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EDITED BY

HARLEIGH PARKHURST

MAJOR, FIELD ARTILLERY, UNITED STATES ARMY

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BATTERIES OF THE 7TH FIELD ARTILLERY, 1ST DIVISION, OCCUPYING NEW POSITIONS HAVING ADVANCED TWO KILOMETERS, TWO HOURS AFTER THE ATTACK. TILLEUL DE LA CLAUX, FRANCE, JULY 16, 1918

THE FIELD ARTILLERY JOURNAL

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FIELD ARTILLERY: PAST, PRESENT AND FUTURE

BY GENERAL HERR OF THE FRENCH ARMY

A Translation

[This treatise by General Frederick Georges Herr, published in French by Berger-Levrault, Paris, is believed to be an outstanding book on the subject of field artillery. In the belief that heretofore there has not been an opportunity to read this in English, it is hoped that its publication in serial form in the JOURNAL will be the means of acquainting more of our officers with this excellent work. During the World War, General Herr was successively the commander of an artillery brigade, an infantry division, an army corps and of an army detachment. He then became Inspector General of the French Artillery.—EDITOR.]

PREFACE

AN army's tactics are influenced by its armament. The plans of those in command, and the combat methods of the troops, should draw out everything possible from this armament; with every improvement in armament, combat methods must be correspondingly modified.

Further, it is obvious that tactics and armament are greatly dependent on enemy combat methods and armament. Formations suitable for the attack of a European Army are not used against a contingent of savages, nor is a perfected armament necessary. On the other hand, a modern, well-trained and efficiently armed enemy, must be opposed with equal, if not better, armament, and with methods of combat appropriate thereto, and this armament and these methods of combat must be immediately adjusted to meet changes made by the enemy.

It may be said that an army's armament is dependent to a certain extent on its tactics; this in order that plans of the command and the maneuvering qualities of the troops based on these tactics may not be frustrated by defects in, or lack of, matériel.

Finally, organization must closely conform to tactical tendencies, since it must be such as to get the most out of the particular armament in use.

To sum up, tactics, armament, and organization are closely interrelated and mutually react on each other.

Were the tactics of the French Army of 1914 appropriate to its armament? Were its tactical methods and armament adequate to victoriously confront the German Army? And finally, was it properly organized? In this book we propose to look into these points in so far as they concern artillery. We will further investigate the evolution in artillery tactical doctrine, matériel, organization and methods of employment, which under the pressure of circumstance, resulted during the war of 1914–1918. We will see the logical outcome of this long and bitter experience and what lessons stand out imperatively in the present hour.

PART ONE

THE RÔLE OF THE FIELD ARTILLERY IN THE WAR, 1914–1918

CHAPTER I

SITUATION AT THE BEGINNING

I. THE FRENCH ARTILLERY IN 1914

THE dominating feature of our tactical doctrine in 1914 was the almost universal belief in the superiority of maneuver over fire power. In the concrete realm of organization, this principle automatically resulted in the preponderance of personnel effectives over matériel. Of course, the power of fire was denied by no one; its importance was apparent to those who studied former campaigns such as the wars of 1870–1871, the Balkan, the Boer and the Manchurian wars. But although all proclaimed it and wrote of it, it seems nevertheless that a true appreciation of its importance was lacking.

Our regulations insisted without limit on the exclusive value of the offensive.

The Regulations on the Employment of Large Units, dated October 28, 1913, stated the following principles: "The conduct of war is dominated by the necessity of giving a vigorous offensive to operations. Battle, the aim of all operations, is the only means of breaking the enemy's will; the first duty of a commander is to seek battle. Battle, once started, must be pushed to the finish, to the limit of all available means, without reservation. A vigorous offensive compels the enemy to take the defensive and constitutes the surest means of guaranteeing the command, as well as the troops, against all danger of surprise."

The Field Service Regulations of December 2, 1913, develop the same idea in paragraphs 96 and 97. "Only the offensive will break the enemy's will. Once commenced, combat is pushed to the end; success depends more on vigorous and tenacious execution than on the perfection of the plan. Infantry is the principal arm. It conquers and holds the terrain. It pushes the enemy from his strong points. It acts by fire and by movement; only the advance, pushed to hand-to-hand fighting, is decisive and irresistible, although generally fire must prepare the way."

The Infantry Regulations of April 20, 1914, reproduce word for word the principles expounded in the Field Service Regulations.

The training of our army was accordingly for the offensive, for the decisive and irresistible advance, supported by fire.

In peace-time exercises, though the advance could be taught, the effects of fire could not be duplicated. Our grand maneuvers, the consummation of our yearly training, were made up of a few days of marching, ending in a great military spectacle where one could see dense infantry formations with drums beating and flags flying, advancing on the position to be taken, with a superb disdain of the enemy's fire. In the critiques, the discussions were only about those things which could actually be seen: for the attacker, the direction of attack, the routes followed, and the pace of the final assault; for the defender, the counterattack with the bayonet; its timing and vigor. The cannon and the machine gun, whose characteristics allowed their effective use only when stationary, were almost forgotten and followed these brilliant fantasies with painful slowness. Few thought of commenting on the method of artillery and machine gun employment and of the influence of these in the final success.

It was from this conception of combat that our doctrines of artillery employment were drawn.

A misconception of the effect of fire lessened the rôle of the artillery in battle. Furthermore, only a limited efficacy was admitted this arm. Statistics of modern campaigns indicated that losses caused by artillery fire were not greater than twenty-five per cent. of the total losses and sometimes went as low as five per cent., whereas the rifle ball caused as high as ninety per cent. of total losses.*

The Field Artillery Regulations of 1910, state that field artillery has great destructive effect on unsheltered living targets, but adds that destructive effects are often difficult to obtain and that neutralization, accomplished with a relatively small number of projectiles, would suffice in certain cases.

Field Service Regulations stated that field artillery fire had only small efficiency against a sheltered adversary and that it was necessary to attack with infantry in order to lead the adversary to uncover himself.

To draw from this, the conclusion that field artillery was only an accessory and a secondary arm, was but a step. Since it had a low efficiency except against living targets in the open, it was useless to employ it to destroy sheltered or even masked targets, or material obstacles. The fight against enemy field artillery which would undoubtedly be masked, could not be decisive. It would therefore only be an episode of secondary importance in the battle. And the artillery preparation of attacks was deliberately renounced as being ineffective.

"It has been assumed until recently," says the Report to the Minister of War, which served as a preface to these Field Service Regulations, "that the first mission of the field artillery in combat was to gain superiority

		Per cent. of losses suffered.	
		Infantry bullets.	Artillery shells.
* War of 1870–1871	German Army	90	5
	French Army	70	25
Russo-Japanese War	Japanese Army	85	8.5
	Russian Army	86	14

of fire over the enemy field artillery and that then its rôle consisted of preparing the infantry attacks by bombarding the objectives assigned to these attacks before the infantry entered into action.* To-day it is recognized that the essential rôle of the field artillery is to support the infantry attack by destroying everything which can oppose these attacks; seeking superiority over the enemy field artillery has no other object than to insure its ability to act with maximum power against the infantry objectives . . . as for the artillery preparation of attacks, this cannot be made independent of the infantry action, because artillery fire has only limited effect against a sheltered adversary, and, to lead this adversary to uncover himself, it is necessary to attack with infantry. The coöperation of the two arms must be constant. *Artillery does not prepare the attacks, it supports them."*

The great progress obtained in 1897 by the adoption of the 75-mm. rapid-fire gun deceived our commanders as to the effectiveness of this matériel, the destructive power of which they overestimated. "The 75-mm. gun," says an official document, "suffices for all the missions which can be intrusted to artillery in field warfare."

This idea caused a new theory, that of the individual power of the rapid-fire gun. The immediate consequence was the idea that, on a front of 200 meters, one battery of four 75-mm. guns was capable of giving everything that could be required from the artillery and that it was useless to concentrate the fire of several batteries on any objective whatsoever.

Finally, nobody believed in the value of long range. Indeed, if the essential rôle of the artillery consisted of supporting the infantry attacks in close contact with that arm, it would never have an opportunity of firing outside of a field of action limited to 3000 to 4000 meters. On the other hand, the artillery could not work without the direct observation necessary for correcting its fire and, since aërial observation was in its infancy, only terrestrial observation could be taken into consideration. But the latter, even with the best glasses, was limited to distances not exceeding 4000 to 5000 meters. The tube of the 75-mm. gun could be used, by giving it a suitable elevation, for a range of over 8000 meters, but the carriage and the sighting mechanisms were conceived and constructed only for a maximum range of 6500 meters.

Our theory of tactics in 1914, as far as it concerns the artillery, can be summed up as follows:

> The war will be a short one with quick changes of position in which maneuver will play the principal rôle; it will be an open warfare.
>
> The battle will be essentially a fight between two infantries, in which victory will be on the side of the greater number of battalions; the army must be an army of effectives and not an army of matériel.
>
> Artillery will be a dependent arm with only one mission: to support the attacks of the infantry. For this it will need only a limited range and its main quality must be rapidity of fire in order to be susceptible

* The Field Service Regulations of 1895 made the *artillery duel* a special phase of the battle and was previous to the action of the infantry.

of action on the numerous and fugitive objectives which will be put up by the infantry.

Obstacles which will be met in open warfare will not be very important; light artillery will have sufficient power to overcome them.

The matériel must be light, flexible and easy to maneuver, so as to be able to follow the infantry which is to be supported as closely as possible. The usefulness of heavy artillery will not be felt very often; it will, of course, be wise to have some batteries, but these batteries must be comparatively light in order to have sufficient mobility and this fact precludes the use of large calibers and powerful matériel.

As a battery of four 75-mm. guns has an absolute efficacy on a front of 200 meters, the concentration of fire of several batteries is not necessary. It would be unwise to be overloaded with too much artillery. The number of batteries which large units should have in their organizations may be calculated according to the normal front of engagement contemplated for the unit.*

We will not deny that the armament of our artillery in 1914, the training of its officers and cadres and its organization in the army corresponded to this conception in a sufficiently adequate fashion.

The armament consisted of:

The 75-mm. quick-firing gun with which the whole light field artillery was armed;

The 65-mm. quick-firing guns assigned to the mountain units;

The 155-mm. quick-firing howitzers, Model 1904, which together with some 120-mm. howitzers (Baquet) and 120-mm. slow-firing guns, Model 1878 (de Bange), formed the whole armament of our heavy field artillery.

The old de Bange matériel made during the years 1877 to 1881 was assigned either to the defense of fortresses or reserved for the eventual formation of siege trains.

Quantitatively we had in the units which were to be immediately mobilized about;†

3840 guns of 75-mm. caliber;
120 mountain guns of 65-mm. caliber;
308 heavy guns for mobile units;
380 de Bange heavy guns which were destined to form siege trains.

With this armament were formed at mobilization:

20 regiments of corps artillery with four groups (battalions) of three batteries, each battery having four 75-mm. guns;

65 division artilleries, with three groups of four gun 75-mm. batteries for the active divisions, and two groups of 75-mm. guns for the reserve divisions;

5 regiments of heavy field artillery of four groups each;

* The Instructions for Employment of Large Units assumes that an Army Corps of two divisions will theoretically occupy a front of 4 km., exceptionally 8 km. and as an average 6 km. Thus thirty batteries of artillery would be sufficient for an army corps.

† There were besides, provided for the defense of fortresses about 7000 heavy guns of old models.

2 mountain artillery regiments;
11 regiments of foot artillery;
In addition several territorial organizations.

Artillery headquarters were organized within the divisions.

In army corps a general who commanded the corps artillery, assured the coördination of the work of the divisional artilleries, directed the fire of the corps artillery, or regulated the distribution of it between the divisions according to the instructions of the general commanding the army corps, and finally he took command, if necessary, of an important grouping made up to work for the divisions. He had under his direct command a corps artillery regiment (four groups) of 75-mm. guns.

In the division the command of the artillery was performed by a colonel whose normal place during battle was at the side of the general commanding the division and who had at his disposal one lieutenant-colonel who directly commanded the nine batteries.*

There was no army chief of artillery. The coördination between artilleries of different army corps resulted only from the instructions of the command or by the agreement of the artillery commanders in question. The heavy mobile regiments once assigned to armies and then by them to the corps of the army were used by the corps in the same way as their corps artillery.

