is fairly well known in the United States; opinion has not yet been crystallized throughout the artillery, which is still more or less open-minded and quite willing to accept the tactical advantages of the split-trail type when some of the present mechanical disadvantages shall have been remedied. It may be stated that the field artillery would be glad to have a possibility of increased elevation and increased traverse, provided the simplicity of construction inherent in the single trail type can be retained. The field artillery believes that a satisfactory split-trail type of carriage can be made.

It is desirable that the breech blocks of all weapons be confined to one type. The three types of breech blocks in use in the present American 75 mm. guns are the French rotating block, the American drop wedge block and the British swinging block. All three types are in general satisfactory. The firing mechanism should be of the fewest possible number of working parts, preferably of the lanyard type.

The consensus of opinion was that the independent line of sight is necessary; also that the general type of panoramic sight of American design with graduations from zero to 6400 mils in azimuth is preferable.

At some time in the future it is probable that all division artillery will be motorized. The result of such change in the prime mover would be to remove the present restriction as to weight of gun and carriage. The board senses a demand in the near future for a light field gun having a maximum range of approximately 15,000 yards; such range may be achieved by increasing the muzzle velocity and, perhaps, the weight of the projectile, although change in the form of projectiles will give some improvement over the present ranges. It is probable that

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the limiting feature in the design of field guns of the future will be the requirement that it should pass safely over temporary pontoon bridges and that the weight and form and size of ammunition must be such that the present rate of fire will not be slowed down.

The board is of the opinion that, except as to perfection of details, the limit of carriage design, as expressed by the most modern type of box-trail and split-trail carriages, has been reached; and feels that with the advent of motor transportation the tendency will be toward a gun mount of the pedestal type expressing the desires of the field artillery with respect to maximum horizontal and vertical arcs of fire.

(b) *The Light Field Howitzer*

15. The consensus of opinion of American artillery officers consulted is that a howitzer of about 4 inches in caliber, firing a projectile weighing from 25 to 30 pounds at a maximum range greater than 10,000 yards, is required. This opinion is concurred in by the French, Italians and English, and it appears further to be definitely established that the mobility of the light field howitzer should be practically the same as that of the light field gun.

The British Army was equipped with a 4½" howitzer, firing a projectile weighing 35 pounds and with a maximum range of 7700 yds.; the weight of the howitzer limbered is 4676 pounds—150 pounds more than the weight of the 18-pdr. field gun—no evidence was found that the British government intended making any alterations in the design of this howitzer; naturally, they will attempt to increase the range, power and accuracy of the projectile by change in its weight, its capacity and its co-efficient of form. During the war the proportion of 4½" howitzers to 3.3" field guns was 33⅓ per cent.; 25,000,000 rounds were fired from 4½" howitzers as compared with 100,000,000 rounds fired from the 3.3" field guns.

The French artillery was not equipped with the light field howitzer of approximately the same weight as the 75 mm. field

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gun. * * * During the war it was found impracticable to construct a light howitzer without interfering with the production of other calibers which were considered more important.

In the earlier stages of the war the Italian artillery was not equipped with a light field howitzer; however, before the end of 1917 orders were placed for several hundred 105 mm. howitzers. * * * It should be noted that several hundred howitzers of this caliber were being constructed before the armistice and that many have been captured from the Austrians by the Italians; this, so far as the Italians are concerned, makes it certain that a light field howitzer will be furnished the Italian Army.

The German and Austrian armies were equipped with a howitzer of the light field type; this weapon had a caliber of 105 mm., firing a projectile weighing 34.54 pounds at a maximum range of 10,500 yds. (stream line shell). The weight of the howitzer limbered was 4500 pounds.

In the opinion of the board, the Germans have proceeded on sound principles in their development of the light field howitzer. Their '98 model was a companion piece for their '96 field gun and in the years that passed from 1898 until 1916 which included their early war experience they kept to the idea of the relation of the two pieces even to the extent of including in a field artillery regiment one battalion of the light howitzers. Their 1916 models of both light gun and howitzer show the endeavor to keep the pieces in the same class; that is, the weight of gun and howitzer in action nearly the same, 2750 lbs. and 2700 lbs.; the weight of the gun limbered and howitzer limbered the same, 4500 lbs.; the elevation of both the same—minus 10 to plus 40 degrees; the carriages are the same type; and the extreme ranges of gun and howitzer are respectively 11,700 yards and 10,500 yards.

From the above it is seen that all the important belligerents except the French and the Americans were equipped with a light field howitzer firing a projectile about twice the weight of the light field gun projectile and having otherwise the same

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general characteristics. There is no evidence to show that the fire of the French and American artillery was not fully as effective as that of any other artillery; however, the testimony of the French and American artillery officers is to the effect:

(a) That the lightest howitzer in use, *i.e.*, the 155 mm. gun, was not sufficiently mobile to be a suitable companion piece for the 75 mm. gun.

(b) That many times the fire of the 75 mm. gun proved ineffective due to its flat trajectory; a howitzer would have been more effective in the attack of certain targets.

(c) That a large volume of fire is necessary.

(d) That while the 155 mm. howitzer is more powerful than the lighter field howitzer, its consumption of ammunition for many purposes is wasteful and extravagant and its volume of fire is insufficient.

(e) That the light howitzer is particularly suited for the destruction of wire entanglements; its better accuracy and more powerful projectile make it more suitable than the field gun for this purpose.

(f) That the 75 mm. field gun projectile is not so satisfactory a gas vehicle as the howitzer projectile which has greater weight.

(c) *The Medium Field Gun*

16. The consensus of opinion of artillery officers—Italian, English and American—is that a medium caliber field gun, *i.e.*, a caliber between the light field gun and the field gun of about 6" caliber, is necessary.

* * * * *

The medium type gun furnished to the American Army was the 4.7" (Model 1906). This gun has a maximum elevation of 15 degrees, with a corresponding maximum range of 8700 yds.

The British army was equipped with the 5" gun—the carriage permits a maximum elevation of 21 deg., 30 min., giving a maximum range of 12,500 yds.

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The French army was equipped, to a certain extent, with the 105 mm. and the 140 mm. gun. The 105 mm. gun has a maximum elevation of 37 degrees, with a maximum range of 13,900 yds. The 140 mm. gun has a maximum elevation of 30 degrees, and, with a high velocity, has a maximum range of 19,500 yds. The French 105 mm. gun is a modern weapon (1913).

The German artillery was equipped with a 105 mm. gun (Model 1917) with a maximum elevation of 45 degrees, and a maximum range of 16,000 yds. The German artillery was also equipped with the 130 mm. gun, having a maximum range of 16,500 yards. The Austrian artillery was similarly equipped.

The Italians were equipped with a 105 mm. gun essentially of the same characteristics as the French 105 mm., Model 1913.

(d) *The Medium Field Howitzer*

17. In the opinion of the French, the Italians, the British and the Americans, the 155 mm. howitzer (Schneider) was conspicuously successful in the present war. It should, therefore, be retained as a type.

The howitzer and carriage, as it stands at present, is a highly satisfactory and efficient piece of armament. For the future it is believed that effort should be made to increase the range by improvements in the form of projectile, and it is believed that the form of howitzer and carriage should be studied with a view of obtaining, through modifications, a maximum range of approximately 16,000 yards.

Many batteries of 155 mm. howitzers (Schneider) were motorized in the American army in France, and the consensus of opinion is definitely toward the retention of this form of prime-mover.

It is interesting to note that all of the important belligerents have settled upon a howitzer of approximately 6" in caliber, and otherwise essentially of the same ballistic characteristics as the type in question.

The projectile of this caliber is the smallest projectile which

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can be called upon to give adequate mining effect against material targets of semi-permanent nature. The place of this howitzer is, therefore, determined by considerations of its destructive ability. It is a splendid destruction and neutralizing weapon.

(e) *The Heavy Field Gun*

18. The consensus of opinion of all artillery officers—English, Italian and American—is that the heavy field gun should be of approximately 6" caliber, and that guns greater than this are necessary in limited numbers for field operations. The French were constructing 194 mm. guns during the latter stages of the war. It is believed that in developing this type of gun the French were actuated almost entirely by the necessity for increased range, since the German 150 mm. gun, Model 1916, outranged the G. P. F. by approximately 5500 yds. The French have recently made considerable progress in securing the necessary increase in range with the G. P. F.

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All of the principal nations engaged in the war used a heavy field gun of approximately 6" caliber. This type has given such general satisfaction that its continuance is assured. The principal missions of the heavy field gun are harassing and interdiction fire, and for these uses the 6" projectile is sufficiently heavy.

The maximum practicable traverse and elevation should be provided by the carriage for the heavy field gun. The G. P. F. carriage has given general satisfaction, but its wide tread and the excessive time required to occupy a position are very objectionable features.

It is the consensus of opinion of all artillery officers—French, British and American—that the heavy field gun should be of approximately 6" caliber with a range in excess of 25,000 yds., with not less than 60 degrees traverse, weighing not more than 12 tons limbered, capable of occupying and leaving a position quickly, and with a width of tread which does not prevent two-way traffic in ordinary roads. The Italians differ from

this opinion only in that they are satisfied with a maximum range of 18,000 yards.

(f) *The Heavy Field Howitzer*

19. No type of heavy field howitzer developed during the war has given general satisfaction. The consensus of opinion of all artillery officers—French, British and American—is that two calibers of field howitzers are necessary, one a companion piece for the 6-inch gun and one of the maximum possible power consistent with the necessary mobility. The lighter of these two howitzers should have the same mobility as the 6" gun, with a caliber of about 8" and a maximum range of not less than 16,000 yds. The heavier field howitzer should be of about 9.5 inches caliber with a range in excess of 16,000 yds.; the carriage should provide for wide traverse and must have sufficient mobility to accompany an army in the field. It will probably be necessary to transport this howitzer in more than one load, and the maximum weight of any load should not exceed 12 tons. The average time necessary for occupying a position should not exceed six hours under actual field conditions.

(g) *Super-heavy Guns and Howitzers*

20. The war has demonstrated the necessity for long range and powerful guns for distant interdiction and harassing work and for super-heavy howitzers for the destruction of semi-permanent fortifications. Artillery of these types can best be mounted on railway carriages and this type of mount offers no serious disadvantages since these guns will not be used except with large forces which require extensive railroad systems for their supply. This does not apply to guns of the type used to bombard Paris; such guns have no military value and their construction is not justifiable.

The British have got satisfactory results from their 9.2" gun and their 12" howitzer and their 14" gun on the Armstrong mount. The French have used a large variety of guns on railroad mounts and during the last year of the war were constructing a considerable number of very long range weapons. While

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admitting that we may never be engaged in another war in which operations assume exactly the form which for so long existed on the Western front, it is the consensus of opinion of artillery officers—American, French and English—that railroad artillery is a necessity in operations that will invariably result when large forces are engaged. These types are needed in limited quantities, considering the needs of Field Armies only, and should be of four calibers: an 8" gun with all round fire, a maximum range of 35,000 yards and capable of being transported on a narrow gauge track; a 14" gun with a range of 40,000 yards and limited traverse; a howitzer of about 12" caliber, with a range of not less than 25,000 yards and a 360 degree traverse, and a 16" howitzer having a maximum range of not less than 27,000 yards and with limited traverse. Of these types the 8" should predominate in number.

These types will not only be needed in field operations but also in the initial contact with the enemy at the coast line and boundaries. The latter use should determine the exact characteristics and numbers of these guns and howitzers and the numbers to be assigned to the general artillery reserve will depend on the general military situation as viewed by the High Command.

III. IMPROVEMENTS IN DESIGN AND CONSTRUCTION OF PROJECTILES

21. Great thought has been devoted to this subject during the war and many experiments have been made. It may be stated that the general laws governing the design of projectiles for maximum ballistic efficiency have not been formulated and, in fact, there is at the present time insufficient data upon which to proceed. The false ogive, boat-tailing, alterations in the shape and location of rotating bands have greatly increased the range of modern projectiles, but there are critical points in each of these modifications at which improvement ceases. There are investigations under way by the Ordnance Department covering this entire subject and the Board recommends that these be

continued. It is to be expected that this subject will require extended investigation and is one which can only be adequately handled by a continuing technical body.

22. The development of the mechanical time fuse should be actively prosecuted. This fuse is particularly valuable for high altitude trajectories, but the powder train fuse as now manufactured must be continued for bulk production on account of the almost negligible manufacturing capacity existing or likely to exist for the mechanical fuse.

23. The Board desires to emphasize the necessity for making fuses for high explosive shell bore-safe. The French type superquick fuse is seriously defective in this regard. The destruction of cannon due to premature bursts during the past war has been enormous, due largely, in the opinion of the Board, to the use of this fuse.

24. It is especially desirable to reduce the types of fuses issued to any single organization. In the past war the 75 mm. shells were normally supplied with four varieties of fuse ranging from the super-quick to the long delay. The evidence before the Board is to the effect that this is an unnecessary complication, and it is recommended that the number be reduced to two. A similar policy has been followed in all other calibers.

25. It has been considered fundamental that all guns be furnished with a type of projectile which will give the maximum range, and that all howitzers except the 105 mm. be furnished with a type of shell to carry the maximum bursting charge. It has also been considered that semi-steel (cast-iron) projectiles should be supplied for production reasons in the most important calibers requiring enormous quantity production. It is considered that the semi-steel projectiles have proved efficient against animate targets and are reasonably satisfactory against matériel where burst above the ground is desired.