The qualities of an artillery do not depend on its ordnance armament, and on its organization alone. Communication and observation equipment has a great influence on its value. What can be required of the artillery depends in fact considerably on this equipment.

As concerns communications equipment the artillery was not in a worse condition than the other arms; it shared with all arms in the general lack of equipment. It had an unsatisfactory telephone in which everything was sacrificed for simplicity and for facility of transportation. It was unsuitable for continuous use and for communication of over 1000 meters. Each battery as well as each group headquarters, had only two telephones with 500 meters of wire; regiments and larger units had no equipment of their own. This scarcity of telephone material was due to the conviction that the telephone was not a means of communication which could be used during battle. The Field Artillery Regulations of 1910 do not even refer to the telephone; according to these regulations the surest means of communication were in their order of importance, sight, liaison agents, and in some cases simple signals.

The observation material was limited to binocular field glasses which were excellent, but issued in a very limited quantity. Nobody believed in long-range firing and field glasses could be well used at distances of from 3000 to 4000 meters.

* This colonel was only fifth in rank among the various chiefs of arms or services at division headquarters and did not have a standing commensurate with the importance of his rôle, as we now see it. It must not be forgotten, however, that according to the ideas of 1914, the field artillery was only an accessory arm.

Aërial observation was only in its infancy as was aviation itself. It was not surprising that means for aërial observation were insufficient in both quality and quantity. Processes of adjustment were primitive, essentially because of poor communications between the airplane and the ground, which could be performed only by dropped messages or by signals given by evolutions of the airplane. However, in some army corps the preponderant rôle of aërial observation was understood and an attempt was made to train artillery observers and to make the batteries work with them.

The corps of officers had been carefully built up over a long period of years from abundant sources of supply. The Polytechnic School regularly furnished a sufficient number of men who had a general education and a high grade of scientific knowledge and who were accustomed to methodical habits of work. A very important supplement was furnished by the Military School where the most gifted noncommissioned officers received additional instruction and technical knowledge of real value.* Finally reserve officers formed a real elite, thanks to the guaranties provided by their origin: government engineers, resigned polytechnicians who were graduates of the Central School or of the School of Mines. In the whole army the tradition of work, of professional honesty and of dignity of mind predominated.

The officers' corps was assisted in its task by a proved cadre of regular noncommissioned officers of sound character and possessing valuable technical knowledge.

The general character of the training resulted logically from the ideas which were in vogue as to the future type of warfare and the rôle which the artillery would play in it.

The battle was mainly an infantry maneuver: "The rôle of the artillery therefore will be limited to aiding with all its means, the advance of the infantry." Therefore artillery must be capable of quick evolutions, of opening an unexpected and sudden fire on objectives which will be constantly changing and on many missions of short duration. Our artillery was indeed marvelously trained for this rôle. It knew how to advance quickly, using the terrain properly. Occupation of positions was performed with facility and rapidity. The battery commanders whose rôle was paramount in such decentralized combat as was envisaged, became real virtuosos of firing.

On the contrary, as nobody expected stabilization, the field artillery was not prepared for the solution of topographic and ballistic problems imposed by a stabilized situation.

Inversely the foot artillery, not expecting to fight with the infantry, was in general ignorant of its tactical methods. It was well trained, however, for siege fire and technically well developed. Unfortunately the concept of war then in vogue was not such as to induce the mass

* However, resignations of graduates of the Polytechnic School began to assume alarming proportions and in addition there was less eagerness to obtain epaulets on the part of the noncommissioned officers.

of our officers towards technical study. The example of the foot artillery officers was not followed by their field artillery comrades and no vivifying exchange of ideas had been established between the two subdivisions of the army. Each remained wrapped up in the problems peculiar to the kind of fighting in which they thought they would take part.

II. GERMAN ARTILLERY IN 1914

On the other hand, what were the tactical tendencies, armament and organization of our future enemies?

With us, the Germans expected a war of short duration with quick movements, the form of which could be compared with the campaigns of Napoleon or with the actions in 1870. While our field artillery was supplied with only 1300 rounds per gun, the supplies for their light gun did not exceed 800 rounds per gun.

The Germans also had absolute faith in the superiority of the offensive.

But while our doctrine attributed a predominating value to maneuver and was based on the decisive power of the advance, the Germans understood the power of fire and relied more on its effect. They realized the importance of the defensive phases in battle. They had also foreseen the necessity of the development of all kinds of weapons to increase their fire power and for field fortifications.

Also, in their preparation for war the Germans had especially in mind a conflict with France. The organization and armament of their military forces were based on the special character which would be given to the struggle by two matériel characteristics: the superiority of our 75-mm. gun over their 77-mm. gun, and the fortification of our east frontier.

The adoption by France, in 1897, of the rapid fire 75-mm. gun with an independent line of sight, indirect aiming, and with considerable traverse constituted a real revolution in artillery matériel. Especially the general adoption of indirect fire which permits the use of protected positions and makes the battle difficult for the hostile artillery, as our batteries, protected by the terrain, will escape the fire of guns having a flat trajectory. The Germans immediately understood the danger and wisely recognized that the sole remedy could be found in curved fire. This caused the introducing by them of the 105-mm. howitzer, Model 1898, which after some changes made in 1909, had become an excellent quick-fire weapon equipped with shields and having a mobility equal to that of the field guns. It could throw a projectile 16 kilograms in weight a distance of 6400 meters and, owing to its curved trajectory, could sweep with fire all the protected positions which were used by our artillery. The Artillery Regulations of 1912 determine its rôle as follows:

"The light howitzer accomplishes the same missions as the field gun. It has a much greater efficacy than the gun against defiladed artillery, objectives protected by overhead cover, against localities, and against troops placed in heavy woods."

The development of our defensive organization in the northeast with its fortresses and large fortified regions, against which a great part of the German Army would, by inevitable necessity, have to strike from the beginning of hostilities, required that Germany be well equipped with heavy artillery. But since they had a strong desire to give to the war a strong offensive character, this heavy artillery, in spite of its power, was required to be sufficiently mobile to closely follow the field army and to undertake without delay the attack of our fortifications.

This mobile heavy artillery consisted of:

Howitzers of medium and large calibers (15-cm. and 21-cm.) for destruction of fortified places;

Long range guns of medium caliber (10.5-cm. and 13-cm.) to protect the deployment of the howitzers at effective ranges.

But we can see that this matériel can also be used for other purposes.

The German command believed that the infantry would not be able to advance under modern fire and especially under the fire of the enemy artillery. Thus it was thought absolutely necessary to begin the battle by a systematic struggle with this artillery; a struggle *differently timed* from that of the infantry attack. Tests conducted at Thorn and at the Camp of Wahn with the heavy artillery had shown that the heavy howitzer was especially suitable for this artillery duel.*

General von Dulitz, General Inspector of the foot artillery, concluded from those tests that it is possible to use this artillery in open warfare and that it is necessary to assign to it the task of carrying out the artillery duel. But it will not have this mission only; from the moment that it is in position, it will be employed for all the needs which may occur. Thus the rôle of heavy artillery in the battle is of essential importance.

The German ideas on the use of the artillery, therefore, were as follows:

The long range of the powerful matériels will be used, from the first moment of contact, to prevent the assembling of enemy troops, against columns on the march, and such batteries as can be located. In order to be ready to fulfill this mission without delay, the heavy artillery will have its place in the column either at the end of the leading division, *to which it will be attached,* or, even sometimes behind the mass of the light artillery of this division. It should be pushed to the front at the beginning of the engagement and deployed as soon as possible.

Placed out of reach of the French 75-mm. guns which have a shorter range, it will first protect the deployment of the light artillery. By systematic action, prior to the action of the infantry, it will proceed to the destruction of the hostile artillery. This result being more or less completely obtained, it will then use its power *for preparing*,

* It was proved that a zone fire, of from 80 to 100 shots from a 15-cm. heavy howitzer, put down on a front twice as long as that of a battery and to a depth of 400 meters caused a loss of 30 to 50 per cent. of personnel and 60 to 65 per cent. of matériel. General von Dulitz wrote relative to this: "It has been proved that in the artillery duel, quick results, with a minimum expenditure of ammunition can be obtained. The logical conclusion would be that the early entrance of heavy artillery into the line, and the assignment of this arm to an accordingly proper place in the column, must be the rule."

together with the light artillery, the attacks of the infantry by destroying material obstacles and by demolishing strong points. This preparation of the attack, performed by the whole artillery, will produce a physical and psychological crushing of the adversary and will make him *ripe for the assault* (Sturmreif) at the place where the command wishes to make the decisive attack.

Protected permanently by the fire of the heavy artillery which will clear away a great part of the hostile artillery, the light artillery will freely and efficaciously devote itself to its main mission, the direct and immediate support of the infantry.

It is apparent that this theory was, in several respects, directly opposite to ours which declared a previous artillery duel fruitless, which did not believe in the necessity of preparing for the attacks and which, finally, little convinced of the usefulness and even of the possibility of having the heavy artillery coöperate in all phases of battle in open warfare, relegated it to the rear of the columns and reserved it for special missions.

The armament and the organization of the German artillery were in perfect accord with their tactical doctrine.

The light field artillery matériel, the new type 77-mm., was an excellent gun, although inferior to our 75-mm., if not in mobility and range, at least in rate of fire and efficacy of the projectile. The Germans made up for this deficiency in the individual cannon by using large numbers.

In addition to the flat trajectory field gun there was a 105-mm. howitzer, of an insufficient range it is true, but light, easily manhandled, and supplied with very good projectiles.

All large units, including the division, contained heavy artillery in their organization. The heavy matériel was homogeneous and of recent design, more modern than the few heavy guns which we had. Their range, caliber for caliber, was generally greater; most of them were of the rapid fire type.

Quantitatively our enemies had about:

5500 field cannon of which about three-quarters were 77-mm. guns and one-quarter were 105-mm. light howitzers.

2000 heavy field cannon, the guns with calibers of 10.5 and 13 cm., the howitzers of 15-cm. caliber, and the mortars with a caliber of 21 cm.

With this matériel, one light field artillery brigade of two regiments was formed in each infantry division, which contained all together three groups of 77-mm. guns and one group of 105-mm. light howitzers, each of three 6-gun batteries. Doubling the number of howitzers was contemplated, thus increasing the number from 18 to 36.

Each army corps had ordinarily at its disposal one battalion of 15-cm. heavy howitzers (a total of 12 pieces) and each army a variable number of batteries of 21-mm. mortars. Thus an army of four army corps had an average of 12 to 16 heavy batteries equipped with modern matériel.

All this artillery was ordinarily assigned to the division for employment, without any intervention of higher units. There was not an artillery command either in the army corps or in the army.

The communications equipment at the disposal of the German artillery slightly surpassed ours in quality, as well as in quantity.

Their aërial observation was really superior to ours, not because their methods were more perfect, but because the personnel was better trained in working with the artillery; also they had a greater number of airplanes.

The technical training of officers, noncommissioned officers and troops was, as a whole, comparable to ours. But the recruiting of officers was inferior to ours, as the artillery profession in the German army enjoyed only a moderate prestige, the infantry and especially the cavalry being preferred by the young of the land.

III. THE QUESTION OF HEAVY ARTILLERY

The Light Howitzer

As we have seen, the problem of heavy artillery was solved differently in France and Germany. Against 308 heavy guns which we could mobilize in France in 1914, Germany put in the line immediately more than 2000 heavy guns equipped for field warfare. Furthermore, the tactical employment of these guns was entirely different in the two armies.

In order to properly understand the motives, the reasons, and the form of the evolution which took place in France after the beginning of the war, it is necessary to outline, at least briefly, the history of the question of heavy artillery, to review the discussions occasioned thereby before the war, and to recall the arguments which served as the foundation for official decisions, and which attempted to justify the principle adopted. It is equally necessary to define the point to which the study of heavy guns had progressed. With the question of heavy artillery, was closely connected that of the light field howitzer, a weapon which can be compared, as far as its weight and mobility is concerned, with the field gun, but having a larger caliber and approaching heavy field artillery in the power of its projectiles. The howitzer thus forms a kind of connection and a transition between the two types of artillery.

We have just seen the radical change which had been made in Germany in artillery matériel, in the organization of this arm and finally in the doctrine of its use in battle.

In France we followed the development of these ideas with interest. They found some adherents but more who were in opposition.

The advocates of heavy artillery brought up the same arguments which prevailed in Germany. They added that, in any event, the use of heavy artillery in open warfare would increase the offensive power of the German armies and that we had no more right to remain inferior to them in this respect than in any other. The adoption of a new implement of war is necessary to any army as soon as its use becomes general in another.

Objections made by the opponents of heavy artillery were as follows: The efficacy of a single shot of a large caliber is much higher than the efficacy of a single shot of a smaller caliber. But what must be considered in war, is not a single projectile, but the total weight of ammunition consumed and the effect of a large number of projectiles. The whole question is whether ten five-kilogram projectiles have more efficacy than a single fifty-kilogram projectile. Large calibers had failed against the intrenchments of the battlefields in the Balkans, in Manchuria and in the Transvaal, and the result could be easily foreseen. It is not necessary to have a projectile of from thirty to forty kilograms in weight in order to make a hole in the parapet of a shelter trench, since a small one will be sufficient. To obtain this fortunate hit, which will probably kill three men, it will be necessary, owing to the dispersion, to fire many large projectiles so that the ammunition chests will soon be empty. It is taking a club to kill a fly, with many chances of missing it. The superior morale effect of the large projectile is admitted, but even so troops finally become accustomed to the noise. On this point, we have the testimony of Kuropatkin, Chief of the General Staff of Skobelev at Plevna, who, after having ascertained the inefficacy of heavy artillery against the Turkish intrenchments, wrote, "The material effect was null; on the other hand, the morale effect was excellent—for the Turks. As soon as they became convinced of our impotence, the result was disastrous to the Russian army."

This controversy became a matter for official consideration.

The General Staff of the Army, informed by the 2nd Bureau which continually received reports on the German artillery, became alarmed. It stated that the 75-mm. gun, notwithstanding its indisputable qualities, could not be used against the German light howitzer which had a longer range and would occupy defiladed positions which could not be reached by the flat trajectory of our guns. It maintained that, contrary to the opinion of those who claimed the 75-mm. gun sufficient for all missions of field warfare, it was necessary to have for the attack of the semipermanent fortifications, a more powerful gun than the 75 mm., but one more mobile than the light siege gun, model de Bange.

To meet this requirement, Captain Rimailho presented in 1904 his 155-mm. rapid-fire howitzer (C.T.R.), which was adopted. It had an excellent mechanism and was comparatively mobile, due to its separation into two loads. A limited number of them were immediately obtained.*

The Superior War Council concurred with the opinion of the General Staff. It even considered the solution offered by the heavy 155-mm. howitzer unsatisfactory, because the weight of this weapon, although suitable for siege trains, would limit its use in open warfare. In 1909, the development was ordered of a light howitzer of 120-mm. caliber to be more mobile, better able to keep up with the infantry, and easier to supply with ammunition.

The 3d Department (G-3), and the Technical Section of the Artillery, were of a different opinion. They declared that the light howitzers

* It should be noted that this gun did not show any improvement, from the ballistic viewpoint, over the 155-mm. de Bange howitzer, Model 1881, the tube of which was used. A maximum range of only 6300 meters could be obtained by it while the 15-cm. German heavy howitzer, which came out two years earlier had a range of 7400 meters and about the same mobility.

were used by the Germans for the artillery duel only because their 77-mm. shells were not effective against the personnel of our batteries having splinter proof shields, and also that the information obtained on the results of the firing of German howitzers led to erroneous deductions. The War Academy was of the same opinion.

Parliament was not indifferent to the dispute. It was disturbed by our unquestionable inferiority in heavy artillery as compared with Germany and gave full expression of its anxiety in the discussions of the budget of 1910. This anxiety was expressed in a manifesto which made its appearance in the winter of 1910–1911, the conclusions being as follows:

> The organization of the foot artillery in Germany is eminently offensive. In France it is only defensive and its contemplated use appears to be limited to siege operations.
>
> The Germans have many heavy guns, of recent design, mobile, improved, and of the rapid-fire type. We have but few, these being of out-of-date design of the slow-fire type, requiring the use of platforms, and without mobility.
>
> The doctrine of the use of heavy artillery is a positive one in Germany where they believe in large guns and will use them in all phases of battle. It is entirely negative in France where large calibers are not favorably considered or at least it is not admitted that their effectiveness is in keeping with the weight of their projectiles.
>
> Thus our organization is inadmissible. It is necessary that our field artillery be made an offensive arm by providing it with new matériel. From this viewpoint the 155-mm. C.T.R. is suitable neither for siege operations for which it is inadequate nor for field warfare, the urgent demands of which it cannot satisfy. We need another light howitzer in the army corps, also a long-range gun of great power in the field army.

The Chief of Artillery, representing the Government in the discussion of the budget, thought it necessary to calm the fears of Parliament by declaring at a public session that the military authorities had not forgotten this question and that the first tests of certain matériels, being developed in the Puteaux works, had been satisfactory, particularly the matériel of double caliber, 75/120, and that adoption as standard would soon be recommended.

This optimistic declaration was, to say the least, premature; in 1911 all these matériels were only in the stage of preliminary tests. In the press, as in Parliament, authoritative voices were raised in protest against this slowness and delay. Attributing these delays, not without reason, to the disappearance of the Artillery Technical Committee which had been suddenly suppressed by a decree of August 22, 1910, they asked for the establishment of a permanent organ "charged with the study, from the technical viewpoint, of all questions concerning matériel and armament and with informing the Minister of War on the matter." A new organ was established by a decision of the Minister of War in September, 1911, in order to satisfy this wish. This organ, which took the name *Commission of New Matériel,* had the mission of establishing programs for the studying of these matériels. It immediately started to work and did its utmost.*

After less than one month, October 28, 1911, its President proposed, for approval of the Minister of War, characteristics and a program for tests of a field howitzer and of a long-range medium-caliber gun. The light howitzer was to be capable of rapid fire, sufficiently mobile to keep up with the 75-mm. gun, sufficiently powerful to produce demoralizing and destructive effects greater than those of the 75-mm. gun. It was to have a wide field of fire and the greatest possible range consistent with the limitation as to weight.

The gun was to be especially designed for long-range fire (12 to 13 kms.) against slightly protected objectives, *i.e.,* zone targets, enemy batteries, etc. The requirements for horizontal and vertical fields of fire were the same as those for the howitzer. The gun was to be capable of being drawn at a walk by six or eight horses on passably maintained or even partly torn-up roads, and of rapid occupation of position even on ploughed ground without requiring pioneer work.

It was decided that the construction of these matériels should be opened to competition so that private industry could take part as well as government arsenals, a measure which was a radical departure from previous practice and which had, as will be seen in this study, the most favorable consequences.

In February, 1912, the Puteaux works presented the two matériels which the Chief of Artillery had discussed with Parliament in 1910, one of 120-mm., the other of 75/120-mm. calibers. Neither of these was found to be satisfactory.

The next month the Schneider works presented a 105-mm. howitzer, which had been constructed for Bulgaria, and a long gun of 42 lines (106.7 mm.) constructed for Russia. The 105-mm. howitzer was entirely satisfactory and exactly answered all the demands of the program. The Commission proposed that one battery be tested during the autumn maneuvers and later by the Commission of Practical Field Artillery Firing at Mailly. The 42-lines gun departed considerably from the conditions of the program. Nevertheless firing tests were satisfactory and the Commission decided to continue the trials and ordered one platoon of this matériel for the autumn maneuvers.

The maneuvers in the West in 1912 had shown to all those who were unprejudiced, the necessity for these heavy field matériels. The two maneuvering forces were on several occasions separated by wide and deep valleys, the bottoms of which could be reached only by curved fire guns, while on the other hand, the width was such that only a long-range gun was able to fire from one side to the other without showing itself on the crest. After a new series of very satisfactory firing tests at Calais in January, 1913, in the presence of the Chief of

* The Commission of New Matériel was presided over by General de Lamothe. The country owes an eternal gratitude to this general for his remarkable foresight and for the unfailing ability with which he directed the work of the Commission. We will see how this work made our production of a powerful modern heavy artillery possible with a minimum delay during the war.

Staff of the Army, the Commission decided to adopt the 42-lines gun which the Schneider works agreed to reduce to a caliber of 105 mm. Notwithstanding these decisions and the urgency announced by the Chief of Staff of the Army, there were long delays in the delivery of the matériel. Thus the first guns were just being made when the war broke out.

The 105-mm. gun did not, of course, fulfill all the requirements called for in the program. Its range and power were not sufficient and were distinctly inferior to the German 13-cm. gun. Accordingly the Minister of War accepted, in theory, the proposed construction of a gun of about 135-mm. caliber, firing a projectile of forty kilograms and having a range of from sixteen to eighteen kilometers. At the same time the construction of a 155-mm. gun of very long range, transported on two vehicles, was studied.

Awaiting the manufacture of these new guns, which would take time, consideration was given to modifications increasing the range and mobility (program of September, 1912) and the utilization of the old heavy guns in service, the 130-mm. gun and the 155-mm. gun. In this connection Lieutenant-Colonel Rimailho studied the possibility of utilizing the 120-mm. gun, Model 1878, on the carriage of his 155-mm. C.T.R. howitzer, by which a notable increase of range could be expected.

During the elaboration of these programs, the tests of the light howitzer were conducted at Mailly, and at the same time the Commission of Practical Firing was looking for a remedy for the limitations of the 75-mm. gun when firing against objectives defiladed behind crests. Three expedients were proposed:

> The use of a reduced charge, which had the disadvantage of complicating the ammunition supply.
>
> A time fuze for the explosive shell, this being opposed *a priori*, for reasons difficult to understand, by the fanatical and exclusive adherents of the 75-mm. gun.
>
> Thirdly, Captain Malandrin proposed that disks, as used by testing boards to prevent ricochets, be used to increase the curvature of the trajectory.

This latter proposal, which had the advantage of immediate applicability without appreciable expense, was recommended *as a temporary measure* by the President of the Commission of New Matériel, while awaiting the construction of light field howitzers, the adoption of which he considered urgent and indispensable. Neither the President, nor even the author of the proposal, suspected the success which was to be obtained by biased publicity given this device, nor foresaw the profoundly regrettable decision, for which it was to serve as a pretext.

On March 7, 1913, a highly important meeting for the conclusion of the test was arranged. The Minister of War, the Chief of Staff, members of the Superior War Council, the Military Affairs Committee of the Chamber of Deputies and of the Senate, and the Commission of New Matériels, were present.

The Mailly Commission expressed the opinion that the projectiles of the howitzer were not satisfactory and when using time fuzes had a prohibitive dispersion.* On the other hand, the great expense necessary for the construction of the howitzer influenced the members of Parliament who were most anxious to conserve the finances of the country.

Accordingly, the cleverly presented proposal to use disks was enthusiastically accepted as it had both the advantage of economy and of a quick and simple solution. The point was made that the use of disks made a double purpose weapon of our 75-mm. gun; a flat trajectory gun and a howitzer with curved fire, the latter being exactly what the adherents of curved fire wished since they would have 36 curved-fire guns per division, instead of the few howitzers for which they asked.

In vain the President and several clear-sighted members of the Commission of New Matériels brought out that this crude proceeding, ballisticly unsound, was only a temporary expedient and not a final solution, and that the entire question of the howitzer still remained. Nobody listened to them and the light field howitzer, implacably rejected, was replaced by a makeshift which was promptly condemned after the outbreak of war.†

Tests of new matériel which were scheduled for competition in 1912, were continued during the year 1913.

On October 31, 1913, a recapitulatory meeting, concerning the modified 155-mm. gun, Model 1877, the 280-mm. Schneider mortar, and the 105-mm. gun, was held at Calais in the presence of the Minister of War.