26. In connection with fuses, by "super-quick" the Board means a fuse which will burst the projectile above the ground without any crater whatever. By "instantaneous" is meant a fuse which will burst the projectile on the outside of a hard

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surface such as a concrete emplacement before penetration or ricochet. This fuse will give some crater on hard ground. By "short delay" is meant a fuse which will burst the projectile on ricochet, preferably at a height of about 6 to 10 feet. Some crater effect will be obtained on hard ground but the fuse is desired for ricochet effect. By "long delay" is meant a fuse which will burst the projectile after complete penetration into hard ground. Obviously there will be a variation in the time element in long delay fuses required for such different types as a 155 mm. howitzer projectile and a 16-inch howitzer projectile in order to obtain in each case the maximum mining effect. This is a question to be determined by the Ordnance Department.

27. The Board has purposely used the term "super-charge" in referring to the propelling charge required in the case of guns to give the maximum ranges. It cannot be too strongly emphasized that the normal charge should be used always within the maximum ranges obtainable with it and the use of supercharges must be prohibited except where necessary, otherwise the wear on the guns will become inadmissible.

28. The Board desires to point out the defects in nitrocellulose powder. This powder takes up moisture from a damp atmosphere and deteriorates in its ballistic qualities. It requires elaborate and expensive containers and, even with the containers which have been provided, large quantities of powder have been rendered unfit for service. A powder containing nitroglycerine or similar compounds can be used in simpler containers and will tolerate adverse conditions of moisture.

IV. TYPES OF ARTILLERY RECOMMENDED; IDEAL AND PRACTICAL

Light Field Artillery

29. (a) Gun. Ideal. A gun of about 3" caliber on a carriage permitting a vertical arc of fire of from minus 5 degrees to plus 80 degrees, and a horizontal arc of fire of 360

degrees; a projectile weighing not over 20 pounds, shrapnel and high explosive shell of satisfactory man-killing characteristics with maximum range of 15,000 yards; fixed ammunition; smokeless, flashless propelling charge; time fuse for shrapnel; bore-safe, super-quick and selective delay fuses for shell. The high explosive shell should be of one type only. It should be designed for maximum ballistic efficiency and should contain the maximum bursting charge compatible with that object. For cheap manufacture a semi-steel shell may be furnished, provided it has the same exterior ballistics as the standard shell. Two propelling charges should be furnished, a normal charge for about 11,000 yards range and a super-charge for maximum range. The proportion should be 90 per cent, of the former and 10 per cent, of the latter. The ballistics of the shell and shrapnel should be the same, if practicable; the ballistics of the round of ammunition should be the same regardless of the type of fuse used. A maximum rate of fire of 20 rounds per minute is deemed sufficient.

30. Practical. For the present arm brigades with 75 mm. material, Model 1916 . . . 50 per cent., and 75 mm. (French). . . . 50 per cent. Continue experiments on carriage types, perfecting the split-trail carriage and studying the subject of a carriage for all round fire; continue experiments with projectiles for increase in range, power and accuracy. Our time fuse is as satisfactory as any at the present time, but a mechanical fuse should be perfected. There is no requirement at the present time for more than one variety of delay action fuse for the 75 mm. gun. For shell the super-quick and short delay fuses only are required. The present super-quick fuse must be made bore-safe. It is not satisfactory in its present form. For motorized regiments rubber-tired wheels are required.

31. Transport. Ideal. Mechanical transport is the prime mover of the future. It is most important that design, experiment and test of self-propelling caterpillar types, also of caterpillar for draw-bar pull, of wheeled trailers for long rapid hauls,

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and of the development of similar ammunition vehicles, be vigorously pushed. For normal use a maximum speed of 12 miles per hour is sufficient. The introduction of mechanical transport will undoubtedly cause far-reaching changes in the types of gun carriages. It is not possible now to state just how far this will go or whether a gun mounted on a self-propelled vehicle or one mounted on some type of trailing vehicle, will be the final result. Both types may be necessary. It is urgent that study and development be vigorously carried on along these lines, as we are on the verge of changes fully as radical as the introduction of the long recoil field gun carriage, and the country first utilizing the new capabilities opened up by mechanical traction and the caterpillar, will have a great advantage in the next war. A limit of 4500 pounds behind the team has heretofore been universally imposed on artillery of this class. The corresponding limit in the future will probably be that imposed by pontoon bridges.

32. Practical. While there is no question that the tendency is towards complete motorization, the Board, from a result of its investigation, does not feel justified at the present time in recommending complete motorization of all division artillery. Therefore, it is thought that four regiments of 75 mm. guns (two regiments of French Model 1897, and two regiments U. S. Model 1916) should be immediately motorized; the remainder to be horsed; mechanical transport to gradually replace horse only after the tractor demonstrates its superiority in service. There are various limitations and imperfections in our present tractor equipment which it is believed can only be fully determined by a daily use of this equipment in service.

33. (b) Howitzer. Ideal. A weapon of about 105 mm. caliber on a carriage permitting a vertical arc of fire of from minus 5 degrees to plus 65 degrees, and a horizontal arc of fire of 360 degrees. Efforts should be made to develop a carriage which can be used interchangeably for the division light gun referred to above and this howitzer. The projectile should weigh about 30 to 35 pounds and should include both shrapnel

and shell. A maximum range of 12,000 yards will be satisfactory. Semi-fixed ammunition and zone charges should be used, otherwise the ammunition should be similar to that provided for the 75 mm. guns.

34. Practical. For the present, brigades should be armed with the 155 mm. howitzer, Schneider, but active development and test should be prosecuted on a type as stated under "Ideal" above, and with ammunition and other accessories to it. Upon the development of the carriage as nearly approximating the ideal as may be practically possible, efforts should be made to secure quantity production in order that it may be incorporated in the division artillery as recommended. In addition a split-trail carriage for this howitzer should be developed.

35. Transport. The light howitzer should have the same means of transport as the light field gun and the same remarks heretofore made as to the probable future development of the field gun also apply to the howitzer carriage. For the present the 155 mm. Schneider howitzer regiments should be motorized. All testimony before the Board and all investigations of the Board emphasized the necessity of this.

Medium Field Artillery

36. (c) Gun. Ideal. A caliber of between 4.7" and 5" on a carriage permitting a vertical arc of fire of from minus 5 degrees to plus 80 degrees; a horizontal arc of fire of 360 degrees. Shrapnel and shell weighing not over 60 pounds; maximum range 18,000 yards; with semi-fixed or separate loading ammunition permissible. The normal charge should be established for about 12,000 yards. Propelling charge should be smokeless and flashless. The fuses should be time for shrapnel, with bore-safe, super-quick and selective delay for shell. One type of shell designed primarily for maximum ballistic efficiency is sufficient. It should contain as large a bursting charge as possible. A normal propelling charge for 12,000 yards should be established with a super-charge for maximum range. The proportion should be 80 per cent. of the former

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and 20 per cent, of the latter. A maximum rate of fire of six rounds per minute is considered sufficient. The limits of weight formerly imposed on this class of matériel by horse traction will no longer exist, and while the Board is not prepared to set a definite limit of weight for future development, it is believed that it may be safely assumed to be not less than 12,000 lbs. for wheeled vehicles or 15,000 lbs. for caterpillars. A normal maximum speed of 8 miles per hour is considered sufficient.

37. Practical. Corps artillery should be armed with the present type 4.7 inch gun, Model of 1906, except that at least one regiment should be armed with the British type 5-inch guns purchased abroad. The Board is influenced in this decision by the quantity of ammunition on hand. It would have been recommended that the bulk of the artillery be armed with the British gun except that it is believed that the large stock of 4.7-inch ammunition on hand must be utilized. In any case, as there will be a large quantity of both types of material on hand for use in an emergency for a considerable period of time, it is believed that both types should be continued in service in order that the field artillery may retain their familiarity with them. The remarks made in regard to the development of a type of carriage under the division field gun also apply to the corps gun and, in addition, it is believed that experimental work should be carried on with a view of developing a satisfactory split-trail carriage. Experiments with projectiles for increase in range, power and accuracy and development of fuses should be carried on as outlined for the division gun. The types of fuses recommended for the division gun apply also to the corps gun.

38. Transport. All corps guns should be fully motorized and wheeled trailers should be developed for long rapid hauls. Similar ammunition vehicles should be developed. The wheels for the gun carriage should be rubber-tired.

39. (*d*) Howitzer. Ideal. A caliber of about 155 mm. on a carriage permitting a vertical arc of fire of from minus 5 degrees to plus 65 degrees; and a horizontal arc of fire of 360

degrees. It would be desirable to develop a carriage which can be used interchangeably for both corps gun and howitzer. The projectile should weigh not over 100 pounds and should be interchangeable with projectiles for other guns of this caliber referred to later on. High explosive shell only should be supplied. Two types of shell should be provided—one for maximum bursting charge and one of comparatively inexpensive manufacture which may contain less explosive; the ballistics of both should, if practicable, be the same. The proportion should be 70 per cent, of the former and 30 per cent, of the latter. Maximum range should be 16,000 yards. Ammunition should be separate loading, and related zone charges smokeless and flashless. Bore-safe, super-quick and selective delay fuses for shell. The maximum rate of fire should not be less than 5 rounds per minute. A split-trail carriage should be developed, interchangeable if practicable with that for the corps gun. Maximum speed the same as that of the corps gun, *viz.*, 8 miles per hour.

40. Practical. The corps should be armed with the 155 mm. Schneider howitzer referred to above. The types of fuses for shell should be super-quick and long delay.

Heavy Field Artillery

41. (e) Gun. Ideal. A caliber of about 155 mm. on a carriage permitting a vertical arc of fire of from 0 degrees to plus 65 degrees; with a horizontal arc of fire of 360 degrees. A projectile weighing not over 100 pounds which should be interchangeable with that provided for the corps howitzer. High explosive shell only should be furnished. The self-propelled caterpillar unit offers a promising field of development for this type of gun, but a certain proportion should be retained on rubber-tired wheeled mounts for rapid transportation; the maximum speed for the former type should be 6 miles per hour and for the latter type 12 miles per hour. Ammunition should be carried in original containers in trucks and tractor caissons. The conventional type of caisson is considered uneconomical

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and is obsolete for this caliber. The maximum range should be about 25,000 yards. A normal charge for range of 18,000 yards should be provided, with super-charge for greater ranges. The ammunition should be separate loading and the propelling charge smokeless and flashless; with bore-safe, super-quick and selective delay fuses for shell. The shell should be of two types: a shell of maximum ballistic efficiency with fair-sized bursting charge (50 per cent.); and a shell of inexpensive manufacture with as large bursting charge as practicable, interchangeable with the 155 howitzer shell (50 per cent.).

42. Practical. Arm with the present type 155 mm. G. P. F. and carry on experiments for type of carriage as outlined for division field gun. The fuses should be super-quick and short delay.

43. Transport. All artillery of this type should be motorized and test and experiment for ammunition vehicles to correspond with the types of carriages developed, should be carried on simultaneously.

44. (f) Howitzer. Ideal. A caliber of about 8" on a carriage permitting a vertical arc of fire of from 0 degrees to plus 65 degrees; and a horizontal arc of fire of 360 degrees. It would be desirable to develop a carriage which can be used interchangeably for the 155 mm. gun and the 8" howitzer; projectile should weigh not over 240 lbs.; the maximum range should be 18,000 yards; ammunition, separate loading; related zone charges, smokeless and flashless; shell only should be furnished which should be of two types, one of maximum capacity for bursting charge (50 per cent.), and one of comparatively cheap manufacture with fair size bursting charge (50 per cent.). For fuses, bore-safe, super-quick and selective delay should be furnished.

45. Practical. Use at present 8" material of British design which is on hand. The caterpillar treads which have been experimentally substituted for wheels are considered to be an advance and it is recommended that two batteries be so equipped for

service test at once. Two types of fuses are required; the super-quick and the long delay.

46. Transport. All this material should be fully motorized. Ammunition should be carried in trucks and tractor caissons. A maximum speed of four miles per hour is sufficient.

Weapons of Greater Power

47. (g) Heavy guns. Ideal. There will be missions requiring the use of direct fire and of a projectile weighing more than that of the 155 mm. gun referred to above. Guns will also be required having a range of more than that considered feasible for the 155 mm. gun and there should, therefore, be provided a limited quantity of guns of a caliber of about 194 mm. to 8 inches firing a projectile weighing about 220 pounds. The maximum range should be 35,000 yards. The ideal carriage for such a gun would conform in its general characteristics to those outlined above for the 155 mm. gun, and such a gun and carriage should be developed and tested until a satisfactory type is evolved. The projectile should be high explosive shell of maximum ballistic efficiency. The fuses should be super-quick and short delay. Suitable ammunition vehicles should be evolved and they should be the same as for the 8" howitzer referred to above. The type of equipment overlaps in its use the field of the 8-inch gun referred to hereafter on a railway type of mounting. The Board has in mind the development of a caterpillar carriage in this case, and while the weights involved appear large for a road type of mount, it is in the general line of development and is one which must be followed out. No gun of this power and weight has so far been arranged for road mounting by any foreign country.

* * * * *

48. (h) Heavy howitzer. Ideal. A caliber of about 9½ inches on carriage permitting vertical arc of fire from 0 degrees to 65 degrees and a horizontal arc of fire of 360 degrees. The carriage should be of a type requiring as little preparation for

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firing as possible. No type of road mount is known which is satisfactory in this respect, but the Board has in mind the development of a caterpillar type. The maximum speed need not exceed 6 miles per hour. The maximum load should not exceed 20 tons. A certain percentage should be on wheeled mounts and the loads divided so that the maximum on four wheels will not exceed 12 tons. A projectile weighing not over 400 pounds, high capacity, high explosive shell, with maximum range of 25,000 yards, separate loading, related zone, smokeless flashless propelling charges, fuses bore-safe instantaneous and selective delay. Three kinds of high explosive shell are permissible: (a) One to secure the maximum ballistic effect with as large a bursting charge as practicable; (b) one with maximum bursting charge; (c) one of comparatively cheap manufacture with fair size bursting charge.