With the 155-mm. gun carriage presented by the Schneider firm, a range of from twelve to thirteen kilometers was obtained, or a range of from three to four kilometers longer than before. The 280-mm. Schneider mortar was a complete solution of the problem of large mortars. Also the 105-mm. gun, made by the same firm, once more established its tactical and ballistic qualities. The tests being entirely favorable, all three matériels were accepted, but their supply was delayed by considerations of secondary importance and the war broke out before the five regiments of heavy artillery which had just been organized, could be armed with this modern matériel of unquestioned value.

However, the debates on the usefulness of heavy artillery, the first phases of which we have already sketched, were far from being ended in France. General Herr, commander of the artillery of the 6th Army Corps, on leave of absence, but without any official mission, had visited, in November and December, 1912, a part of the theater of operation in

* They abstained from stating that the dispersion of time fuze fire with a curved trajectory could be greater than that of flat trajectory fire without affecting the efficacy to a great extent and that in addition the manufacture of fuzes by Schneider had not the precision obtained by the Pyrotechnic School in Bourges which would be intrusted with this manufacture if the matériels were accepted.

† It is interesting to note how much the realities of war changed the peace-time opinions. Of the three proposals for the improvement of the effect of the 75-mm. gun: reduced charge, time fuze for the explosive shell, and employment of small disks, the latter was adopted in peace-time. The experience gained during actual war caused its early abandonment, and proved the value of the two other proposals, both of which after being tested were found excellent, were adopted, and rendered brilliant service.

the Balkans a few days before the conclusion of the armistice. He had the opportunity to consult the Servian and Turkish artillery officers who had taken part in the great battles and he was absolutely convinced by this investigation that *long-range heavy artillery* was indispensable in modern battle and that it should work in constant liaison with the light artillery. For this reason it should be included in the *army corps artillery*. The publication of his report in 1913 caused a stir in military and parliamentary circles. The adherents of the 75-mm. gun, irreconcilable opponents of all heavy artillery, started a violent campaign in order to nullify his statements. They found among officers who also had visited the Balkans after the war, some who made formal contradiction of his statements and even questioned his good faith. A note by the General Staff of the Army of January, 1914, summarized the arguments of the opponents of heavy artillery. After a detailed comparison of the French and German field artilleries, this note concluded with the statement that the few groups of 120-mm. guns and 155-mm. C.T.R. howitzers which we possessed, reënforced by 105-mm. gun batteries, would be sufficient against the German heavy field artillery in the very rare cases where the 75-mm. gun would be unable to combat it and that besides "a maneuvering artillery which knows how to use the terrain will be able to get within suitable distance of the enemy and will only rarely need a long-range gun." This was the theory of the superiority of maneuver over fire applied to the artillery.

Such was the status when the war came and ruthlessly ended the argument by deciding in favor of the proponents of heavy artillery. We will see later on how sound were their tactical conclusions, and see how the technical studies instigated by them, and carried on thanks to their patriotic insistence, facilitated and accelerated the creation, during the war, of a heavy artillery suitably adapted to the requirements of modern war.

Debates on heavy siege and fortress artillery were more temperate and an agreement on this matter was quickly reached, since opinions were less divergent and of less public interest.

In 1909, the President of the Artillery Committee considering, on the one hand, that the existing siege and fortress matériel was no longer suitable for modern war, and on the other hand, influenced by the lessons of the siege of Port Arthur and by the results of certain firing tests conducted in France, obtained from the War Department and from the Fortress Commission, approval of a program along the following lines:

Maximum utilization, by simple modifications of the matériel then in service;

Long-range guns, to be assigned during the attack to act on the morale of the besieged by long-range bombardment, and to be assigned, in the defense, to hinder and delay the investment;

High-powered mortars intended to fire against concrete and armored works;

For all models, a mobility sufficient to assure quick occupation and change of position.

This matériel was to consist of:

Two types of long-range guns (from 13 to 14 kilometers), improving the existing 155-mm. and 120-mm. guns;

A light howitzer with a caliber of 120 mm.;

A 370-mm. mortar operating on a 60-cm. light railway;

A gun of small caliber, and a small mortar for the close defense of fortresses.

The 370-mm. mortar was constructed by Captain Filloux by 1913 and was ready for its preliminary tests before the end of that year. On the other hand, nothing was done on the other matériels. The President of the Commission of New Matériels submitted to the Minister, on February 20, 1913, a new program which took account of the progress which had been made abroad and of tests conducted in different countries on the resistance of concrete and armored works. This program consisted of:

A long-range 135-mm. rapid-fire gun superior from all viewpoints to the German 13-cm. gun;

Utilization of the existing 155-mm. gun on a new carriage giving increased range, and which would not require a firing platform.

Continuation of the manufacture of the 370-mm. Filloux mortar;

The manufacture of a 280-mm. mortar, in place of the existing 270-mm. mortar, the tests of which, made in Ochakoff, had shown insufficient effect on concrete works and armored turrets;

Modification of the 155-mm. Rapid-fire Howitzer, Model 1904, to allow transport on a single vehicle;

Modification of the 155-mm. Howitzer, Model 1881, to allow more rapid fire.*

This program was partially accomplished upon the outbreak of the war. The stabilized character of the war caused the utilization of the modified old guns (155-mm. gun, Models 1877–1914; 155-mm. C, Models 1881–1912) and of the new matériels (280-mm. Schneider mortar, and 370-mm. Filloux mortar).

To sum up, this brief review is sufficient to show that although the French Army was behind the German Army in the *manufacture* of heavy artillery (field artillery, siege artillery and fortress artillery), and although the *doctrine of employment* of artillery was still the subject of passionate discussions, the war did not take us entirely unprepared as concerns the *preliminary studies* and the *preliminary tests* of the matériels. Government as well as private factories had satisfactory models ready for manufacture as soon as the order should be given. It was only necessary to give this order and to arrange for quantity production. We will soon appreciate the fortunate results of this preparatory work, which shortened by several months the delay in the accomplishment of the intensive heavy artillery program.

* This modification had already been accomplished by Major Filloux during the preceding year (1912).

IV. ANTIAIRCRAFT ARTILLERY

The airship and the airplane, upon their appearance, were immediately acknowledged as formidable weapons which must be taken into consideration in a future war, and everyone appreciated the necessity of being able to stop or at least to hinder their observation and reconnaissance, and of developing a defense against their offensive missions.

The gun was obviously the arm indicated for this purpose. But the conditions of fire against aërial targets are entirely different from those of terrestrial targets. To hit flying targets which have great speed, matériel must have a large vertical and lateral field of fire, a rapid rate of fire and a high muzzle velocity.

Guns used for terrestrial targets did not have these requirements to a sufficient degree. Two solutions were presented: first, to give the ordinary guns the qualities which they lacked, thus making them suitable for firing at any target, aërial as well as terrestrial; second, to make new matériel, especially for use against aërial targets.

The first solution was at first sight the most attractive: it would be extremely advantageous if all artillery could accomplish all missions. Accordingly a solution was first sought by improvement of existing matériels, especially the 75, or by the development of a general utility gun suitable for aërial as well as for terrestrial targets.

Colonel Deport, who had left the army, but continued his studies of rapid-fire guns at Chatillon-Commentry, constructed as early as 1909, a gun which, owing to its split-trail carriage, had a horizontal field of fire of 900 mils and a vertical field of fire of from –10º to +50º. He stated that this gun was suitable for antiaircraft firing. When offered to the Commission of New Matériel in April, 1912, the Deport gun was not accepted.* The Minister of War, for other reasons, already had ordered that a study be made for the improvement of the 75-mm. gun, Model 1897. On the recommendation of the President of the Commission, he now decided to include in this study a requirement for firing at aërial targets. This requirement was to be extended to all the new field matériel including the light howitzers, but excepting the mobile heavy artillery. A development along these lines was approved in October, 1912, but by August, 1914, no solution of value had been proposed.

Few officers were much concerned over the situation. According to them (that was the theory of the regulations) the 75-mm. gun, Model 1897, was sufficient for all missions; thus it could be also used for firing at aërial targets. Of course, as high angles of elevation were to be used, a special arrangement for increasing its vertical field of fire was necessary; but they expected to find the solution by building a special platform of the form of a truncated cone, elevated over the surrounding terrain, and encircled by a ditch, in which the trail would be moved. This very simple arrangement, improvised when needed with a few strokes of the pick-ax, would make it possible to give to the gun an elevation of 45 degrees, which was thought sufficient for use

* Colonel Deport was authorized to offer his gun to foreign countries. Italy accepted it as a field gun a short time later.

against airplanes and airships, which at that time were flying very low.

Fortunately several officers of the Puteaux works, excellent technicians, to whom we owe the greatest homage, had another conception. They had realized as early as 1907, that the greatest factor in the antiaircraft problem was that of the carriage. They saw the necessity for a special carriage, or a special platform which would admit of quickly aiming the gun at any point in space, and of easily following all the movements of a rapidly moving target. A carriage, in order to fulfill these requirements would unquestionably be very complicated, making it heavier than permissible for a field gun, thus making mechanical traction necessary. Another consideration lead to the same solution: the antiaircraft guns, being special matériel, would be limited in number; thus they could fulfill their mission only by compensating for their small number by being able to change position with great rapidity. Furthermore, at that time firing against airships was the main consideration: only a gun with motor transport would be able to reach, in time, the course signalled as being followed by the airship. The antiaircraft gun must therefore be incorporated with a special motor vehicle.

With this conception, the correctness of which was proved by the experience of the war, the technicians of the Puteaux works succeeded in manufacturing, in 1914, a 75-mm. motor-gun the perfection of which was never surpassed or even equalled by any other weapon, either French or foreign. Of course, during the war its sighting mechanisms were modified, improved fire-control devices were added, and improved methods of firing were adopted. Thus its efficiency was materially changed, but its basic construction was still the same.

Unfortunately in August, 1914, *only one gun* of this excellent matériel existed and many months were needed to put its manufacture on a large scale. However, in the case of the antiaircraft artillery, as in the case of the heavy artillery, all the preliminary design was completed, all the studies finished, and it was only necessary to begin manufacture.

CHAPTER II

THE FIELD ARTILLERY DURING THE WAR

I. OPERATIONS BEFORE STABILIZATION (1914)

THE war broke out on August 2, 1914. In the first clashes, two fundamental defects in our theory of tactics and in our organization were discovered; a misconception of the efficiency of fire, and the inadequacy of our heavy artillery, both as to quality and quantity, and the poor use of its fire.

In the second half of August all the French armies assumed the offensive and began the *Battle of the Frontiers*. In Lorraine, the Ardennes, and Belgium, everywhere, the scene was the same.

Our light artillery was often surprised in march column by the long-range fire of German heavy artillery, and had to go into action hurriedly on heavily wooded terrain full of natural obstacles and such that maneuvering and the effecting of liaison were difficult. The range of our guns was insufficient to reach the enemy heavy artillery, which sprayed us with projectiles, without our being able to reply, thus causing our disorganization. The battle developed so quickly that our modest heavy artillery, which marched at the rear of the columns, could not intervene at the proper time and so allow our 75-mm. guns to give the necessary support to our infantry which, in most cases, did not even ask for it.

Our infantry, full of dash, and lead by officers and noncommissioned officers inspired with the most marvelous offensive spirit, launched itself in attack, as taught by the Regulations, before effective artillery support could be provided. It hurled itself against an intact enemy infantry prepared and awaiting our attack, protected by trenches, and often by barbed wire.

The entire fire power of the enemy—rifles, machine guns, light guns and heavy guns—retained its complete freedom of action and its power of destruction. The enemy fired as if at maneuvers, literally mowing down our unfortunate infantry which suffered horrible losses, especially in officers and noncommissioned officers, and was forced to recoil.

The French High Command wisely decided to stop a contest so poorly initiated, in order to reorganize, select position and renew the offensive with a united force. To stop, or at least slow down the enemy advance, the use of obstacles and of short, violent counterattacks was ordered. As to tactics, the preparation of the attack by the artillery was recommended, as well as a modification of the rate of our infantry advance during attack, and the use of more open assault formations.

In the meantime, the enemy assumed the offensive, penetrated French territory and marched on Paris. Their heavy artillery could not always keep up with the infantry advance during their rapid offensives of this phase, and they frequently felt keenly its temporary absence. Our 75-mm. gun now regained its advantage and being free to apply its deadly qualities against unprotected targets at short range, at times veritably massacred the German infantry. Our difficulties began again as soon as the German heavy artillery caught up with their infantry. We were forced to withdraw, retreating before the "big blacks" to whom we could not reply.

So we come to the *Battle of the Marne*. Our High Command now considering the strategical situation favorable, set the morning of September 6th for the resumption of the offensive. Our infantry, reinforced, and warned by its previous experience, was more prudent and gave an exhibition of remarkable qualities. On the other hand, the enemy infantry, excited by its first successes, with less support from its artillery, which could hardly keep up, and was short of ammunition, suffered heavy losses from the short-range fire of our 75-mm. guns.*

The enemy, hard pressed, retreated to the natural fortress which was formed by the plateaus between the Oise and Aisne. Their heavy artillery, which due to the shortening of their line of communications, had been able to rejoin and be resupplied with ammunition,

* At La Vaux-Marie, for instance, September 10th, a violent attack of the Crown Prince's Army was checked on the spot by the mass action by all the artillery of the French 6th Corps.

again nullified our field artillery which was held out of range. After a series of violent engagements in which our troops suffered greatly from severe bombardments by the German heavy guns, the two adversaries were forced to recognize their impotence for the moment. The battle of the Aisne came progressively to an end as was already the case in Champagne, Lorraine and Alsace, and little by little the front became fixed.

Then commenced the so-called *"Race to the sea,"* which resulted in the bloody battles of the Iser and Ypres. Notwithstanding their large forces, the support of powerful heavy artillery brought from Antwerp, and the presence of the Kaiser, the German armies finally suffered an indisputable defeat at a cost to them of about 500,000 men. This result was due unquestionably to the heroism of the allies, effectively supported by our artillery which, well supplied with ammunition (by diverting the supply from the already stabilized fronts) performed wonders against an imprudent infantry, less trained and not so well commanded as that previously encountered and which was thrown into the attack in compact masses by commanders who wished victory at any price.

There also the front became stabilized about November 15th. Everywhere operations on a large scale were prevented due to the lack of artillery matériel, and especially of ammunition. This was the beginning of the long crystallization of the so-called *trench warfare*.

What did our embryo heavy artillery do during this first phase? It had to be squandered in order to compensate for its numerical inferiority. Thus the first group of 120-mm. long guns with mechanical traction* used in the III Army until the Battle of the Marne, were on September 20th brought to the vicinity of Rheims after having traveled over 700 kilometers. They departed again on October 16th and having covered 300 kilometers in four days opened fire on October 20th on the Yser. We had often lost heavy artillery guns during the retreat. Also in order to compensate for the insufficient range of our heavy artillery the maximum charge was always used, thus wearing out the tubes. By September 10th a group of 155-mm. C.T.R. howitzers, assigned to the IV Army, had only one gun in firing condition; all the others were worn out.

LESSONS

This first part of the war was rich in lessons.

Power of Fire.—The first battles proved to everybody the terrific power of fire, that it could disorganize, decimate and stop the best of infantry. We were its first victims during the battles on the frontiers but later the Germans also paid a heavy toll, suffering tremendous losses, especially at the battle on the Yser.

Expenditure of Ammunition.—This intensity of fire could, however, be obtained only at the price of an expenditure of artillery ammunition

* The only tractor-drawn group which we had at that time. This was in some degree the father of our artillery with mechanical traction.

far in excess of that contemplated before the war. We started the war with 1300 rounds per 75-mm. gun, and by the end of the battle of the Marne, the supply had diminished alarmingly. The French Command could supply 75-mm. shells for the battle on the Yser only by entirely depriving all other parts of the front. Fortunately for us the same error in estimation had been made by the German Command and their 77-mm. guns, supplied with only 800 rounds per gun, were short of ammunition after the battle of the Marne. Only the more adequate supply for their heavy artillery,* which moreover had fired less, was sufficient to last until November.

Importance of Heavy Artillery: Caliber and Range.—Notwithstanding its marvelous qualities, and contrary to the opinion which had been held by many in France, the 75-mm. gun was not sufficient for all missions on the battlefield. It destroyed infantry appearing within range in too dense formations. It annihilated batteries venturing within range, if taken by surprise. But in many cases the caliber and the range were inadequate.

The heavy German artillery, and especially the 15-cm. howitzer, showed remarkable power. The larger quantity of explosive of the heavy shells was absolutely necessary for the destruction of obstacles, for the demolition of strong points and for the leveling of trenches. The morale effect of their explosions was considerable: it was sometimes sufficient, especially at the beginning, when the effect was doubled by surprise, to cause evacuation of a position before the arrival of the hostile infantry or to completely interdict a route of approach.

To the advantage of large caliber was added the benefit of long range. Heavy artillery had a longer range than the light artillery. In many advances the Germans could attack, delay and even disorganize our columns with heavy howitzer shells, while our artillery was unable to intervene effectively. With their long-range guns, especially with the 13-cm. guns, they could harass our back areas, annoy our reserves, disturb our command, make our withdrawals very costly, and on the other hand facilitate the retirement of their own troops.

Necessity of Counterbattery.—The harassing and demoralizing action of the German artillery made clear, from the beginning, the advantage which would be obtained by silencing it with counterbattery fire.

Besides, the peculiar idea previously mentioned, that the artillery duel should be given up under the pretext that it is never decisive, was changed. It was understood that if the artillery duel should not destroy the hostile artillery, it could at least neutralize it and stop its firing. Unfortunately we were badly armed for counterbattery. Neither the range nor the power of our 75-mm. guns was sufficient for this task and we learned, to our cost, the correctness of the German opinion as to the special fitness of heavy artillery for counterbattery.

Insufficiency of Observation and Communications Equipments and of Aviation.—The effectiveness of the fire on the one hand, and the long

* German heavy artillery had a supply of 4000 rounds per gun.

range of the German guns on the other, caused going into action at unprecedented ranges. Commanders of groups or of batteries, if close to their guns, were unable to observe. They had to advance several hundreds, sometimes several thousands of meters, to a crest from which they could see the infantry dispositions and the locations of the enemy batteries. But to maintain touch with their units, and to continue the fire, they had to be provided with means of communication, particularly the best one, the telephone. Hence we must acknowledge that before the war we committed a serious error in equipping our batteries so scantily with means of communication. After the first experiences our artillerymen tried to rectify this error. They could be seen everywhere searching post offices and private houses to find telephones, or even a few meters of wire which they so cruelly needed. An Army Corps Commander sent one of his officers to Paris with the mission of buying there any telephone material which he could find.

Terrestrial observation should be supplemented, at long ranges, by aërial observation. But military aviation had only just been born. The few airplanes which were at the disposal of the command were used for general reconnaissance. However, in several corps some were given to the artillery and they did excellent work by spotting batteries in action or by informing us by signals, of pending infantry attacks, thus allowing the artillery to crush the enemy with a heavy, effective and unexpected fire.

MEASURES TAKEN TO CORRECT DEFICIENCIES

In the minds of the troops, the outstanding artillery feature was the irresistible power of heavy artillery. To the High Command, enormous expenditure of ammunition, the rapidity with which our ammunition reserves were disappearing, and the absolute inadequacy of production, were matters of grave concern.

To meet the most urgent needs, it seemed wise to use everything available. Early in September, the Commander-in-Chief authorized several armies to borrow from the ammunition supplies of the eastern fortresses; a few days later, he asked the Minister of War for authority to take, first, guns, and secondly, personnel, from the heavy artillery of the fortresses (95-mm., 120-mm. and 155-mm. guns; 155-mm. howitzers, and 220-mm. mortars) and then even to use the Coast Artillery (270-mm. mortars and 14-cm. and 16-cm. guns). In this way we could improvise the heavy artillery which we lacked, in order to hold our own against the powerful guns of large calibers with which our adversaries were provided. Finally, in a letter of October 14, 1914, the Commander-in-Chief drew up a detailed program for the utilization of all our resources in matériel. This program can be summed up as follows:

1. To organize 100 batteries of 90-mm. de Bange guns to supplement the 75-mm. guns until the manufacture of ammunition should be sufficient;
2. To form, as quickly as possible, mobile groups of 95-mm. and 120-mm. guns, using these to organize heavy corps artillery;

3. To continue the organization of batteries: of 155-mm. guns, with wheel shoes (cingoli), to be fired on platforms; of 155-mm. howitzers, Model 1912; and of 220-mm. mortars then in the service of the foot artillery units;
4. To provide the armies with heavy draft teams in order to make the movement of these batteries possible;
5. To study and provide, with the shortest delay, for the organization of units equipped with more powerful matériels borrowed from the Navy or Coast Artillery, or manufactured by private industry.
6. To replace, in all these matériels, the black powder with which they were still supplied, with smokeless powder.
7. To supply all units with telephone wire.

The accomplishment of this program was started immediately. It was this obsolescent heavy artillery (95-mm. guns on field carriages or on the siege and fortress carriages, 120-mm. and 155-mm. guns on siege carriages provided with wheel shoes, 155-mm. howitzers, Models 1912 and 1904, and 220-mm. and 270-mm. mortars) that we kept our enemy respectful during the first years of the war. Even at the end of the war a great number of these old guns were still in service at the front. Although out of date, with slow fire, mounted on rigid carriages, they had been so well designed from the ballistic standpoint by Colonel de Bange, and so well manufactured from the metallurgic standpoint by the artillery arsenals, that they still put up a brave front, forty years after they were placed in service, and allowed us to wait without too flagrant an inferiority, for the issue of more modern guns. We must pay the most respectful homage to the artillerymen who in 1877 and 1881 provided us with such remarkable artillery.

The program of October 14th was completed by a directive issued to the armies on November 27, 1914, by which every army corps was provided with a group of heavy artillery (either 155-mm., 120-mm. or 105-mm. guns). We must remember this date which marks the change in our ideas concerning heavy artillery.

But if it was important to provide our armies with powerful guns, it was still more urgent to put at their disposal the ammunition necessary to supply the artillery they already had. As we have seen, the situation from this viewpoint was, after the battle of the Marne, a most alarming one. The initial stocks, which did not exceed 1300 rounds per 75-mm. gun, were almost exhausted* and the daily production which had been planned, only 13,600 rounds of 75-mm. ammunition and 465 rounds of ammunition for the 155-mm. C.T.R., was entirely insufficient not only to build up a supply, but even to meet the needs of current consumption. Thus radical measures were imperative; the following steps were taken without delay:

1. Economizing of the remaining ammunition for 75-mm. guns by putting into service old guns of 90-mm. caliber and even the

* There were only 500 rounds per gun, 250 of which were in the reserve of the General-in-Chief. Thus the batteries no longer had in their ammunition chests the prescribed 312 rounds. The daily production of 13,600 rounds represented the ridiculous number of three or four rounds per gun.

80-mm., for which large supplies of ammunition still existed;

2. Increasing considerably the production program.

In principle the wartime manufacture of ammunition was to be only in government artillery arsenals;* private industry was depended on only for raw materials. We corrected this error, and made an energetic appeal to private industry. On September 20th, the Minister of War held a conference at Bordeaux, in which the principal manufacturers in France were called together and where the foundation of a real mobilization of industry was laid. The Commander-in-Chief asked on September 15th, that the daily production of 75-mm. shells should be raised, in the shortest possible time, from 14,000 to 40,000 shells, or that it be about tripled. The Minister of War decided that the daily production of 75-mm. shells should be increased to 100,000. Soon afterwards he ordered the manufacture of heavy artillery shells, which had not been hitherto planned. But several months passed before the desired production could be reached.

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* And by the government powder arsenals as far as the manufacture of powders and explosives was concerned.

(To be continued.)

PRELIMINARY R.O.T.C.

YOUNG Dave was brilliant as could be—
    At least that's what his mother said.
But as for his geography,
    He couldn't get it through his head,
Until to ask the boy began
    What dad had fought as in the war.
"Son, I was an artilleryman."
    (His father wished he'd asked before.)