49. Transport. Ideal. Mechanical transport, caterpillar drawn. Continue experiments on caterpillar mounts with the idea of developing a satisfactory type. Corresponding ammunition vehicles should be developed.

50. Practical. The present design of 240 mm. howitzer should be continued in service. It is unsatisfactory in the length of time required to emplace for firing, but it represents modern practice reasonably well. The super-quick and long delay fuses should be furnished.

51. (i) Super-guns. In the design of all artillery of this class, it is essential that the Seacoast Defense problem be considered, since this type of artillery should be suitable not only for use in the field, but also for use along our coast against naval targets. For this reason, all carriages should be provided with means of obtaining all around fire, either from a position previously prepared, or from a temporary platform. This feature of all round fire in the case of large guns and howitzers, will doubtless be in addition to the regular means provided for firing the mount in the field against the stationary target. The design of the carriages should be studied with the view of obtaining a universal barbette mount that could be emplaced in the

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present seacoast emplacements, in simple auxiliary emplacements and with trucks under it forming a railway mount.

52. Gun. Ideal. A gun of 8-inch or 10-inch, 50 calibers in length, on railway carriage, permitting a vertical arc of fire of from 0 degrees to 50 degrees, a horizontal arc of fire of 360 degrees, a high explosive projectile weighing not less than 240 pounds for 8-inch or 510 pounds for 10 inch, with a maximum range of not less than 35,000 yards. Separate loading ammunition, smokeless flashless charges, bore-safe, instantaneous and selective delay fuses. Maximum time for occupying a position under actual field conditions should not exceed one hour for the 8-inch or four hours for the 10-inch. The maximum rate of fire should not be less than one shot every two minutes.

53. Transport. Railway carriages adaptable for transportation over standard gauge track (carriages should be equipped with narrow gauge trucks, 60 cms. (24"). Axle load should not exceed 17 long tons per axle. The mount should lie entirely within the International Clearance Diagram, and thus be suitable for transportation over European railways. Provision for both American M. C. B. standard couplings and the French type of couplings should be provided.

A gas electric locomotive of about 400 horse power capable of speeds up to 25 miles per hour should be developed for use with this type of artillery. Ammunition cars suitable for the storage of powder and projectiles are required. A complete repair shop should be provided. Tool equipment to be capable of making repairs on this type of artillery.

54. Practical. There are now being completed in the United States, 36 railway carriages of the Schneider type for mounting the 10-inch Seacoast guns, permitting a vertical arc of fire from 10 degrees to 55 degrees. The gun gives an estimated range of 24,000 yards with a 510-pound projectile. Also 37 8-inch guns have been mounted on railway mounts of the above characteristics except as to range. Range of these 8-inch guns with 200-pound projectiles is 20,000 yards. Arm units with these available on railway mounts. An experimental

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8-inch 50-caliber railway mount, or 10-inch 50-caliber railway mount, should be manufactured in order that the proper type may be selected.

55. Gun. Ideal. A 14-inch gun 50 calibers long on a railway mount, permitting a vertical arc of fire from 0 degrees to 50 degrees, and a horizontal arc of fire of 360 degrees, from prepared position, or to 15 degrees when fired from curved track; a high explosive shell weighing not more than 1400 pounds with a maximum range of 40,000 yards, separate loading ammunition, smokeless flashless charges, bore-safe instantaneous and selective delay fuses. Time required for firing from prepared position not to exceed one hour. From unprepared position not to exceed 8 hours.

56. Practical. Arm units with available guns on railway mounts.

57. (j) Howitzer. Ideal. A 12-inch howitzer 20 calibers in length on carriage providing vertical arc of fire from 25 degrees to 60 degrees and a horizontal arc of fire of 360 degrees. A high explosive shell weighing about 700 pounds with a maximum range of 25,000 yards, or a 1046 pound shell with a maximum range of about 18,000 yards. Related zone charges, smokeless flashless powder, bore-safe instantaneous and selective delay fuses. Time to occupy field position not to exceed one hour, for all around fire.

58. Transport. Ideal. Same as above.

59. Practical. Arm units with available howitzers on rail-mounts.

60. Howitzer. Ideal. Sixteen-inch 25-caliber howitzer mounted on railway mount permitting a vertical arc of fire from 25 degrees to 65 degrees. A horizontal arc of fire of 360 degrees from a prepared position or 10 degrees from a temporary position. High explosive shell weighing not less than 1600 pounds with a maximum range of 30,000 yards, related zone charges, smokeless flashless powder, bore-safe instantaneous and selective delay fuses.

61. Transport. Ideal. Same as above.

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62. Practical. The manufacture of a pilot 16-inch 25-caliber howitzer on railway mount should be inaugurated.

Other Artillery

ANTI-AIRCRAFT GUNS

63. (k) In the recommendations of the Board under the heading "Ideal" it will be noted that the maximum elevation stated to be desirable has been made 80 degrees for the Division and Corps guns and 65 degrees for the heavier types. This is in view of the greatly increased air activity to be expected in the future and is with the expectation that the division and corps guns will be often used against airplanes and the heavier types against balloons. These ideal types are, however, not yet practical and the following special anti-aircraft equipments are necessary. Moreover, special anti-aircraft weapons will probably always be required on account of the need for a higher initial velocity than is permissible in a general purpose gun.

64. Light gun. Ideal. Caliber of about 3-inch with initial velocity of at least 2600 f.s.; semi-automatic breech block, mounted on carriage, permitting 80 degrees elevation and 360 degrees traverse; projectiles weighing not less than 15 pounds, of one type high explosive shell with maximum ballistic qualities and as large explosive charge as possible; fixed ammunition; smokeless flashless powder, mechanical fuse. In this type every effort must be made to increase rate of fire and decrease time of flight; this latter is limited only by considerations of a reasonable accuracy life for the gun.

65. Practical. Arm units with present 3-inch anti-aircraft equipment; continue experiments leading to the development of the ideal.

66. Transport. Ideal. Caterpillar mount or caterpillar trailer mount drawn by caterpillar tractor, each unit to permit a sustained speed of 12 miles per hour.

67. Heavy gun. Ideal. A caliber of 4.7 inches to 5 inches, with initial velocity of at least 2600 f.s.; semi-automatic breech

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block; mounted on a carriage, permitting 80 degrees elevation and 360 degrees traverse; projectiles weighing not less than 45 pounds; one type high explosive with maximum ballistic qualities and as large bursting charge as practicable; fixed ammunition; smokeless flashless powder; mechanical fuse. In this type every effort must be made to increase rate of fire and decrease time of flight; this latter is only limited by a reasonable accuracy life to be obtained for the gun.

68. Practical. Arm units with present 4.7-inch anti-aircraft gun and continue experiments leading to the development of the ideal.

69. Transport. Ideal. Self-propelled caterpillar mount permitting sustained speed of 8 miles per hour with maximum weight not to exceed 10 tons, trailers to be provided for long and rapid hauls.

PACK ARTILLERY

70. (*l*) Gun. Ideal. A caliber of about 3 inches; to use projectiles of division gun, if possible; to permit elevation of at least 45 degrees; a range of not less than 5000 yards; to pack in loads about 225 pounds per load exclusive of pack equipment; to be equipped with panoramic sight; ammunition semifixed, flashless, smokeless, with about four zones; capable of being pulled on wheels by the gun crew on normal ground, and for short distances over any ground. A shield is unnecessary.

71. Practical. Continue the present 75 mm. Vickers equipment in service. The material is, however, of an old type and it is one of the items of artillery in most urgent need of development.

INFANTRY ACCOMPANYING GUN

72. (*m*) Gun. Ideal. A gun of about 2.5 inches caliber firing a projectile of about 10 pounds weight, mounted on a carriage, permitting elevation of from minus 5 degrees to plus 50 degrees and having a field of fire of not less than 6 degrees. The carriage should be designed so that it may be divided into

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loads, the maximum of which should not exceed 100 lbs. The gun and carriage complete to weigh not more than 300 pounds and to be arranged so that it can be readily hauled by two men over sod. The complete equipment must be capable of being man-handled in trenches. The gun should be effective for direct fire at 2500 yards. A telescopic sight should be furnished and the ammunition should consist of high explosive shell with maximum bursting capacity and instantaneous fuse. A cannon similar in general but of less power was examined in Italy and two equipments with 6000 rounds of ammunition were ordered through the Military Attaché's office in Rome.

73. Practical. Utilize the present 37 mm. guns on hand. These are deficient in the fact that the projectile is too light. In the opinion of the Board a cannon of the type described above would have the mobility of the 37 mm. gun and would provide in addition a most desirable substitute for the 3-inch Stokes trench mortar as used in the present war.

74. Transport. These equipments will be handled by men only, except on the march when they should be loaded in trucks.

TRENCH ARTILLERY

75. (n) As stated, the Board is of the opinion that the infantry accompanying cannon can be made to serve the purpose of the light trench mortar as used in the present war. It is believed that a field exists, in addition, for a trench mortar of about 6-inches caliber firing a projectile weighing about 50 pounds and having a maximum range of about 4000 yards. So far as known, such a mortar has not been developed. It is recommended that experiments along this line be carried on. The mortar should be fired at elevations of from 40 degrees to 65 degrees. The 6-inch Stokes mortar used in the present war is not considered satisfactory, due to its lack of range and its great weight; also its type of mounting was such that a change in elevation affected the traverse, and *vice-versa*. The principal value of the trench mortar, in the opinion of the Board,

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lies in its cheapness and the rapidity with which a large number may be constructed. Therefore, the greatest simplicity in the design should be maintained.

ANTI-TANK CANNON

76. (o) For tanks as they existed at the end of the past war a caliber 50 machine gun with a bullet weighing about 700 grains, together with the 75 mm. field gun, were efficient. There was being developed armor-piercing ammunition for the 37 mm. gun. In the opinion of the Board, the 37 mm. gun with armor-piercing shot, the caliber 50 machine gun and the 75 mm. field gun, are suitable weapons for the attack of tanks in their present stage of development. There is, however, every reason to expect that the future development of tanks will be along the lines of better armor protection and of carrying more powerful cannon. It is, therefore, anticipated that in the future their development will be such that neither the caliber 50 machine gun nor the 37 mm. gun will be sufficient for their attack. It is believed that their armor protection will be such that it will have to be attacked by a base fuse shell, probably of about 75 mm. caliber. For the present, it is recommended that armor-piercing ammunition be issued for 37 mm. cannon for anti-tank protection, especially as this caliber will be retained for the present as the infantry accompanying gun.

V. ARTILLERY TRANSPORT

General Discussion

77. Mechanical transport is in such a state of development in this country that there is no need in dwelling upon its numerous advantages over animal draft. It is, however, pertinent to give a brief outline of the extent of its employment by foreign governments, while stating that the United States is far in advance of all other world powers in respect to self-propelled vehicles applied to artillery transport.

GERMAN: Wheeled tractors of the farm and road repair

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type, with low speed, great power and extreme weight for hauling heavy weapons.

Wheeled trucks of the two-wheel-drive type with medium speed, medium power and normal weight, carrying anti-aircraft guns, directly and permanently mounted upon the chassis.

ITALIAN: Wheeled trucks, similar to the German as anti-aircraft gun mounts.

Wheeled tractors of two-wheel-drive type, medium power, speed and weight for hauling heavy weapons.

BRITISH: Rear-wheel-drive trucks, four-wheel-drive trucks, and a limited number of the heaviest American commercial farm caterpillars for hauling heavy weapons.

It is noted that these nations confined themselves, for the most part, to wheeled vehicles, which type at once limits mechanical artillery transport almost entirely to good roads.

FRENCH: While using four-wheel-drive trucks of great power and mobility throughout the war the French finally recognized, during 1917, the necessity and advantage of cross-country mechanical transport, as evidenced by their development of platform caterpillars for carrying their 155 mm. howitzer mounted on its wheeled carriage, and for towing other heavier weapons; of cargo-carrying caterpillars for ammunition and other supply purposes; and of self-propelled caterpillar gun mounts for heavier guns.

78. While these nations were employing limited motorization, the whole project appealed to them as a thing apart from animal transport and, apparently, with the possible exception of the French, who later realized the great possibilities of the caterpillar tractor, no idea existed relative to replacing animal draft by the motor-driven vehicle; they considered each a valuable means of bringing the weapon to the proper place at the right time.

79. The United States approached the subject of motorization from the standpoint of obtaining a better means of transport for its artillery than offered by the draft animal. The result has been a mechanism which directly replaces the team in

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draft, giving at the same time a better performance, because of the fact that while animal transport, especially with lighter weapons, possesses great mobility, it does not possess a sustained or persistent mobility; exhaustion surely renders it inactive after a limited period and the time required for recuperation is fatal, if coincident with a critical point in the military operation. This question of exhaustion of animal transport is best illustrated by analyzing the mechanics of the forward push or breaking through, which is the object sought for in the struggle for a military decision. Our offensive military machine must be designed not only to fit every phase in the mission of breaking through but also to remain intact when the breaking through has been accomplished.

80. In the completest conception of an offensive, the machine starts from rest. It is at this time that the offensive mass is at its maximum. The preliminaries in an offensive combat are designed to break down the physical and moral resistance of the enemy, the opposing friction, so to speak, and to make subsequent progress as economical as possible and as rapid as desirable. Motion, or velocity of offensive progress, commences when the enemy's organized resistance begins to yield. It is at this time that the energy—that is, the mass and the movement of the offensive—expresses itself in progress toward the desired goal, namely, the break through.