Now Dave has got the world down cold
    And every target he locates.
Each country, whether new or old,
    He plots out in coördinates.
His teacher marvels at the change
    But shivers when he says, "I'll slap
In twenty rounds. I've got the range."
    For Davey's firing by the map.

FAIRFAX DOWNEY.

PORTÉE ARTILLERY IN THE HAWAIIAN DIVISION

BY LIEUTENANT CHARLES W. HENSEY, F.A.

[EDITOR'S NOTE.—The earlier experiments mentioned in this article were conducted by Captain Charles W. Mays, then commanding Battery B, 13th Field Artillery. An article by Captain Mays regarding this subject appeared in the March-April, 1925, issue of THE FIELD ARTILLERY JOURNAL. The later series of tests mentioned were conducted by Captain Henry E. Tisdale, then commanding Battery D, 13th Field Artillery. Lieutenant Hensey had extensive experience with this type of transport while assigned to the latter organization.]

DURING the late war in France, when it became necessary to move light field artillery over a long distance in a minimum of time, it was found that the best means of transportation was to carry the guns and caissons on trucks and trailers until a point was reached near the front, where the guns and caissons were unloaded and moved to their positions in the lines by some means, otherwise provided. This method of transportation for light field artillery seems to have originated in the French Army, and became known as portée artillery.

Due to the particular tactical situation confronting the Army on the Island of Oahu, Hawaiian Department, it is considered desirable to have certain units of light artillery that are capable of moving thirty to forty miles in the least possible time. As the running gears of our guns and caissons are not designed to travel at high speeds over a distance of any length, it was believed that their construction mitigated against towing this matériel behind fast-moving vehicles.

In the spring of 1924, the 13th Field Artillery was ordered to conduct experiments to determine the capabilities and limitations of portée transportation including some method of transporting the gun tractors. Preliminary experiments quickly indicated that carrying the gun and one caisson in the truck and towing the tractor on a trailer was the most favorable combination.

The portée method as above modified was found to provide an excellent means of transporting light tractor-drawn artillery when a march of considerable length has to be made in a short time. When a point is reached where it becomes necessary to leave the road and move the guns and caissons across country, the matériel is unloaded and travels under tractor power to its destination. There is thus no loss of mobility or speed in occupying a position after reaching a point beyond which the trucks cannot travel.

It was demonstrated that on dry, good, fairly level roads speeds of twenty-five to thirty miles per hour can be attained should the emergency be such as to justify it. For peace-time training it is not believed that speeds of over twelve to fourteen miles should be employed and this speed should be materially decreased when on grades—either up or down.

The practicability of this method of transport was demonstrated on dirt roads in good weather and on good roads under all weather conditions encountered on Oahu. Many "around the Island" marches have been made under adverse conditions, including both the ascent and descent of the steep side of Nuuanu Pali.

The initial experiments having indicated the tactical value and practicability of this method for local conditions, the 13th Field Artillery was ordered to conduct more extensive experiments, with the object of determining the best methods of loading and unloading, standardizing the equipment and gaining further practical experience in road marching.

Great strides have been made along these lines, but perfection has by no means been attained. A good, feasible working basis, however, has been established and some remarkable results obtained.

In the following discussion it is not intended to go into the minute history of the evolution of portée artillery, but to enumerate some of the main points learned from the experiments conducted since the initial experiments above mentioned. This discussion is divided into three parts: (1) equipment, (2) loading and unloading, (3) marching and march discipline.

EQUIPMENT

The subject of equipment brings up the question of special equipment, available equipment, and alterations or modifications of the latter.

Much might be written about special equipment, such as specially built trucks and trailers with a number of built-in features to facilitate loading and unloading, blocking, etc. This is something for our technical experts in the Ordnance Department to ponder over, and we must be content with, and confine ourselves to, the available equipment. However, there are a few items of equipment that have to be made especially for portée artillery, such as tractor ramps for the trailer, gun ramps for the truck, channel guides for the truck (to prevent side movement and to facilitate blocking the load), specially cut blocks (for chocking the load), tractor logs (to prevent tractor from climbing on gun ramps), and connecting bars (to couple the tractor to the trailer). All of these can be made at any ordnance machine shop.

The tractor ramps (No. 5) now used are the result of much experimenting and are built up of three 3 × 6 inch timbers 9½ feet long, placed edgewise and bolted with 3 × 6 inch spreaders between them at the upper and lower ends and in the middle, making an overall width of fifteen inches. On the top surface, placed one foot apart and inlayed one-half inch, are nine 1 × 1 × 15 inch steel bars fastened to the timbers by means of counter-sunk screws. On the upper end are bolted two z-shaped bearing brackets made from ¾ × 4 inch steel having an overhang of six inches. The lower end of the ramp is beveled on the under side so that it rests horizontally on the ground and is covered with a shoe made from ¼-inch boiler plate.

The gun ramps (No. 1) are built up from the gun ramps furnished with the 3-inch gun trailer or are made from 6-inch U-beams or 6-inch I-beams 9 feet long. If the 3-inch trailer gun ramps are used, they must be reinforced on the under side. The gun ramps must have a bearing bracket on the upper end and a bearing plate ½ × 3 × 16 inches fastened to the lower end (to prevent turning over).

The channel guides are made from 6-inch U-beams and extend the full length on the inside of the truck body. The chocks (No. 2) are cut from 6 × 6-inch timbers. They are of such length that, when the carriages are loaded and the tail-gates closed, they will prevent any movement of the carriages in the truck. The ends next to the wheels are cut on the same radius as the wheels.

The tractor logs are 6 × 8-inch timbers 7 feet long (No. 3).

The connecting bar (No. 4) is made of 1-inch round steel with an eye turned in each end that will fit into the pintle of the trailer and the front pintle of the tractor. The bar is of such length that, when the tracks of the tractor are against the front part of the trailer, it is just possible to snap the bar into the pintle.

The available equipment, also the most important, is the three-ton Standard B truck and the three-inch gun trailer. These two vehicles, with a few minor modifications, are all that are needed for portée artillery, except the few special items mentioned heretofore. The alterations or modifications necessary to the Standard B truck and the three-inch gun trailer are as follows: The channel guides above mentioned, two 6-inch U-beams, are bolted flanges up, to the floor of the truck, parallel to the sides, and running the full length of the body. The distance from center to center is sixty inches. This is the only modification necessary for the truck. On the trailer it is necessary to remove the ramp bracket from the rear to allow the use of the specially built tractor ramps. The trail spade pan must be removed from the floor to facilitate working on, and observing the steering arm bracket, and also to make accessible, and to allow the freeing of the tractor ramps should they become fast beneath the tractor.

The two light artillery regiments of the Hawaiian Division are equipped with 75-mm. guns, Model of 1917 (British), and five-ton Holt tractors. All experiments were conducted with this equipment.

Photo by Signal Corps, U. S. Army.

SPECIAL EQUIPMENT USED WITH PORTÉE ARTILLERY IN THE HAWAIIAN DIVISION

AT THE TIME THIS PICTURE WAS MADE THE BEARING PLATES HAD NOT BEEN ADDED TO THE GUN RAMPS (NO. 1), THESE ARE ATTACHED AT A.

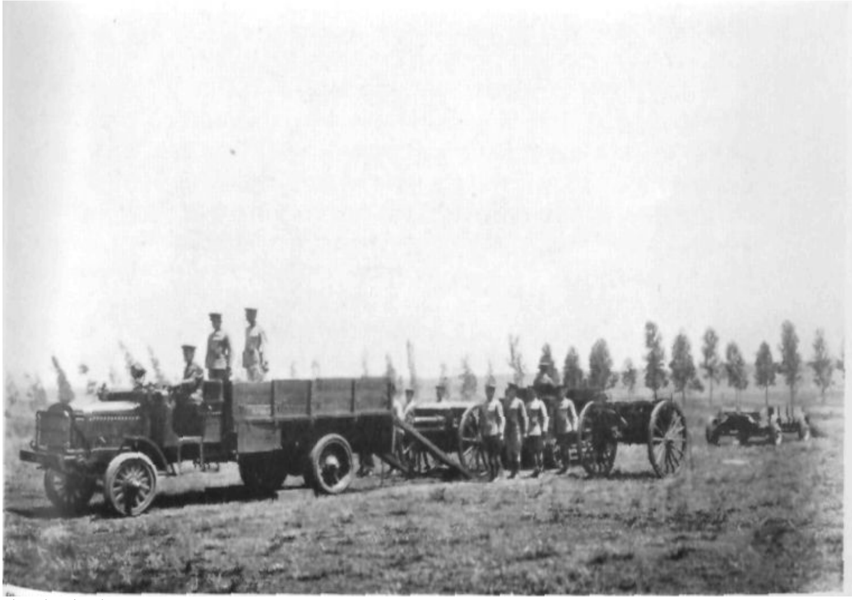


Photo by Signal Corps, U. S. Army.

FORMATION PREPARATORY TO LOADING

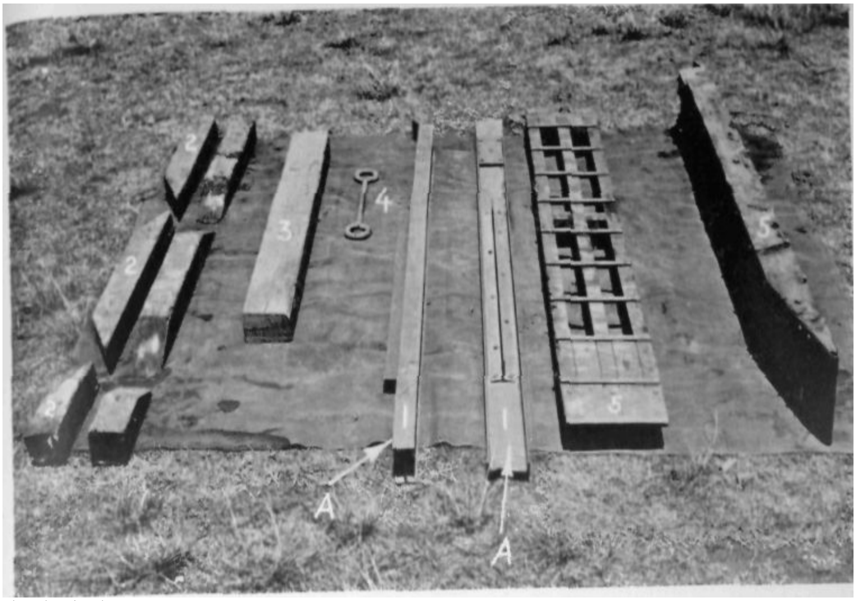


Photo by Signal Corps, U. S. Army.

LOADING THE GUN

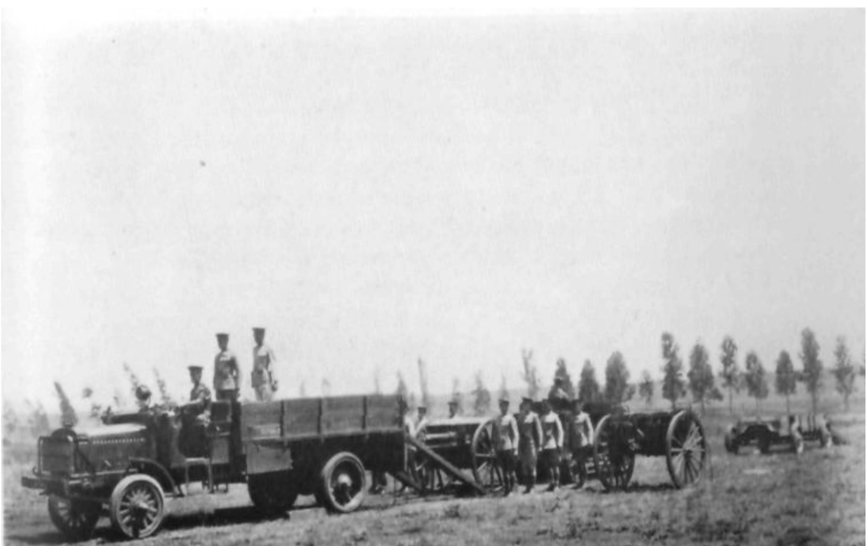


Photo by Signal Corps, U. S. Army.