81. In the second phase, we find the machine in motion. It is now that the varying rates of speed of the different combat agencies begin to impress us most particularly. It is now that the time element, more or less inconspicuous in the first phase, begins to be a dominating one. It is now that transportation—supplies, ammunition, guns, etc. has to move. Infantry will certainly move; across country, it is the most mobile combat agency. Velocity there will certainly be in abundance as the lighter lines progress into the enemy's country, but mass and, therefore, energy will be lacking unless artillery and supplies keep up. An advance goes well enough in the area covered by artillery fire. Beyond the action of artillery, however, the

enemy is unhampered in his defensive and counter-offensive dispositions. The mass of the enemy's resistance increases to a point where it is not possible to penetrate it with a rapidly diminishing offensive mass, no matter how high the velocity of the latter may be. The offensive lacks energy due to the absence of those agencies which made the original advance possible; exhaustion exacts its penalty.

82. During the phase of motion the animal is called upon for its maximum exertion, while receiving the minimum of care. Exhaustion is the natural result and, therefore, as is borne out by the analysis of many experiences of the European War, we may say that against an organized enemy a break through is not possible with animal transport alone.

83. The difference in national ideas of animal and mechanical draft is probably due to the road conditions existing here and abroad, the European having at his disposal a vast network of excellent roads with speed as the only limitation to the horse, his idea of other transport being a fast moving vehicle whose use is merely occasional; on the other hand, the American artilleryman is confronted with roads which are little better than the untraveled cross country. The solving of the transport problems has placed us in a far better position to meet all warfare conditions than other nations because of the fact that we now need not confine our activities to the highways but have at our disposal the vast area of untraveled off-the-road terrain, leaving the roads open for the high speed motor vehicles of the supply departments.

84. In other words, we had developed the use of man and animal power to practically the limit. The use of good roads and the use of railroads is well understood, but now we are in a way to conquer the broadest field, that is, cross country, by the use of mechanical transport, allowing the great duty which was placed on good roads and the railway as avenues for artillery transport to be handled more particularly by cross country mechanisms.

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Gasoline Propelled Vehicles

85. The transportation limitations of the above can be generally stated as follows: The rear wheel drive truck and high speed motor car can be operated on good roads.

The four-wheel drive truck and light motor cars can be operated on almost all classes of roads.

The caterpillar can be operated on all classes of roads and also in the open country.

MOTOR CARS

86. The war has brought about no radical changes in motor cars. About the most that can be said on this subject is that certain commercial cars have shown greater strength of parts and ease of operation than others. They are, therefore, favored for military purposes.

MOTOR TRUCKS

87. When motor trucks were first used for military purposes the commercial types were naturally used. The two-wheel drive type was the first to appear; later, to meet a demand for utilizing to the best advantage the full power, the four-wheel drive type made its appearance in the commercial world. When the two types were tested in the early days of the Mexican Expedition, real dependence was placed on the four-wheel drive trucks, there being instances where whole trains of two-wheel drive trucks were stalled. At a later date when the roads had dried and improved, the two-wheel drive type made a better showing and came out with a better reputation.

88. However, the artillery is most interested in the type of truck that is best suited for bad road conditions. The United States Marine Corps which has had to use motorized field artillery for some of its minor operations adopted, after many tests, the four-wheel drive truck to handle its artillery. Throughout the entire war, the English, French and Russian Governments purchased considerable quantities of trucks driven on all four

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wheels for use in their artillery service, and as late as July, 1918, the French made an urgent demand on the American E. F. for 300 such trucks. The four-wheel drive truck has such power, application and weight distribution as to assure movement of the vehicle if traction can be obtained even by one wheel.

89. Up to the fall of 1917, there had not been found a type of four-wheel drive truck as refined in mechanical detail as some of the higher types of two-wheel drive trucks. This was natural, as the development of the four-wheel drive truck came later than the two-wheel drive. However, the Ordnance Department undertook the development of a four-wheel drive truck that would not have any of the defects of the four-wheel drive commercial types. This truck was ready for production in May, 1918, and was recommended by a board of officers from practically every department of the service for adoption as the standard type of four-wheel drive truck for the United States Army. (See Par. 30, S. O. 91, W. D., April 18, 1918.)

In the opinion of the Board, the four-wheel drive two-wheel steer type of truck is the only heavy cargo-carrying wheeled vehicle which is adequate to meet artillery needs in the battery, battalion and the regiment as well as in the artillery ammunition train, and until definite recommendation to this effect is approved, artillery will be burdened with a heterogeneous mass of trucks whose use is confined almost entirely to good roads.

CATERPILLARS

90. The superiority of the caterpillar over all other mechanical prime movers across country may be realized when we consider the essential features embodying its construction. The frame supporting the power plant with the necessary power transmission members is mounted upon small wheels; these wheels, instead of having direct contact with the ground, travel continuously upon a track, the rails of which are permanently mounted upon a flat, broad surface. This surface or tread corresponds

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with the sleepers or cross-ties of the railroad, and is of such width as to secure very low unit pressures upon the ground. The track with its tread is formed into an endless belt which is driven by a sprocket identically as the bicycle chain. The whole vehicle, therefore, may be said to constitute a wheeled mechanism which lays its own track as it moves over the ground. Further, by articulating the track and the frames or trucks which mount the wheels, the varied ground surfaces are accurately conformed to a feature which further insures traction. Again, the power is applied in such a manner that an individual drive is assured on each of the two tracks. With such a structure movement is assured over very soft ground owing to low unit pressure, which is usually about 5 lbs. per square inch. The caterpillar can span wide gaps or ditches or climb steep slippery grades. The grip on the ground or traction is secured by cleats or grousers which project to a height of approximately three inches from the surface of the treads. With the grousers removed the caterpillars do not seriously damage hard roads. The above advantages make the caterpillar the only logical prime mover to replace the team in draft.

History of Artillery Motorization in U. S.

91. Serious and practical experiments with the caterpillar for artillery transport were started in the United States by the Ordnance Department in 1914, and the next year a commercial farm tractor of the most promising type was tested by the Field Artillery Board, resulting, in 1916, in the complete re-design of a number of such vehicles to adapt them to artillery field service, and in the actual motorization of one medium heavy battery in this country and one medium heavy regiment in Honolulu. This re-designed caterpillar still contained many small weaknesses, the elimination of which led in 1917 to the development and manufacture of the present artillery tractors.

92. The progress in artillery motorization is best indicated by the recommendations and results obtained by Boards of

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Artillery and Ordnance officers; these recommendations were arrived at after long, careful study, test and investigation, not only in the laboratory but also in the field under simulated and actual war conditions. The authority in each case is given, together with the substance of the recommendations of the various boards.

93. Special Orders No. 98, W. D., 1917, par. 51, appointed a board to "consider the question of motor traction for Field Artillery." This board recommended:

- (a) The motorization of the 4.7" gun.
- (b) The motorization of the 8" howitzer.
- (c) The use of rubber tires on all Field Artillery matériel.
- (d) The formation of a pool of 30 artillery tractors for each combat division.
- (e) Sending a member of the Board to France to investigate the motorization of the 6" howitzer.

These recommendations were approved by the Secretary of War, and the several supply departments were directed to put them into effect.

94. The result of the investigation in France was Special Orders No. 83, par. 7, G. H. Q., A. E. F., 1917, appointing a board to "consider and report upon the question of motor transportation for 6" howitzer matériel."

This board recommended:

- (a) The motorization of the 6" howitzer.
- (b) The retention of the divisional tractor pool.
- (c) The development of motor transport for artillery in all forms.

These recommendations were approved by the Commander-in-Chief, A. E. F., in cablegram 149, paragraph 15, to The Adjutant General, Sept. 11, 1917, and the supply departments were directed to comply.

95. Par. 69, Special Orders No. 242, W.D., 1917, appointed a board to continue the work of the Field Artillery Motor

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Traction Board, "to consider all questions of motor traction for Field and Heavy Artillery."

This board recommended the motorization of:

- (a) The 6" howitzer.
- (b) The 4.7" gun.
- (c) The 9.2" howitzer.
- (d) The 240 mm. howitzer.

The board further recommended:

- (a) The use of wheeled trailers in certain motorized organizations for rapid transport of the tractors.
- (b) The use and general requirements of the staff observation and reconnaissance cars.

These recommendations were approved by the Secretary of War, and the supply departments were directed to comply therewith.

Based upon data collected by the above boards, the General Staff drew up Tables of Organization for motorizing the 155 G. P. F., and the 5-inch and 6-inch seacoast converted guns.

96. An Artillery Board at G. H. Q., A. E. F., after practical test recommended:

- (a) The motorization of 50 per cent. of the 75 mm. gun regiments in each division.
- (b) The motorization of the caisson companies of the ammunition train.

These recommendations were approved by the Commander-in-Chief, A. E. F., in cablegram No. 1771, par. 1, October 9, 1918.

Weapons of various sizes have also been placed on experimental self-propelled caterpillar mounts, namely, the 75 mm. gun, the 155 G. P. F., the 8" howitzer and the 240 mm. howitzer.

97. To date, with the exception of 50 per cent. of the 75 mm. guns in the combat divisions, the motorization of all Artillery mobile weapons has been authorized and would have been put into effect had the war lasted a few months longer, or if ship bottoms had been available during the war. At the cessation

of hostilities in 1918, sufficient tractor equipment had not been delivered in France to carry out this project; this was unfortunate, for many of our artillery personnel had had experience with commercial farm caterpillars, with their serious defects and unadaptability to artillery transport, and had consequently formed erroneous opinions based on such performance. It is, however, interesting to note the reports of those artillerymen who were fortunate enough to have received even a small proportion of the adequate allowance of motor equipment in its present stage of development for artillery purposes.

Types Produced by Ordnance Department

98. The Ordnance Department has, up to the present time, accomplished the following general mechanical development with respect to artillery motor equipment:

- (a) An efficient 10-ton artillery tractor for pulling heavy gun loads has been designed, tested and is in quantity production, *i.e.*, 2800, of which 933 are in France.
- (b) An efficient 5-ton artillery tractor for pulling medium gun loads has been designed, tested and is in quantity production, *i.e.*, 4000, of which 1018 are in France.
- (c) Efficient heavy mobile repair shops have been designed, tested and put into production, *i.e.*, 17 shops of 2 sections each, one of which is in operation in the occupied zone of Germany.
- (d) An efficient artillery repair truck has been designed, tested and is in quantity production, *i.e.*, 1332, 420 of which are in France.
- (e) An efficient 3-ton four-wheel drive truck has been designed, tested and adopted as standard for use in the army.
- (f) Caterpillar tracks to replace wheels on certain heavy guns.

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(g) The following have been designed, built and are being tested:

2½-ton tractor,

Heavy motorcycle for artillery,

Self-propelled gun mounts for various weapons,

Cargo-carrying caterpillars or tractor caissons,

Cargo-caterpillar trailers.

It can be stated with respect to (a), (b) and (c), that the United States is far in advance of all other world powers.

Types Recommended to be Developed

99. The maximum speed for draw bar tractors should fall within a definite scale of approximately 12-8-5-3 miles per hour, with such a total reduction in each case for low gear as to provide a sure means of pulling out under all conditions. It is apparent that when good roads exist and traffic conditions are such as to allow their employment by artillery, a great loss of time is involved where long marches are necessary. The only solution is the employment of sprung, rubber-tired wheeled vehicles to transport the tractors and gun matériel, using a high speed wheeled truck as the prime mover. With such an arrangement, sustained movement over long periods at a speed of 15 m.p.h. may be economically accomplished. At the present stage of development, the trailer is the only available medium, but we can easily conceive of the application of sprung rubber-tired wheels to the tractor as an inherent part of its construction, in such a way as to permit the tractor to be quickly formed into a wheeled trailer; this, however, still requires the use of a wheeled truck as a means of transport—the next and ultimate step is to utilize the power plant of the tractor to drive its self-contained wheels. We will then have a self-propelled vehicle capable of operating as a caterpillar over cross-country terrain and, also, at a moment's notice, capable of conversion into a truck operating at a high speed on good roads.

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100. While improving the caterpillar truck tractor, gun design will also progress; but with the weapon upon its wheeled carriage, a point will soon be reached where no improvement is possible. In all probability such a weapon and carriage will embody the split-trail feature, large angles of elevation and traverse, lightness coupled with stability and high power; but such a unit is not the limit of progress, for we have the broad field presented by the possibilities of the gun mounted directly upon a self-propelled vehicle. Already, the self-propelled caterpillar gun mount is well along in the experimental stage and has passed to fact from fancy, and while the weights are excessive, the gun traverse limited, and slight relaying necessary, the results arrived at indicate final success in the near future. This success will be realized in a gun using, possibly, a pedestal mount, possessing perfect stability, all round fire, 90 degree elevation, mounted upon a caterpillar truck tractor.

101. While it is readily conceivable that in the future all weapons will be so constituted and that experiment should be pushed to the utmost in this direction, it is essential that, for the present, there be developed to the minutest detail the draw-bar vehicles now existing and already in a safe state of perfection, utilizing these to the best advantage in conjunction with the weapons now at our disposal. To carry out this scheme, we must augment the existing equipment along the present lines in order that there may be a suitable range of tractors to move the weapons now in use.

TRACTORS

102. To augment properly the existing types it will be necessary to develop the following:

(a) A small cargo-carrying caterpillar without power plant, to be pulled by two men as a cart, with the tongue operating ratchets to drive the tracks when very difficult terrain is encountered; such a vehicle is primarily an ammunition carrier whose use is necessarily limited to stabilized warfare.

(b) A small unit having wheels or caterpillar treads, driven

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by a very light engine, the whole being operated by a man on foot, total weight being such that it can be readily man-handled by the operator; this vehicle being used for transport of heavy machine guns, infantry accompanying guns, ammunition service, and for laying wire.

(c) A light weight tractor to fulfill the one incomplete detail lacking in motorization, *i.e.*, the motorization of the individual man. This tractor would have a very low center of gravity, 40 inches wide over all, articulated tracks approximately 6 inches by 8 feet, with small body for carrying 2 men or 500 lbs., water-cooled engine capable of operating under water and at all possible tipping angles, with speed ranges from a sure low reduction of 3, 8 direct-drive, 12 over-drive, miles per hour. This tractor to be designed for replacing the horse of individually mounted men, for use in reconnaissance, for pack transportation, including machine and mountain guns, for transport of ammunition, laying wire, etc.

(d) A heavy tractor similar to the present 10-ton type, embodying long track, great power, slow speed, no armor or auxiliary front steering wheel, total weight approximately 15 tons, for pulling loads of 18 tons maximum.

103. In general, the ranges covered by the proposed and existing equipment will appear as follows:

The tractor cart, light loads up to 200 lbs.; the $\frac{1}{4}$ -ton tractor replaces the riding horse or carries loads not exceeding 500 lbs.; the $2\frac{1}{2}$ -ton tractor replaces the six-horse team or hauls loads not greater than 6000 lbs.; the 5-ton tractor replaces the eight-horse team or hauls loads up to 12,000 lbs.; the 10-ton tractor, loads of 24,000 lbs.; and the 15-ton tractor, loads of 36,000 lbs., maximum.

TRUCKS

104. The four-wheel drive truck of 3 tons cargo-carrying capacity is entirely suitable for the corps and army artillery, but due to its weight is not entirely suitable for divisional motorization; for this purpose a four-wheel drick truck of

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approximately 1 to 1½ tons pay load capacity is necessary in order to operate satisfactorily over very bad roads or unfavorable terrain. The tire may possibly be pneumatic 36" × 6", compound filled to prevent puncture, as ordinary pneumatic tires are not recommended for field service cargo-carriers. The need for the development of such a vehicle has been felt for many years in connection with the motorization of the lighter weapons.

TRAILERS

105. Sufficient wheeled trailers now exist to cover practically every requirement, but our great effort should be in the development of the caterpillar trailer. Such a vehicle with a cargo capacity of 1½ tons should be designed, tested and put into production, to replace the 75 mm. gun and light field howitzer caissons in motorized units. A 3-ton cargo caterpillar is now being tested and should be perfected to replace the caissons in 155 mm. howitzer and 4.7" gun units. The horsed sections of the divisional ammunition trains should be replaced by tractors pulling caterpillar trailers.

TRACTOR CAISSONS

106. The self-propelled cargo-carrying caterpillars, while very useful, are deemed of too great weight to apply to division or light corps weapons, but may be advantageous for heavier gun equipment, especially those normally rated at a capacity of 3½ tons, which can readily maneuver over ordinary open country with a load of five tons. The heavier vehicle normally rated as a five-ton carrier is thought to be entirely too heavy.

SELF-PROPELLED GUN MOUNTS

107. While there is great promise for such mounts, those at present in existence and under test are, for the most part, excessively heavy. The most promising at this time is the 75 mm. gun mounted on an approximation of the 2½-ton tractor. This mechanism, when carried on a 4-ton trailer and hauled by the 3-ton four-wheel drive truck, is capable of going over good

ARMAMENT AND TYPES OF ARTILLERY MATÉRIEL

roads at considerable speed, and after being demounted from trailer can proceed across country under its own power. It has, therefore, important strategic and tactical uses.

108. The 155 mm. G. P. F. self-propelled mount also presents immediate possibilities, especially when we realize that to fire, the vehicle simply has to come to rest, with the power plant running, whereas, upon its present wheeled carriage, several hours are normally required to prepare the firing emplacement.

109. These two mounts, the 75 and 155 mm. guns, should be immediately developed to the utmost, paying particular attention to mobility and lightness consistent with strength and stability.

110. Caterpillar tracks replacing gun carriage wheels have been tested here and in the A. E. F. with great success, especially on heavy howitzers. At present they should be applied only to the 8-inch howitzer carriage.

Complete Plan of Artillery Motorization

111. The following tables set forth artillery motor equipment already adopted, that being developed and that proposed to carry out the expansion of the present scheme, together with the application and general characteristics of each:

GENERAL CHARACTERISTICS

CATERPILLAR TYPES

| Vehicle | Draw bar pull lbs. | Cargo capacity | Speed M. P. H. | | Remarks |
|---|--------------------|----------------|----------------|-------|---|
| | | | Min. | Max. | |
| Tractor cart ^{r1} | | 200 lbs. | 1 | 4 | Operated by man on foot. Replaces riding horse of individually mounted man. |
| ¼ T. tractor ^{r1} ..... | ..... | 500 lbs. | 3 | 12 | |
| 2½ T. tractor ^{d1} | 4,000 | | 3 | 11-12 | Replaces caissons in heavy batteries. Not thought practicable due to excessive weight. |
| 5 T. tractor* | 7,000 | ..... | 3 | 8 | |
| 10 T. tractor* | 10,000 | ..... | 3 | 6 | |
| 15 T. tractor ^{r1} | 15,000 | ..... | 1 | 5 | |
| Tractor caisson mark VII ^{d1} ..... | ..... | 3½ T. | 1½ | 4 | |
| Tractor caisson mark VIII ^{d1} | | 5 T. | | | |

* Adopted.

^{d1} Under test and developing.

^{r1} Proposed.

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GENERAL CHARACTERISTICS—*Continued.*

TRAILERS

| | | | | | |
|---|-------|-------|-------|-------|--|
| 3-ton caterpillar trailer ^{d1} | | 3 T. | | | Replaces caissons in medium heavy batteries. Replaces caissons in division artillery. |
| Light caterpillar trailer ^{r1} | | 1½ T. | | | |

WHEEL TYPES.

| | | | | | |
|--|----------|---------|----|----|--|
| Ord. standard four-wheel drive* | 8,000 | 3 T. | 3 | 12 | |
| Light four-wheel drive ^{r1} | | 1-1½ T. | 3 | 15 | |
| Heavy motorcycle with side-car ^{d1} | 500 lbs. | 3 | 50 | | |

TRAILERS

| | | | | | |
|-----------------------|-------|-------|-------|-------|---|
| 3-ton trailer* | | 3 T. | | | Transport of 10 ton tractors, etc., in heavy batteries. |
| 4-ton trailer* ..... | ..... | 4 T. | ..... | ..... |  |
| 10-ton trailer* ..... | ..... | 10 T. | ..... | ..... |  |

APPLICATION.

| | |
|-----------------------------|---|
| <i>Tractor Cart</i> ‡ | Wire Reels Heavy Machine Guns Infantry Accompanying Gun |
| $\frac{1}{4}$ Ton Tractor† | Misc. Pack Transportation Heavy Machine Guns Mountain Guns Replaces horse for individually mounted men Wire Reels |
| $2\frac{1}{2}$ Ton Tractor† | 75. mm. Gun Light Field Howitzer Reel Carts |
| 5 Ton Tractor* | 155 mm. Howitzer 4.7" Gun 9.2" Howitzer } breaking into 3 loads. 240 mm. How. } |
| 10 Ton Tractor* | 8" Howitzer 155 G.P.F. 9.2" Howitzer } breaking into 3 loads. 240 mm. How. } |
| 15 Ton Tractor‡ | Salvage. 5" Seacoast 6" Seacoast 194 mm. Gun Salvage |

* Adopted.

† Under test and developing.

‡ Proposed.

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APPLICATION—*Continued.*

| | |
|---------------------------------------|--|
| <i>Tractor Caisson-Mark VII</i> † | Ammunition transport with battery 155 G.P.F. tractor hauled or tractor mounted, and army artillery |
| <i>3 Ton Caterpillar Trailer</i> † | Ammunition transport with battery 4.7" and heavier guns and howitzers |
| <i>Light Caterpillar Trailer</i> ‡ | Ammunition transport with battery 75. mm. Gun Light Field Howitzer |
| <i>4-Wheel-Drive Standard Truck</i> * | Army and Corps Artillery All Uses |
| <i>Light 4-Wheel-Drive Truck</i> ‡ | Divisional Artillery All uses, including Ammunition Trains |

These charts indicate that certain vehicles are so closely allied that, excepting very special cases, we may follow a general principle of grouping in motorization.

The Division.

2½-ton tractor,
1½-ton caterpillar trailer,
1½-ton four-wheel-drive truck.

The Corps.

5-ton tractor.
3-ton caterpillar trailer,
3-ton four-wheel-drive truck.

The Army.

10-ton tractor,
3½-ton tractor caisson,
3-ton four-wheel-drive truck,
10-ton wheeled tractor for transport of tractors on
good roads.

112. From this general grouping of transport vehicles is formed the following practical table for the general scheme of motorization:

* Adopted.

† Under test and developing.

‡ Proposed.

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| | | | | | |
|---|------------------------------------|---|--|---|--|
| Weapon | Gun transport | Ammunition transport with firing battery | Other battery ammunition transport | Baggage, rations, fuel, water, miscellaneous supplies | B. C. detail, special detail, etc., reels, etc. |
| 75 mm. gun, light field howitzer | 2½-ton tractor | 2½-ton tractor and 1½-ton caterpillar trailer | 2½-ton tractor and 1½-ton quad truck, 1½-ton caterpillar trailer | 1½-ton quad truck | ¼-ton tractor and caterpillar cart and 2½-ton tractor with reel cart |
| 4.7" gun, 155 mm. howitzer | 5-ton tractor | 5-ton tractor and 5-ton caterpillar trailer | 5-ton tractor and 3-ton caterpillar trailer and 3-ton quad truck | 3-ton quad truck | ¼-ton tractor and caterpillar cart and 2½-ton tractor with reel cart |
| 155 mm. gun, 8" howitzer, 9.2" howitzer, 240 mm. howitzer | 10-ton tractor | 10-ton tractor and 3-ton caterpillar trailer. 10-ton wheeled trailer for rapid transport of tractors and tractor trailers on good roads, pulled by quads from | 3½-ton tractor caisson and 3-ton quad truck | 3-ton quad truck | Reconnaissance and staff observation cars and motorcycles and 2½-ton tractor with reel cart |
| 194 mm. gun | 15-ton tractor | 3½-ton tractor caisson | 3½-ton tractor caisson and 3-ton quad truck | 3-ton quad truck. | Reconnaissance and staff observation cars and motorcycles and 2½-ton tractor with reel cart |
| SPECIAL CASES | | | | | |
| 75 mm. gun, self-propelled mount | 3-ton quad truck and 4-ton trailer | 1½-ton quad truck (together with 2½-ton tractor and 1½-ton caterpillar trailer) transported by 3-ton quad truck and 4-ton trailer | | 1½-ton quad truck | Reconnaissance and staff observation cars and motorcycles and 2½-ton tractor with reel cart. (2½-ton tractor and reel transported by 3-ton quad truck and 4-ton trailer) |
| 155 mm. Gun, S. P. mount | S. P. mount | 3½-ton tractor caisson | 3½-ton tractor caisson and 3-ton quad truck | 3-ton quad truck | Reconnaissance and staff observation cars and motorcycles and 2½-ton tractor with reel cart. (2½-ton tractor and reel transported by 3-ton quad truck and 4-ton trailer) |

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Immediate Application of the Above Plan

113. The following recommendations are based upon experience abroad, reports of motorization boards, tests and data resulting from experiment and research, and recommendations of artillery higher commanders:

(a) The immediate motorization of all weapons larger than the 75 mm. gun and 4-inch howitzer for use as follows:

- 1st. The Regular Service.
- 2nd. The Reserve.
- 3rd. The National Guard.
- 4th. The several educational institutions.

(b) The immediate motorization of the 75 mm. 3" gun and division howitzer for use as follows:

- 1st. The Reserve.
- 2nd. The National Guard.
- 3rd. The several educational institutions.

(c) The motorization when conditions warrant of:

- 1st. The 75 mm. or 3" guns and 4" howitzers in the division.
- 2nd. The horsed sections of ammunition trains, employing for such motorization vehicles having the same tactical mobility as horse-drawn carriages.

(d) The adoption, as standard vehicles, with such minor modifications as war experience has indicated, of:

- 1st. The 10-ton artillery tractor.
- 2nd. The 5-ton artillery tractor.

(e) The adoption, to the exclusion of other types of cargo trucks, of the four-wheeled drive, two-wheel steer type, with some form of steel cargo body:

- 1st. For artillery use.
- 2nd. For artillery ammunition trains.

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Special Recommendations

114. (a) That motor equipment prescribed for artillery transport must be sufficient to maintain a prolonged rapid advance, and must be of the best and most suitable type.

(b) Sufficient special motor vehicles of all types should be retained in service, or contracts completed, to completely equip all contemplated regular and reserve artillery organizations.

(c) That ample reserve of spare parts for motor equipment belonging to tactical organizations be maintained, and that ample spare parts be actually carried with artillery organizations including ammunition trains to permit the attached repair facilities to function properly.

(d) That responsibility for the repair of all motor equipment within artillery organizations be definitely assigned to the Ordnance Department.

(e) That adequate repair facilities as indicated in the following table be provided to assure the proper care, repair and maintenance of both motor and gun material.

| Weapon | Battery | Battalion, normally with regimental supply company | Brigade |
|-----------------------|--------------------------|--|--------------------|
| 75 mm. gun | | I artillery repair truck | |
| Light field howitzer | I light repair truck | I supply load D | Mobile ordnance |
| 4.7" gun | | I supply load B | Repair shop |
| 155 mm. howitzer | | | |
| 8" howitzer | I light repair truck | | I heavy artillery |
| 155 mm. gun | I artillery repair truck | | mobile repair shop |
| 194 mm. gun | I supply load D | | (2 sections) |
| 9.2" howitzer | I supply load B | | |
| 240 mm. howitzer | | | |
| 5" seacoast | | | |
| 6" seacoast converted | | | |

| AMMUNITION SUPPLY | | Repair facilities |
|-----------------------------------|-------|--------------------------|
| Unit | | |
| Each ammunition truck company | ..... | I light repair truck |
| Each 2 ammunition truck companies | ..... | I artillery repair truck |
| | | I supply load D |
| | | I supply load B |

(f) That no motor transport be definitely approved for artillery use without a thorough test by artillery organizations.