LOADING THE GUN

THE WHEELS ARE OFF THE INCLINED RAMPS BEFORE THE GUN IS UNCOUPLED FROM THE TRACTOR.

LOADING AND UNLOADING

This phase of portée involves a consideration of the distribution of the load and of the method used in loading and unloading, which, in turn, involves the subjects of simplicity of equipment, safety of personnel, road space and time.

In the first experiments the tractor was loaded on the truck and the gun and caisson on the trailer. This proved to be unsatisfactory for several reasons. It made an excessive and top-heavy load on the trucks; it was dangerous to load, both to the tractor and its driver; it required long, heavy ramps and the tractor could not be unloaded from the truck in a jam without first getting the trailer out of the way by some other agency. It was therefore decided to place the tractor on the trailer. The gun and caisson were then loaded upon the truck in every possible combination, the most satisfactory one being to place the gun in the truck first, with the trail to the rear and the trail hand spike removed, the caisson coming next with the trail at the rear and extending over the tail-gate.

Various methods of loading and unloading have been tested out with varying degrees of success. Rolling the gun and the caisson into the trucks by means of man power was first tried out, but this was laborious and involved a great deal of danger to the personnel. The next method to be tried out, which for some time was the approved way of loading, was to pull the gun and caisson into the truck by means of a rope passing over the driver's seat to a tractor in front of the truck. It was found that without an unwieldly and complicated arrangement of rollers and pulleys, there was tremendous wear on the rope, especially when the caisson was being pulled up, as the rope had to pass under the gun carriage. With this method several men had to be at the trail in order to guide the piece or caisson and to lift the trail into the truck. There was always the danger of the rope breaking or becoming unfastened as the carriages were going up or coming down the ramps, thereby endangering the men. Another fault found with this method was that there was no satisfactory means of fastening the drag rope to the front of the gun other than to the advance loop, which was considered to be too weak for safety. Several other minor details entered into this method of loading which made it less desirable than the method to be described later. These include items such as the additional road space required in front of each truck; ropes that had to be carried and replaced when they became so worn as to be unsafe; time required to unload, limber and move off, etc.

The next method to be tried, and which was found to be by far the best, was to push the gun and caisson into the truck by means of the tractor.

This method is as follows: The Standard B truck is spotted, with the hand-brake set, blocks in front of the rear wheels, and the tail-gate down. The gun ramps are then placed so that the brackets on the upper end rest in the U-beams inside the truck, the lower ends being so placed as to be in prolongation of the U-beams and sixty inches from center to center. The forward chocks are placed in the U-beams. The trailer is placed, pole to the front, about sixty feet directly in rear of the truck. The tractor ramps are then placed in position. The gun, muzzle forward and hand spike removed, is moved by hand until both wheels are in line with, and touching, the lower ends of the gun ramps. The tractor is then placed in rear of the gun, facing to the rear.

The gun is then coupled to the rear pintle of the tractor which backs the gun up the ramps. When the gun has been moved one or two feet up the ramps the tractor log is placed on the ground at the ends of, and perpendicular to, the ramps. This log enables the tractor to back up far enough to let the wheels of the carriage into the truck, without allowing the weight of the tractor to come on the gun ramps. As soon as the wheels of the carriage are in the truck, the tractor halts, and the gun is uncoupled and run forward by hand until the wheels come against the forward chocks. The center chocks are then placed in rear of the gun wheels. The caisson is similarly placed, trail to the rear, is run up in the same manner as the gun, and the rear chocks are placed in rear of the caisson wheels, the tractor log and ramps are removed and placed in the truck. The tail-gate is raised with the caisson pole extending over the top. As soon as the caisson is uncoupled the tractor moves to the rear of the trailer and climbs aboard. The connecting bar is coupled between the front pintle of the trailer and the pintle of the tractor, and the tractor ramps are shoved beneath the tractor. The truck now backs up and is coupled to the trailer, all pintle latches are wired down, and the section is ready to move off as a whole. It was found that some pintles on the tractors were a trifle smaller than others and could not be unlatched when the gun was in the truck. This can be remedied by filing these pintles down until they give no trouble.

Unloading is practically the reverse of loading, except that when the caisson is about two-thirds of the way down the ramps, the tractor is halted and the gun is run back and coupled to the caisson. The whole section then moves off.

In the method just described, a very little special equipment is required. The danger to the personnel is reduced to a minimum as all the men stand clear as the carriages go up or down the ramps. The only time the men are required to go between the ramps is when they are coupling or uncoupling the carriages, at which time the wheels of the carriages they are coupling or uncoupling are in the truck and not upon the incline. The time required by trained personnel

Photo by Signal Corps, U. S. Army.

LOADING THE CAISSON

THE USE OF THE TRACTOR LOG ALLOWS THE CAISSON WHEELS TO REACH THE TRUCK BODY BEFORE THE TRACTOR TRACKS COME IN CONTACT WITH THE RAMPS. IN THIS POSITION, THE CAISSON IS UNCOUPLED WHEN LOADING, OR COUPLED WHEN UNLOADING.

Photo by Signal Corps, U. S. Army.

READY TO MOVE OUT

Photo by Signal Corps, U. S. Army.

UNLOADING

GUN HAS JUST BEEN COUPLED TO THE CAISSON. TRACTOR MOVES FORWARD COMPLETING THE UNLOADING WITHOUT FURTHER HALT.

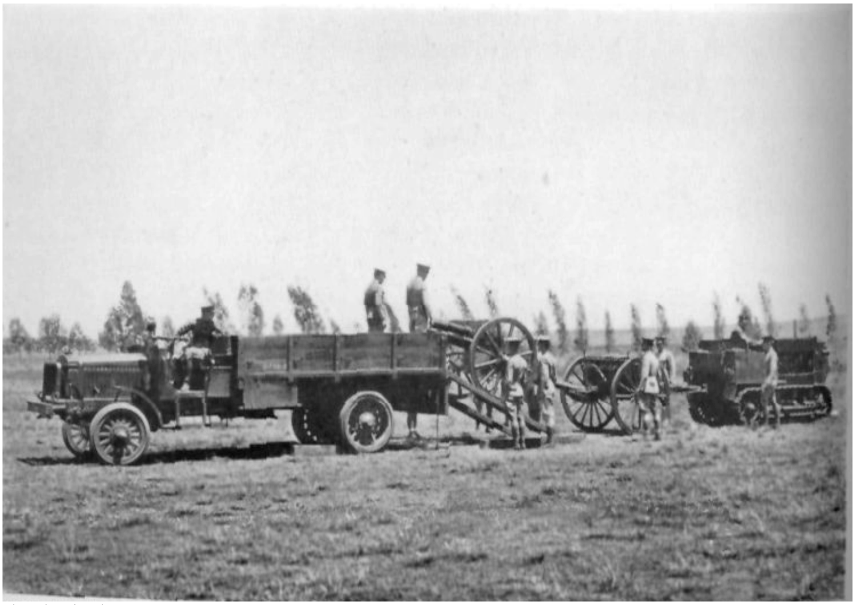


Photo by Signal Corps, U. S. Army.

UNLOADING

to load and unload in this manner is less than by any other known method. With trained personnel, the battery spotted for loading and each gun section provided with the equipment above described, the time required for a battery to load and be ready to move out should not exceed five minutes. On many tests this time has been materially bettered, the best time on record being one minute and fifty seconds.

MARCH AND MARCH DISCIPLINE

The total weight of the load, including truck and trailer, is approximately fourteen tons. Once in motion, it requires highly trained and skillful drivers to handle it under all conditions when on the march. In fact, this point cannot be stressed too strongly. Even though a man is a skillful truck driver, it does not follow that he can handle a portée load without special training. He should, first of all, be a man with a cool, level head, able to think quickly and act with courage and good judgment in a tight place, he should have a thorough knowledge of the truck he is driving as to its capabilities, limitations, and eccentricities. He should be taught that, before going up or down a steep grade, he should always stop before his truck is on the grade and shift his gears to either first or second speed, depending on the circumstances and the grade in question, and stay in that gear *under all circumstances* until the bottom or top of the grade is reached. Any attempt to shift after the load is on the grade will usually result in a runaway that ends disastrously.

The brakes on both the truck and trailer MUST at all times be in *excellent condition*. A cannoneer is detailed to man the brakes on the trailer and it is his duty, when going down hill, or when it is necessary to slow up or stop, to apply the brakes on the trailer. He must be trained to keep an eye on the steering arm bracket and, should it be broken or should the stud bolts be sheared off or work loose, to at once notify the driver, who should stop immediately. Certain cannoneers are detailed to ride on the trailer and they must have, within easy reach, blocks for chocking the wheels of the trailer or truck, as the case may be. These men are trained so that, the instant the truck stops when going up a hill, they will place the blocks in rear of the rear wheels of the truck, otherwise, the load may start backward down the hill. Should the driver fail to engage the gears while attempting to shift them or should he stall his motor, the brakes even though good, may fail to hold the load on a steep hill if it is once in motion. If, while going down a hill, it becomes necessary to stop for any reason, the chocks are placed in front of the rear wheels of the trailer.

While on the march it is important that each section maintains a distance of not less than seventy-five yards, as this allows much greater flexibility in handling the trucks. When halted, the sections close up to thirty yards.

Time may be gained and a great deal of strain removed from the trucks when a steep grade of several miles is encountered, by unloading the tractor. The tractor, on steep grades, can exceed the speed of a portée loaded truck, and relieved of the tractor load, the speed of the truck is materially increased. The unloading and loading of the tractor involves only a halt while the tractor ramps are placed and the tractor descends or ascends them. With trained personnel the time required for this operation should not exceed two minutes.

Portée artillery can negotiate almost any road in dry weather and should average from eight to ten miles an hour, including all halts, but during wet, inclement weather, it is almost impossible to take it off of hard-surfaced roads. Smooth asphalt roads, such as are encountered in the Hawaiian Islands, becomes difficult and dangerous in wet weather, especially when going down hill, as the weight of the tractor and trailer pushing on the truck is apt to "jack-knife" the load when traction is poor. Under this condition, it is always best to unload the tractor and let it proceed under its own power until the hill is cleared. Chains on the truck wheels help considerable on wet roads, but cannot be depended upon too much.

DETERMINATION OF DEAD SPACE

BY JOHN H. HINDS, 1ST LT. F.A.

FOREWORD

THIS article is an extract from a thesis on this subject written at the Massachusetts Institute of Technology in 1922-1923. The thesis includes a chart which was first plotted to rectangular coördinates but before the thesis was completed, Professor Norbert Weiner of the Massachusetts Institute of Technology suggested the use of polar coördinates and the device described incorporates that suggestion. A mathematical discussion of the subject included in the thesis is omitted here for the sake of brevity. The part omitted is unnecessary for the understanding of the practical application of the method herein described.

After this thesis was written it was learned that there was an independent development of the same principle at about the same time by a French officer presumably. A copy of the then latest French Firing Regulations explaining a similar method of finding the point of impact for a known elevation was received at the Field Artillery School about three months after I had outlined the method to Professor C. L. E. Moore of M. I. T. The French plan did not use the principle to find the graze point. I am sending the original thesis and letters showing its independent deduction to the Editor of the FIELD ARTILLERY JOURNAL.

OBJECT

When artillery is in position it is very important that each commander who directs fire should have at his disposal charts showing what areas cannot be brought under fire by the various batteries under his command. This is important in order to avoid the assignment of impossible missions; to make the best possible use of the guns at hand; and to warn the supported infantry of such dead space areas so they can prepare, by the disposition of machine guns, etc., to do without artillery support in those places. These charts are known as dead space charts. Their use has been more or less restricted to stabilized situations because of the excessive time required for their computation. At the Field Artillery School in 1922 it took many officers between ten and fifteen hours to solve a certain dead space problem. In general, dead space charts would be useful in warfare of movement as well as in warfare of position. In all cases the charts are needed as soon as the exact gun positions have been determined. It is highly desirable, therefore, that the time consumed in their preparation be cut to a minimum.