(g) Eliminating present artillery supply truck body, replacing it with repair body, using suitable chests, cabinets, etc.

(h) That the vehicles and repair facilities supplied in time of peace be of the types contemplated for war use.

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(i) That there be manufactured immediately 150 Ordnance 3-ton, model 1918, four-wheel drive, two-wheel steer, truck chassis, approved as standard for use in the army by board appointed by Par. 30, S. O. No. 91, W. D., 1918, to be used in motorizing one regiment of 155 mm. howitzers.

(j) Improvement in design and construction of caterpillar treads.

(k) Lowering unit ground pressure of artillery tractors.

(l) Improvement in application of grousers on artillery tractors.

(m) Noiseless exhaust of engine and production of a silent tractor.

(n) The water-proofing of artillery tractor engines to permit them to run submerged for short periods.

(o) A simple form of coupling or attachment to enable guns, tractors, trucks, etc., to be hitched in tandem for towing purposes.

As amended by minority report:

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As amended by minority report:

ROBERT E. CALLAN,
Brigadier General, U. S. Army.

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JAMES B. DILLARD,
Colonel, Ordnance Department.

RALPH MCT. PENNELL,
Colonel, Field Artillery.

WEBSTER A. CAPRON,
Lieutenant Colonel,
Ordnance Department.

As amended by minority report:

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Lieutenant Colonel,
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MINORITY REPORT

of

BOARD OF OFFICERS

Appointed by Par. 142, Special Orders No. 289-0, War
Department, 1918

* * * * *

Although it has been the endeavor of the Board to keep as free as possible from questions of organization in its discussion of types, the report shows that this could not be done entirely. Types of artillery are dependent on missions to be performed and missions are interwoven with organizations. A reading of paragraphs 11, 12 and 13 might lead to the impression that a field army should include organic army artillery and that a reserve of artillery for reinforcement and special missions should be organized as a thing apart from the organic artillery.

This does not bring out the views of the minority on one of the most important artillery developments of the European War. The inadvisability of forming organic army artillery has been evidenced on all sides. The opinion of our higher artillery officers in France was opposed to organic army artillery;* in fact, no expression of any views favoring such an idea were heard in any of the conferences which the board had in Europe. To go further, considering the organization of European Armies

* The use of the word "organic" in this connection is thought to be misleading. It is believed that the majority opinion of all Field Artillerymen favors the types enumerated in paragraph 12, a light field gun and howitzer, a medium field gun and howitzer and a heavy field gun and howitzer. The terms, "Divisional," "Corps" and "Army" are applied in much the same way as "light," "medium" and "heavy" and paragraphs 11, 12 and 13 of the majority report assign those types as the normal Artillery of the Field Army of the United States, the expression "field army" being used in its broadest sense. "Organic" as used in the minority report refers to an assignment of a fixed number of organizations and cannon to each of the armies, of the Great Field Army, which may be operating in the Field. From this viewpoint there appears to be no real difference of opinion in the two reports, unless it is that the Majority report marks a distinct dividing line between the Artillery of the Field Army, *i.e.*, the Field Artillery, on the one hand, and that of special occasion, super and emergency types and other weapons from whatever source derived on the other hand.—EDITOR.

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and the opinions of many of our own officers, organic corps artillery is of questionable value. While the Army Artillery of our First Army was organic and without the reserve principle, except latterly for railroad artillery, the consensus of opinion of those officers who were immediately connected with the Army Artillery, as a result of the experience, is opposed to organic army artillery and is in favor of an Artillery Reserve.

The views of the minority of the Board on this whole subject are in brief as follows:

In addition to the assignment of division and corps artillery there must be additional artillery available; there must be a surplus of division and corps types, properly transported, for strategic reinforcement of divisions and corps during such times as the allotment to such units may be insufficient, and also for replacement of disabled units of these types; there must be heavier guns and howitzers for the missions of interdiction, neutralization and destruction which require greater power and range, or either, than the capabilities of the normal corps or medium field types; there must be artillery of special purpose—trench artillery, pack artillery, anti-aircraft artillery and super-guns and howitzers. Whether there be one or more field armies this additional artillery should constitute the Artillery Reserve. It should be a complete organization, with proper staff and all the necessary facilities for organizing, equipping and training artillery units as well as for the repair and replacement of units that have been used up in combat. The High Command should assign a certain amount of this artillery to the army or armies in the necessities of the general situations demand, and as the High Command views the relative importance of these situations; such an assignment to any particular army constitutes the Army Artillery.

From the assignment made, the Chief of Artillery of an army is prepared to assign to divisions and corps, such units as the general artillery plan demands; and with such super-guns and howitzers as he may have, he is prepared to undertake, through his own staff, missions of interdiction and destruction

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which fall beyond the corps artillery's activity or cover zones of adjoining corps and which could, therefore, be better handled for the general good under his immediate orders. When units are used up or are no longer needed, or the plans of the High Command demand a rearrangement of the reserve artillery, these army units should be sent to the Artillery Reserve for repair, re-equipment, replacement and general refreshing, or to some other theater of action, as the case may be. First of all, this method permits the most economical use of artillery and facilitates upkeep and replacement; and second, it relieves an army from the burden of unnecessary artillery and of much of the large administration, supply and repair problems that such units involve.

Under the foregoing the Artillery Reserve should contain properly organized and trained units of the following:

Trench mortars.

Pack artillery.

Anti-aircraft artillery.

Guns and howitzers of division and corps types.

Guns and howitzers of types heavier than those in corps artillery.

Railroad artillery.

In the composition of large forces there is always the danger of being led astray by the attractions of symmetrical organizations which are not based on the requirements of the battlefield. There is a variety of missions that might be given to an army of the United States; and in the organization of such a force to fit the necessities of the case, there would be greater variations from any normal assignment, in what are known as army troops than in any of the lower subdivisions of the army. Perhaps in no case would this be more true than in the Army Artillery. In some cases almost no heavy artillery would be needed; in others, the heaviest available might be required. Therefore, whatever may be the plan of military preparedness, the Artillery Reserve, though a thing not considered in our pre-war ideas

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of organization, should be organized and developed to a high state of efficiency. From the wide range of artillery that such a reserve would contain, the high command, guided by the general mission, could select and assign to an army the tactical units of the appropriate types that should constitute its army artillery.

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DISCUSSIONS

A Method for Open Warfare

CAPT. K. P. WILLIAMS, 150 F.A.

[EDITOR'S NOTE.—*Captain Williams's paper on "Open Warfare Methods of Fire Control" is an interesting study of a special case: that of a battery held in readiness for a sufficient time to allow a very complete reconnaissance, and when it is necessary to select an observing station far from the guns. His method of preparing a table for shifts of fire in a wide sector is ingenious, but on analysis it will be found to be merely an adoption of the parallax method found in Field Artillery Drill Regulations.*

Under ordinary conditions, calling for rapid action, this method is no improvement on those at present prescribed by regulations, for the following reasons:

(1) *The observing station would not be far from the guns. Difficulties of communication and control make it imperative that the observing station be close to the battery.*

(2) *Lack of time for the necessary calculations.*

(3) *Such a system would influence the battery commander to place his guns too far to the rear, and so limit their zone of action.*

The methods of fire control found in Drill Regulations are very rapid, and the speed with which a trained battery can get on a transient target is remarkable. We should avoid anything that tends to slow up the preparation of fire or influences the battery commander against pushing his guns well forward. Lack of boldness and procrastination were the two greatest complaints against our Artillery in France. A return to the old rapid open warfare methods is the thing most needed now in the Field Artillery. Every officer should at once make himself thoroughly familiar with Volume III, Field Artillery Drill Regulations. If he knows the methods of fire control found therein he will have little need of more elaborate computations to meet any situation that will arise in open warfare.]

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It is very essential that there should be a careful study and analysis of the methods employed by the artillery upon the western front. The feeling is natural that the conditions that existed were of a nature that led to the use of methods which are not of a general character, and which could not be applied under different circumstances. This idea is usually expressed by saying that artillery should be trained more along the lines of the former methods of open warfare. If, however, in doing this, a proper consideration is not paid to certain developments and necessities which have existed under actual service conditions, a distinct loss will result. While it is perhaps not probable that American artillery will again be engaged under conditions similar to those in France, it is equally impossible to predict what the conditions and requirements will be, and to state with any certainty that the methods used before the war will in any sense be adequate. All of the developments that took place during the war were the result of actual necessity, and the incompleteness or inadequacy of former ideas. An effort should be made to seek out the exact nature of the inadequacy, and the general principle that was found to correct it. The actual development of this principle may have led to the employment of details and high refinements possible only under special circumstances. But nevertheless it may be possible to find means of completing former methods that will have a very wide range of application, and will have in them the ideas that gave the great flexibility and accuracy of fire that artillery recently developed.

One thing which the experiences of the war would seem to demand is that batteries which are in a position for even as much as a few hours must have means of firing quickly on any target in a rather large zone, and of changing fire rapidly. This means that we must not wait until a target is assigned before starting computation of data. We must very quickly have at hand facilities for directing almost instantly our fire where we wish it. The element which requires the most computation is the deflection. Any method that requires that we start,

for each target, at the very beginning, and which needs, each time, estimates of offsets, or such other quantities, is obviously wasteful of time and inaccurate. The prior computation of deflections for prominent objects on the terrain, and recording them on a panoramic sketch, is not the best solution. It is not sufficiently general, but varies with the situation. We consume time deciding on the points we shall prepare data for. We may overlook certain regions, and when a target is assigned may not have data for it.

This paper does not deal at all with batteries that must go into position rapidly and open fire at once upon special targets. It deals with those batteries for which a reconnaissance has been made. It is here that time should be used to the best advantage. In an engagement of any size, lasting for any length of time, where much artillery is employed, many batteries will be in this situation.

We wish to be able to choose our battery position and our observation point as independently of each other as possible. The primary object of the observation point is to afford a view of the sector, but if we need to make use of it to determine data for firing, we are restricted. Either we cannot choose the post that gives the best view of the sector, or we will not be able to put the guns in the best position, exposing them perhaps to hostile fire. The ability to see a common aiming point from guns and observation point, or to see the latter from the former, are both great restrictions. Examples show this. The front edge of a wood might give an excellent view, and we could get good cover for the guns behind it, but neither of the conditions mentioned above would be fulfilled. Again, in the case of howitzers, one of whose chief advantages is the ability to fire over almost any defilade, we may be deterred from putting the guns in a very accessible ravine, because no aiming point was visible, and because the observation post, situated to the front of the covering hill, was invisible from the guns.

If we select our observation post at some distance from the guns, "Artillery Firing," Chapter 4, directs that, in the absence

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of maps, a place-sketch be made and used. This requires a plotting-board and instruments. The method here outlined accomplishes practically the same result by entirely different means. It is of course also applicable to those cases where we are fairly near the guns. In fifteen minutes or half an hour it would allow the battery commander to open fire upon any point in a large sector.

In an article entitled: "Diagrams for Determining Data" published in the FIELD ARTILLERY JOURNAL for October-December, 1918, the writer gave a diagram to obtain quickly the convergence table that batteries in position warfare found it

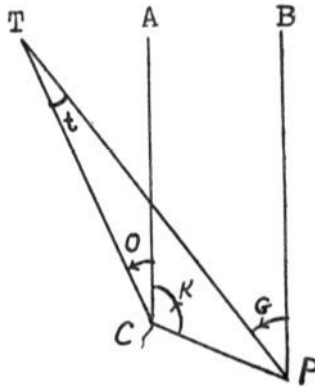


FIG. 1.

necessary to employ. It was stated there that the diagram could be used in the preparation of fire by the parallel method. This article is a development of that idea, with a diagram specially constructed for the purpose. The table that is constructed might be said to be a general case of the convergence-table.

Suppose the guns are at P (Fig. 1) and the observation post at C . The guns are laid parallel in the direction PB , which is chosen near the center of the sector. An observation telescope at C is oriented parallel to PB , as shown by CA , with the reading zero. The way to accomplish this will be noted later. Suppose we wish to fire at T . We direct the telescope

on the point and read the angle O (observed angle). The guns must move through the angle G (gun angle). We have the relation

$$G = O + t.$$

To fire on any point we need then to know the value of t for that point. It depends on the angle O and the distance CT . The method consists in obtaining quickly from a diagram the value of t , for values of O equal to 100,200,300 mils left and right of the base direction CA , and for values of OT equal to 2000, 3000, 4000, 5000 yards. These are tabulated. Then when a target appears we read the angle O , estimate the range, or measure it with a range-finder, and interpolate in the table for the value of t . The change in direction for the guns is then obtained at once.

We must first see how general the formula is:

We shall call O and G *positive* when measured *counter-clockwise*, *negative* when measured *clockwise*. The angle t is always *positive*, except as is noted later. The formula will then be true for all positions of T if CA is to the left of OB . For example:

- (a) T is seen 250 mils left of base direction. Then $O = 250$. Suppose $t = 55$. Then $G = 250 + 55 = 305$; and guns must go left 305.
- (b) T is seen 45 mils right of base direction. Then $O = -45$. Suppose $t = 105$. Then $G = -45 + 105 = 60$; and guns must go left 60.
- (c) T is seen 310 mils right of base direction. Then $O = -310$. Suppose $t = 50$. Then $G = -310 + 50 = -260$; and guns must go right 260.

If the line CA is to the right of PB we find

$$G = O - t,$$

with the same rule as above for signs. Example: Observer is to right of guns. He sees a target 200 mils left of his base direction. He finds from his table $t = 130$, say, then $G = 200 - 130 = 70$; and the guns must go left 70.

The formula then is:

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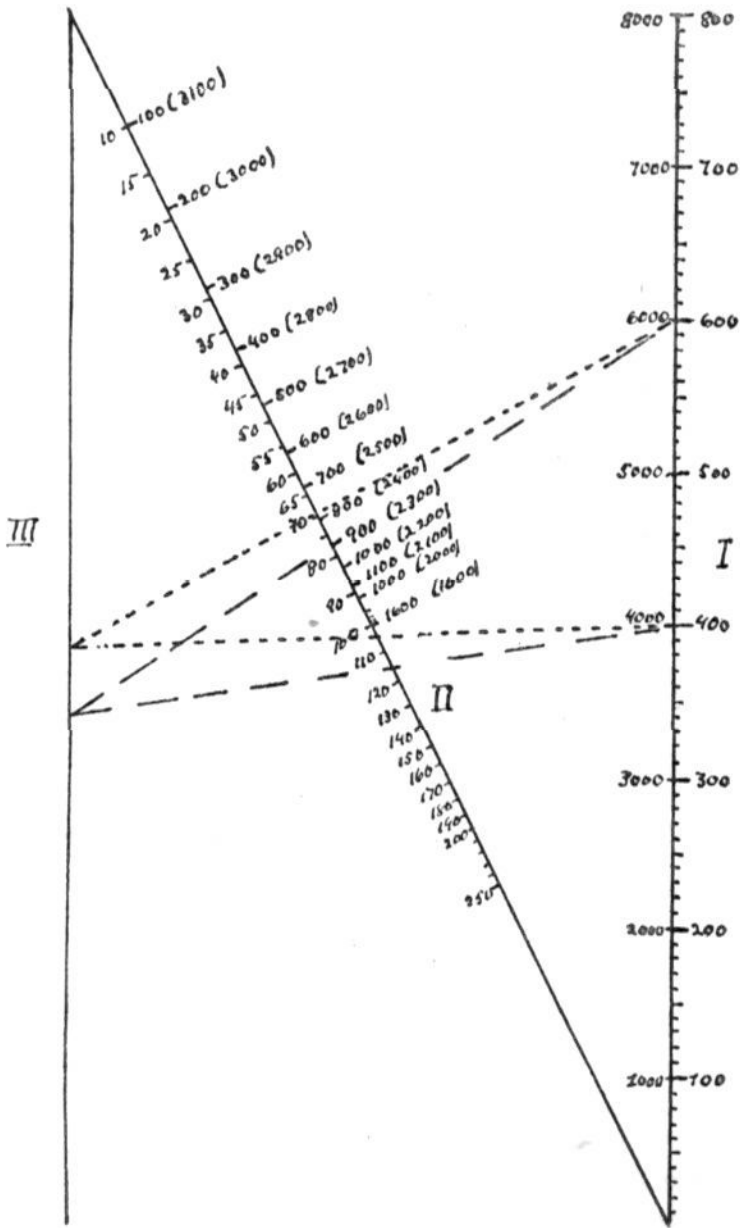


FIG. 2
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$G = O + t$, if observer is to left of guns.

$G = O - t$, if observer is to right of guns.

The diagram is so constructed as to determine the angle t if we know the distance PC , the entire angle at C , namely, PCT and the distance CT .

Example: Suppose $PC = 600$ yards, angle $PCT = 2300$ mils, and $CF = 4000$ yards.

Make a thread, or straight edge pass through graduation 600 on the right of scale I (see Fig. 2) and through graduation 2300 on the right of scale II. This is shown in the broken line - - - Pivot it where it crosses III, and make it pass back through graduation 4000 on the left of I. Read the value, 115, from the left of II. This is a first value of t . To get a more accurate value we add this to the value of PCT , giving $2300 + 115 = 2415$, and repeat the process, using 2415 as 2300 was used before. This is shown by the dotted line. . . . The value 105 is now read from the left of II, and is the value to be used.

We shall now consider the question of the laying of the guns, and the determination of the data which we need in order to use the diagram. We shall lay the guns by the aiming circle. It is the most general method, is independent of any distant point, can be used even at night, and gives a parallel sheaf at once. The battery commander selects a magnetic bearing, suitably situated in his sector, and has the guns laid in that direction. To orient his observation telescope in this direction, he sets the aiming circle up at the observation post, with the scale reading zero, and centers the needle.¹ He takes the reading on any suitable object in his sector. He subtracts from this the bearing at which he intends laying the guns. He sets the scale on the observation telescope to read this amount, and using the lower motion directs it on the point in question. The instrument is then oriented in the direction CA when it reads zero.

¹ In what follows it is supposed that the readings on the aiming circle and observation telescope increase in the same direction.

DISCUSSIONS

Example: The guns are to be laid in the direction magnetic bearing = 400. The aiming circle is oriented, and the reading taken on the corner of a distant house. Suppose it is 635. We subtract, $635 - 400 = 235$. The observation telescope is set at 235, and with the lower motion is directed at the house. It is then oriented when reading zero.

To apply the method we need the distances PC and the angle PCT . To get the angle PCT we shall measure PCA , which we denote by K , and to which we give the plus sign if CA is to the left of PB , and the minus sign if to the right. For any target then

$$PCT = K + O,$$

where the proper sign is used with O . If the sign of PCT that results from this is minus, we disregard it, as we need only the numerical value of PCT to use the chart.

Example: Suppose the guns are to the right, and the numerical size of K is 2200. Then $K = -2200$. We wish to fire at a target seen 300 mils left of CA . Then $O = 300$, and $PCT = -2200 + 300 = -1900$. We then drop the sign and use 1900 on the chart.

In case $K + O$ gives us an angle greater than 3200 mils, as it will if C is to the front of P , we subtract 3200 from the result, and take the remainder as the value to be used on the chart.²

If the guns are visible from C , the distance CP can be obtained by measuring the angle subtended by a line of known length held perpendicular to CP , and the angle K by taking the reading on C after the telescope has been oriented. In case the guns are not visible, the distance and angle must be otherwise determined. The distance can be gotten from the amount of telephone wire used, which can be stretched so as to be as nearly straight as possible, and which the battery commander

² In this case the formula for G changes, and we have $G = O - t$, if observer is to left, $G = O + t$, if observer is to right; or, what is the same, we can use the same formula as before, but say that t is negative, whenever PCT is greater than 3200. Example: Observer is left, $K = 3050$, $O = 350$. Then $K + O = 3400$. Subtract 3200, giving 200 for the value to use on the chart. Let the range be 5000, and the distance $CP = 600$ yards. We find the value of t from the chart to be 22, but as PCT was greater than 3200 we put $t = -22$, and have $G = 350 - 22 = 328$.

can previously have graduated into 100 yards. The angle K can be gotten from the general direction of the wire. An error of 50 mils in K will not lead to a large error in t . If the battery is to remain in position very long, and the situation allows, a traverse should be run from C to P .

As soon as the data is determined we tabulate the values of t for the values $K - 300, K - 200, K - 100, K, K + 100, K + 200, K + 300, \dots$ mils and ranges of 2000, 3000, 4000, 5000, 6000.

We shall completely work a problem to illustrate the process.

Suppose the observation post is 550 yards from the guns, to the left, and that angle $K = 2050$. The values of the angles to be entered on the right of scale II are then

1750, 1850, 1950, 2050, 2150, 2250, 2350, and for each of these angles the ranges 2000, 3000, 4000, 5000, 6000 are used.

When tabulated the results are:

| Direction \ Range | | 2000 | 3000 | 4000 | 5000 | 6000 |
|-------------------|-------------|------|------|------|------|------|
| | | | | | | |
| Right (-) | { 300 | 250 | 170 | 135 | 108 | 90 |
| | { 200 | 240 | 165 | 128 | 105 | 88 |
| | { 100 | 230 | 163 | 120 | 98 | 85 |
| | { 0 | 210 | 150 | 118 | 93 | 80 |
| Left (+) | { 100 | 195 | 140 | 110 | 88 | 75 |
| | { 200 | 180 | 130 | 100 | 82 | 70 |
| | { 300 | 160 | 120 | 92 | 75 | 65 |

An inspection of the way the numbers in the table are running will enable one to detect an error of any appreciable size. This point may be of value. It is really sufficient to record the values of t in most cases to the nearest 5 mils.³ If $K + O$ is

³ A remark as to the accuracy of the results may be of interest. If we use the value obtained in the first approximation, it will be too large. The value which is obtained the second time, and which we have taken for the correct value of t , is a little too small.

In the example worked, if we construct a diagram on a scale of 1/10,000 and measure the different angles for 2000 meters, we shall find them to be 260, 250,

DISCUSSIONS

greater than 3200, the value of t should be recorded with the minus sign, as explained above.

Suppose now that a target appears 100 mils to the left of the base direction, and the range-finder indicates a range of 4000 yards. From the table we find the value of t to be 110 mils. As we are to the left, we add this to the value of O , and get

$$G = 100 + 110 = 210,$$

so the guns should go left 210.

Another target appears, 250 mils right, at a range of 3500. We must interpolate. For 250 right at 3000 we have 168, and at 4000 the value 130. Interpolating between these two we have 150. Thus, $O = -250$, $t = 150$. Hence

$$G = -250 + 150 = -100.$$

so the guns go right from the base line 100 mils.

In the method that we have described it is necessary to use the aiming circle both at the observation post and at the guns. It is needed at the observation post but for a brief moment, to note the magnetic bearing of some object on the terrain. This should be done as soon as the observation post is established. The observation telescope could then be oriented, and the aiming circle would be available for laying the guns upon their arrival.

A table such as that given in the problem worked can be made by two men in fifteen minutes. One man should record, and keep the other, who works the diagram, posted as to the data to be entered, saying, for instance, "Distance 400, angle 2100, range 5000."

By graduating line III the diagram could be used to obtain the difference between the gun range PT , and the distance CT of the target from the observer. It should be sufficient to estimate this.

238, 220, 205, 190, 170, uniformly ten mils greater than those we have tabulated. These values are obtained from the diagram if we repeat the operation another time. In any case where the second value is 40 to 50 mils smaller than the first, it would be well to add, say, 10 mils, to the second value. It is to be noted that in what we have just said we are considering a short range, with observation post at a relative great distance from the guns and well to the flank.

CURRENT FIELD ARTILLERY NOTES

Confidential and Secret*

For distribution by aeroplane

Bull. No. 50.

HEADQUARTERS, 1ST ARMY, A.E.F.

Second Section, General Staff.

SUMMARY OF UNINTELLIGENCE

NOVEMBER 10, 1918.

PART I

I. *General Depressions of the Day:*

The enemy reacted violently all over the sector. Strong attacks west of the Meuse were thrown back easily by us. Small local attacks by our troops succeeded in driving the enemy from his positions. During the afternoon, violent counter-attacks appear to have caused us to readjust our lines slightly to a depth of ten kilometres.

The day was quiet. Otherwise, there was nothing to report.

The enemy appears to place his main reliance on machine guns, infantry, artillery and aeroplanes to resist our attack. This is taken as an indication of something very significant, namely, the tremendous shortage among the enemy of all other branches. Otherwise there is nothing to report.

Two men were seen entering a ravine near (CHRILELY?). This confirms prisoner's statements of a general withdrawal to the Frideg-Stellung.

On the right, the enemy are extremely nervous. They showed their nervousness by raiding our trenches and throwing hand grenades at us.

* By the author of the "Dere Mable" letters, who was a lieutenant of field artillery during the war.

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II. *Enemy Front Line:*

The enemy line follows ours in a general way, except in one or two places where it runs south of it. East of the MEUSE it runs in an easterly direction to the left (inclusive). W. of the MEUSE, it runs in the opposite direction (exclusive). Thence it runs in a N.E. direction (inclusive) turning due N. for 200 M. Thence due S. for 200 M. From here on, there is no change. This has not been confirmed.

III. *Enemy Disorder of Battle:*

(a) *Identifications:* 12th Meulskinnens—A prisoner of the 12th Meulskinnens recently captured confirms the belief that this is not the 12th Meulskinnens at all but the 115th Schutzenfests. Order of battle confirmed.

11th Jaeger Wullens—A prisoner from this division captured between 3 hrs. last Wednesday, states that this regiment was recently disbanded and transformed into the 10th Flanelraper Battalion. Order of battle confirmed.

3.33 KUKs—The 3.33 KUKs have been replaced by the 17th KAKs. Order of battle confirmed.

449th Gesundheits—The 944th Butterbrots have been identified as the 449th Gesundheits. They recently came from the Uskub front. Order of battle confirmed.

(b) *Presumed enemy order of battle:* The efforts of the enemy to fill the gaps in his line appear to have resulted in a confused order of battle. There are divisions on the right and left. Apparently some are in the rear. Others are on the roads between these points. Several prisoners recently captured state that they have no idea what the enemy order of battle is. This shows the extreme confusion in the enemy ranks.

(c) *Comment on enemy units:* 42nd Landwhere Balloon Kumpanie—A prisoner from the Kumpanie states that when our attack started they were 40 kilometres to the North. When the news of the attack reached them, however, they came down immediately.

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Prisoners report that the 402nd Landsakes Division now opposite our front is composed entirely of one-legged men impressed into the service from the great Sauerkrut Factories at Essen. This and other documentary evidence indicates the terrible internal disorders in Germany.

(d) *Enemy intentions:* That there is great indecision on the part of the German General Staff as to the point to which the line will be withdrawn is indicated by the statement of a prisoner of the 77th Krapshooter Battalion. When questioned on this point he replied significantly, "I don't know."

It is generally supposed that the enemy will fall back first into the Katzundjammer Stellung (from a captured map dated April, 1913). From here he may fall back into the Meuse. There is every indication that a stand will be taken at LA TRINE.

IV. *Enemy Infantry Activity:*

The enemy infantry were extremely active during the day, jumping up and down and climbing trees. A number of nests have been observed in the BOIS DE BANDYLEGS. Perhaps it is safe to venture the assumption that these were made by machine guns. A counter-attack during the morning succeeded in establishing a deep pocket in our lines in the region of the HULLABELLOO BOIS Woods. Later in the day our troops turned this pocket inside out.

V. *Enemy Artillery Activity:*

The artillery now opposite our front readily lends itself into two main groupings: (1) The East Meuse Grouping; (2) The West Meuse Grouping. It is very significant that since the beginning of the attack all batteries reported in action have been in one of these two groups.

A careful study of the terrain shows the river MEUSE separating the country on the right of it from the country on the left of it. The country varies from hilly to flat with woods and open spaces. Roads run between the towns. All conditions

CURRENT NOTES

make the country ideal for the artillery which we are safe in presuming to assume is there.

During the day (and night) the firing all appeared to come from a northerly direction. The preponderance of fire was from 77s, 105s and 150s. Gas, H.E. and shrapnel were chiefly used.

A battery at J 00000 was reported by a prisoner. This was confirmed by photographs which show nothing at this point.

MANGEY-ANNE was shelled with duds during the afternoon. Battery J 7.11 was immediately counter-battered. This was apparently effective for toward morning the shelling stopped.

Our artillery successfully counter-battered 17 batteries (enemy) during the day (and night).

Two batteries were reported in action: J 0.789 and J 098.7. Upon reference to the Plain Directour one of these appears to be in the middle of the MEUSE River. Our only explanation of this is that the enemy must be using torpedo boats.

VI. *Enemy Movements:*

Visibility: Poor and intermittent during the night.

Railways: No unusual activity observed. Most of the railroads seemed to remain in the same place during the day.

Roads: An old man in a wheel chair going from BAR-devant-MEUSE to BAR-derriere-MEUSE tends to confirm the belief that the enemy is retreating.

At 12/64, 600 men were seen going from VANDYANNE to ANDYVANNE. At 12:74, 600 men were seen going from ANDYVANNE to VANDYANNE. It is thought that this move was made by the enemy with a view to increasing the circulation of his troops.

During the day an old man was seen sitting outside a house in VINGT-ET-UN. No other unusual activity was observed round the town.

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At 15:82, 12 wagons, believed to be a battery, were seen on the ANCY-BUZANCY Road going in both directions.

Two men were seen to come down the HARRICOURT-BARRICOURT Road and enter a small wooden hut at 322 × 11.4.5. This is thought to indicate a relief.

VII. *Enemy Works:*

Fox holes and occasional rat-holes have been observed in front of the Bois de Bois Woods.

A captured German map has been found showing a new Stellung. This Stellung is indicated by a line scratched across it in pencil. This is undoubtedly the point on which the enemy will fall back Thursday. The map fails to show the Stellung east of the river. We have drawn in the missing portion on the attached map.

A study of recent photographs confirms the presence of the Meuse River as shown on the Plain Directors.

A Study of the Meuse

Photographs show that the Meuse River runs in a northerly direction to STENAY. From here it turns in a westerly direction. This tends to confirm the Plain Director. There are no unusual bridges between the towns and many of these have been destroyed. No photographs north of this point are available, but there is every reason to suppose that the river does not end here.

(Be sure and get to-morrow's study: "Wild Towns Along the Meuse.")

VIII. *Enemy Aërial Activity:*

The enemy was very active during the period, particularly on the right and left and in the centre. Most of the enemy planes crashed. Otherwise there was nothing to report.

CURRENT NOTES

Enemy balloons were observed North of VERDUN, West of SOUILLY, and East of BAR-LE-DUC.

IX. *Miscellaneous:*

Extract from a captured German document:

"I received your letter and was glad to hear that you are sending down an extra pair of knitted socks. Since I put on the last pair you sent me, about six months ago, I have never been without them."

(Signed) WILHELM.

This is undoubtedly a message in code from the Kaiser and is thought to contain the order to fall back on the KURZUNDLANG-STELLUNG, thus confirming our previous assumption. Order of battle confirmed.

X. *Activity of Our Own Troops:*

Our troops spent the day tightening their lines and improving their positions which were very awkward.

XI. *Our Aërial Activity:*

The dampness made the day impossible for flying. In spite of this, our planes were up in great numbers destroying numerous enemy planes and taking dozens of photographs in spite of the dense fog which rendered visibility impossible.

Our scout patrol of three planes met 20 Fokkers. The Fokkers immediately burst into flames and crashed.

The ceiling was so low that at times our planes were forced to run along the ground. In spite of this, we penetrated deeply into the enemy's territory bringing back invaluable information as to the location of towns, rivers and roads behind his lines.

Lt. Cholmondelay Brown destroyed three enemy balloons in their beds by descending upon them so suddenly that they became tangled in the bed clothes and were unable to escape.

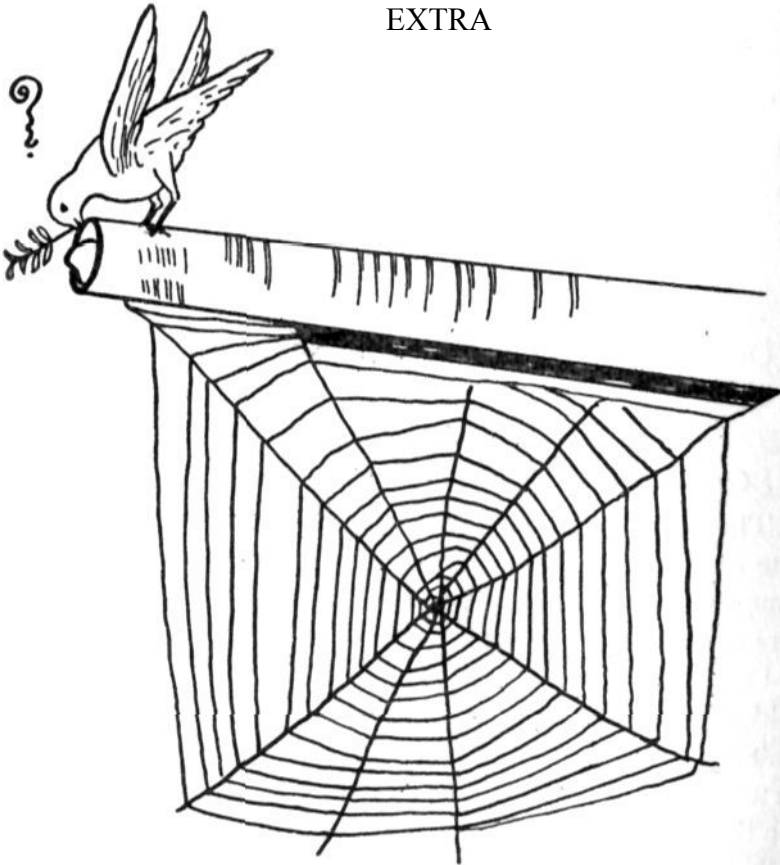
THE FIELD ARTILLERY JOURNAL

Lt. Dunwiddy brought down a balloon at dawn. Owing to the darkness, Lt. Dunwiddy brought down one of our own balloons. Luckily it was an old one. The observer jumped but was not seen to land. Confirmation is requested.

XII. *Order of battle confirmed.*

NOTE.—Be sure to get our next number: "The WAR Number."

EXTRA



OWING TO AN UNEXPECTED BUSINESS TRIP INTO HOLLAND OF OUR PRINCIPAL CONTRIBUTOR THE BULLETIN ANNOUNCES THAT IT HAS SOLD ALL RIGHTS TO "LA VIE PARISIENNE" AND WILL APPEAR UNDER THIS HEAD UNTIL FURTHER NOTICE.

CURRENT NOTES

O.G.
No. 111

HEADQUARTERS PREMIERE ARMEE
Office of G-Whiz

EUROPE, 11 November, 1918.

From 11 H, November 11, 1918, to 11.11 H, November 11,
1918

1. *Hostile Situation at Beginning of the Day:*

Artillery and infantry belonging to the enemy are running very rapidly across the German border, pursued by Yanks and British tanks, who joined the rush of dashing Franks. Huns ran in great disorder.

2. *Information Received of Enemy During the Day:*

Interrogated prisoners say they might come back another day and start again their little fray, because they weren't frightened. But information late to-night (not from G-2, for this is right), shows that although they say they might, we know damn well they mightn't.

3. *Hostile Movements, Changes and Conduct During the Day:*

Boche infantry across the Meuse, artillerymen, machine gun crews got so mixed up they could not choose to tarry any longer, they couldn't see relief ahead, for if they'd stayed they'd all be dead, and so they went straight home to bed, where they knew they'd be stronger.

4. *Maps Illustrating Above:*

Look it up.

5. *Own Situation at Beginning of the Day:*

Herewith, behold in full display the 1st U. S., in grand array on this, its latest fighting day prepared to make a wind-up. An end run or an on-side kick, a forward pass or any trick would be successful mighty quick with these divisions lined up:

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| | | | | | | |
|----------------|-------------------|------------------|-----------------|-------------------|--------------------|-----------------|
| Left End 80 | Left Tackle 89 | Left Guard 90 | Center 5 | Right Guard 79 | Right Tackle 26 | Right End 81 |
| | Left Half 1 | | Quarter 32 | Right Half 2 | | |
| | | | Full Back 42 | | | |

On the bench—6, 77, 78, 30, 29, 3, 15 D.I.C., 10 D.I.C.

6. *Own Changes, Movements and Action During the Day:*

As one division moved ahead, another started back instead, a third walked back and forth till dead and thereby made improvement. For every unit every day came in or out but didn't stay; they had to shift, and so we say, "Considerable movement."

7. *Information Received from Neighboring Units:*

The army to the left of us put up a most ungodly fuss because we chased Fritz in a bus and landed in their sector. But if we had not gone right through to Sedan then could we accrue a jag tonight? I ask of you. Your answer, "No, by Hector." And on our right the second stands and stands and stands and stands and stands and stands and stands and stands and stands and stands, and so it is reported. We call them each and ev'ry day and ask them what they have to say. "Enemy aircraft getting gay," is what they have retorted.

8. *Orders Received:*

We've orders, orders everywhere, so many that we can but stare and wonder how in hell and where they were originated. We read them back and forward, too, and then we don't know what to do, though once again we look them through, and leave us agitated.

9. *Action During Day and Orders Issued and Received:*

The doughboy laid his pack aside, the iron ration still inside, and opened up his jacket wide and sailed right in, by thunder! He tore them right, he tore them left, and laughed while he

CURRENT NOTES

used all that heft, for every German's bean was cleft, he rent the Hun asunder. Behind him, too, artillery roared, while overhead the big shells soared and into German batteries bored; my soul, it was attractive. But way above them in the sky they looked in vain for things that fly—Report on "visibility shy aeroplanes inactive."

10. *Result of Action, Both Own and Enemy:*

A hundred thousand captured Huns, a million more or less of guns, deloused machines and tons and tons of German-made commodities. Some cannons, and some cooking stoves and Generals, Captains, other coves were chased behind in droves and droves along with other oddities. Our line extends from left to right along the Meuse thence to the height of Brandeville and out of sight, it really is too long to note. We've captured many a town and wood and hill and vale where towns have stood, we've taken everything we should and tied the can to Willie's goat.

11. *Maps Illustrating Above:*

See paragraph No. 4.

12. *Estimate of the Situation:*

This is this! And that is that! And who is who and what is what! Such thoughts are running neath our hat in mighty cogitation. To find a phase with which to cope, we tried, but now there is no hope; we must announce our latest dope, "There ain't no situation."

13. *Plans for Future:*

Exit at 32nd Street, a wild mad dash across the street until the rails beneath our feet we'll cross the gin mill's border. We've quite resolved to never think, we only want to sit and drink and drink and drink and drink, "Here waiter, take the order."

14. *Remarks:*

The captured roads are poor to fine, supplies are normal everywhere, morale is quite beyond compare, the men are all in

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clover. The visibility now is fine, there are no Germans on the Rhine, so lets uncork a little wine, THE DAMNED OLD WAR IS OVER.

G. WHIZ.
Chief of Chaff.

(By permission of the author in G-3 1st Army.)

Distribution:

Salvation Army.

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W.A.A.C.

Maxim's.

Fatimas.

Bustanoby's.

Bavarian Republic.

Turkish Trophies.

Erie Railroad.

S.O.S.

Swiss Navy.

Hoboken Police Department.

Cook's Tourist Bureau.

Ford Peace Party.

Roll of Honor

PRO PATRIÂ

BATEMAN.—Drowned, July 4, 1919, at Fort Sill, Oklahoma, Lieutenant-Colonel Harold H. Bateman, Field Artillery.

JACOBUS.—Died of pneumonia, at Base Hospital, Trier, Germany, December 24, 1918, First Lieutenant Harold F. Jacobus, Field Artillery.

STEWART.—Died of peritonitis, on board U. S. S. Capfinisterre, July 12, 1919, First Lieutenant William Stewart, Field Artillery.

CANNON.—Died of peritonitis, on board U. S. S. Capfinisterre, July 12, 1919, First Lieutenant William S. Cannon, 76th Field Artillery.

Current Index to Field Artillery Literature

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