THE PROBLEM

It should be understood from the start that every method of dead space calculation must include the use of a contour map of 1/20,000 scale, or better. It is probably safe to say that this is the scale we will always deal with in connection with dead space because it is unlikely that any extensive maps will ever be made to a larger scale. It should be kept in mind that the results can be no more accurate than the contours on the map. On the best of maps contours are not very accurate, except at certain control points. For this reason it can be seen that any attempt at great precision is a waste of time and would lead to a false estimate of the accuracy of the results. It is only the general outline of the dead space areas that should be expected. Briefly, a dead space chart is a tracing from the map showing only the bounding lines of the sector and the dead space areas indicated by shading. The areas are determined by drawing from the gun position a number of

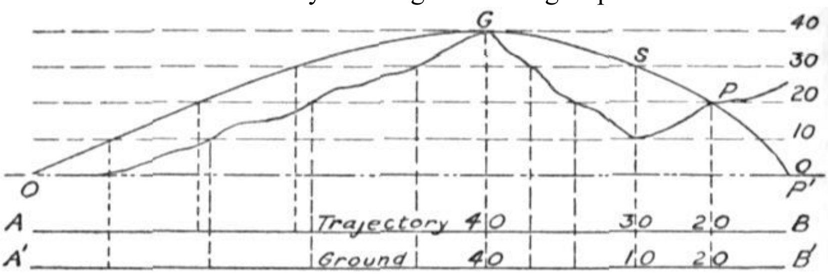


Fig. 1.

radial lines referred to as rays. The near and far limits of the dead space areas along each of these rays is then determined by various methods. These limits are the graze point, G, and the point of impact, P, in Fig. 1. A smooth curve is then drawn through these points inclosing the areas. The quick determination of these points is then the problem that confronts us. The graze point can generally be easily picked out from the map because it is usually the highest point on the covering crest or very close to it. If there is doubt, the quadrant elevations of several points must be determined. The one which requires the greatest quadrant elevation to be hit is, of course, the graze point. The chart described hereafter forms the quickest possible means of determining the quadrant elevation to any point. It is even quicker than the method described in Par. 409, T.R. 430-85 (F. A. Firing) because this chart is so constructed and the manner in which it is used is such that the range to the point does not have to be scaled nor does the difference in altitude of the gun and the point have to be determined. No calculations are necessary. The determination of the point of impact for a given trajectory is rather tedious by the methods now in use because its location depends both on the range and the altitude of the ground in the vicinity of the point of fall. The range to the point of impact is altered by the conformation of the ground and as the range is altered the conformation of the ground changes. For this reason the point of impact has to be found by trial. The chart described below affords a means of determining the point of impact by a direct comparison of the trajectory to the ground profile, thus avoiding all computations.

METHODS NOW IN USE

In all methods now in use a great deal of time is lost in altering in various ways the data given by the range tables and that given by the map in order to compare the trajectory to the ground profile. This time-consuming feature could be eliminated by the graphical representation of the range table data in such a manner as to permit the direct comparison of the trajectory to the ground profile by the application of the chart to the map. These charts *once* made could be printed and supplied to organizations as a part of their range tables.

PRINCIPLE OF PROPOSED METHOD

In Fig. 1 it can be seen that the line AB has points on it indicating the height of the trajectory at those points. Similarly the line A′B′ has points on it indicating the height of the ground. Let us call these points contour points. At the point G the trajectory and the ground are of the same height. Therefore the contour points on the lines AB and A′B′ must be of the same value 40. Also at the point of impact P the relationship of the ground profile and the trajectory is clearly indicated on the line AB or A′B′ by the fact that both contour points are 20 at that range. At any other point as S, the trajectory is higher than the ground. This fact is indicated by the contour points 30 and 10 on AB and A′B′. In other words, the relative positions of the trajectory and the ground can be fully determined at any point by comparing the contour points on AB and A′B′.

The line A′B′ is simply one of the rays drawn through the gun position on the map. The points of intersection of the ray with the contours on the map are the contour points of the ground profile.

The line AB: Fig. 2 shows a portion of a chart so constructed that if we draw any line through the gun position at O, it will be the "AB line," for the trajectory whose quadrant elevation is indicated on the arc. To illustrate, assume the altitude of the gun position to be 430 and number the curves accordingly. Then OP′ is the AB line for the trajectory whose quadrant elevation is 65, and it cuts the curves at the points which indicate the heights of this trajectory as shown by the numbers on the curves. The chart should be printed on a transparent material.

HOW TO USE THE CHART

The method of using this chart can best be explained by first telling how to find the quadrant elevation to *any* point. Suppose we are given the gun position on contour 430 and the point on contour 470, both plotted on the map. Write the number 430 on the dotted curve and number the others to correspond. Pin the chart to the map by a pin through the point O and the

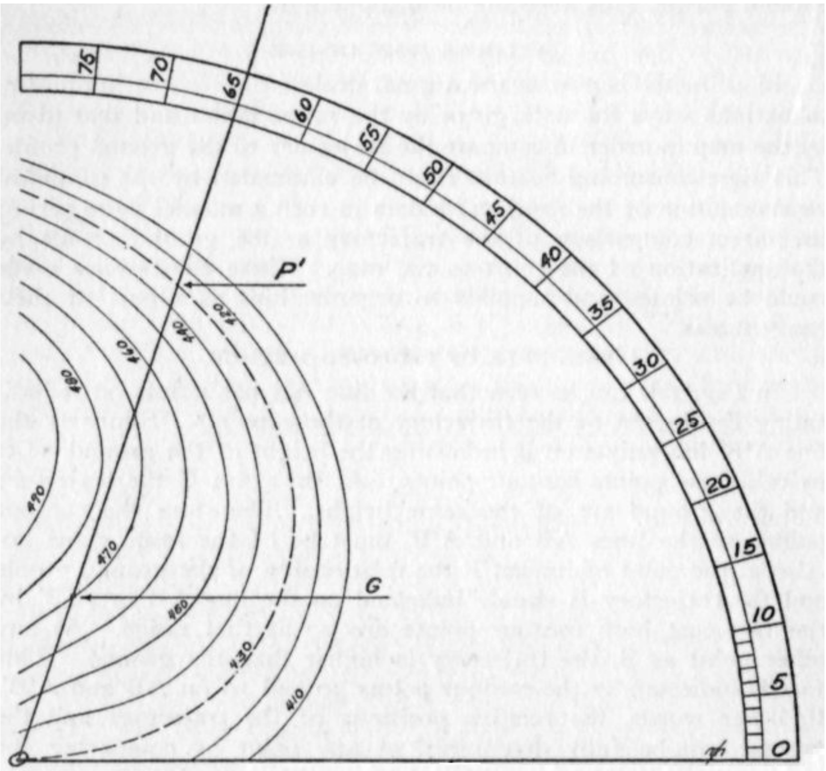


Fig. 2 **(Chart on transparent paper)**

gun position on the map. Rotate the chart so that the curve on the chart bearing the number 470 passes through the given point on the map. The quadrant elevation to hit that point can then be read where the ray through the point cuts the arc. To illustrate suppose the ray on the map appears through the chart as the line OP′ in Fig. 2. The given point would appear as G on the 470 curve as well as being on the 470 map contour. The quadrant elevation would be read on the arc as 65. In finding the quadrant elevation in this manner, we had no need to scale the range nor to find the difference in altitude of the gun and the point. In rotating the chart as we did, we found *the* trajectory which has the same altitude at that point as the ground.

If the point chosen above be a *graze point,* the point of impact will be found on OP′ where the trajectory again has the same altitude as the ground in the vicinity of P′. P′ is the point where the projectile would strike if the ground at that point were at the same level as the gun, *i.e.,* 430 in this case. Looking at the map contours at P′, if we find the ground to be higher (*i.e.,* the number of the ground contour is greater than 430) we know that the range will be shortened and we move back toward the gun until we find the point where the ground and trajectory have the same altitude as indicated by the map contours and the curves of the chart. This will be the point of impact. If at point P′ we had found the ground to be lower the point of impact would have been found beyond P′.

As previously mentioned the graze point is usually the highest point on the covering crest or close to it. If doubtful it should be verified that its quadrant elevation is the greatest in that vicinity. This can be done quickly with the chart by determining in the manner described above, the quadrant elevation to two points bracketing the first point. However, it is useless to be too exact about this because the contours themselves may have an error of a contour interval. In no case should a contour interval be split in determining from the map the altitude of the gun and the crest for dead space computation. The gun should be considered to be on the lower contour if it is between two, and the graze point on the higher if between two. These two approximations combine to make a factor of safety which should be increased if firing over your own troops.

To sum up this method: Given a contour map with the gun position plotted on it; the curves of the chart being numbered to correspond to the contours of the ground. Required to determine the points on a ray which limit the dead space caused by some obstruction:

Determine from the contours of the map the altitude of the graze point, 470 for example. Rotate the chart so that curve 470 passes through the point. Without changing position of chart find the point of impact where curves and contours have same number.

COMPARISON OF METHODS

Other methods require scaling ranges and determining differences in altitudes from the map. This is followed by some computation, numerical or graphical, which diverts the attention from the map. After this we return to the map and plot the results. In the method described above, all three of these operations are simultaneous so that the attention can be fixed on the map until the solution is completed. The speed with which dead space can be determined in this way is limited only by the rapidity with which the contours can be read and matched with the curves.

EDITOR'S NOTE: There appear to have been several independent determinations of the principal above described. A graph using rectangular coördinates was worked out by one of our officers in 1917 and submitted to the Field Artillery School in 1918, but since no action was taken on the matter at that time, knowledge of the method at the School did not remain after the officers involved were detailed to other duties. This graph was practically identical to the basic graph of Lieutenant Hinds' thesis. The conversion to polar coördinates is believed to be of material advantage. The development by Lieutenant Hinds and the subsequent knowledge of an earlier development by the French, is mentioned in the article. In 1924, Mr. Carroll F. Merriam of the Pennsylvania Water and Power Company, Baltimore, Md., submitted a graph using polar coördinates, which was identical to that earlier evolved by Lieutenant Hinds. Mr. Merriam's device was offered to the War Department but has not been adopted.

The chart described in this article is believed to be an undoubted time saver, but is subject to the disadvantage of requiring a separate chart for each different type of projectile, charge and fuze. Should more than one map scale be used, a duplicate set of charts would be required for each map scale.

The calculations for the construction of a chart are simple, the most difficult part for the average officer being, perhaps, the drawing on a transparent material of fine smooth curves through the points determined by calculation.

One method of constructing the chart is as follows: Determine the map scale, gun, projectile, charge and fuze to be used. At a map scale distance greater than the maximum range to be used, draw an arc about o (gun position) as a center. Using an arbitrary angular unit, graduate this arc, numbering the divisions counter-clockwise with figures representing in mils the value of the minimum to the maximum quadrant angles of elevation expected to be used.

To obtain points on the various lines (contours) at a range of say 3000 yards: For purposes of construction, draw lightly a circle about o (gun position) as a center, with a radius equal to 3000 yards, map scale. Assuming that the angle of elevation for 3000 yards as obtained from the Firing Tables is 81.2 mils, mark the point where a line from o to 81.2 on the graduated arc cuts the 3000 yard circle. This is a point on the line of zero altitude with respect to the gun, *i.e.*, site = o. We will assume that we wish to show contour intervals of 20 feet. At 3000 yards a 20-foot difference of altitude corresponds to $\frac{20}{3 \times 3} = 2.22$ mils. Since within 300 mils of the horizontal, each contour interval practically corresponds at this range to a 2.22-mil change in site, we may space off on the 3000 yard circle, distances that subtend 2.22 angular units on the graduated arc. Successive points above zero point are numbered +20, +40, +60, etc., while those below have similar negative numbers. Check the extreme points by projecting a line from o through the point to the graduated arc. The reading obtained at the arc should equal 81.2, plus the site for a target of corresponding range and altitude.

In the same way, points for greater and less ranges are obtained. If large quadrant angles of departure are included on the chart, the site to points on the ascending branch of the trajectory should be obtained by the use of tangents rather than by the usual mil relation. Within the assumed rigidity of the trajectory, the above method gives accurate results.

Points of equal altitude are now inked in with smooth curves and the chart is completed. It will be seen that the chart represents all trajectories between the limits taken on the circular scale of quadrant angles of elevation. Any line from o to the arc shows, for that quadrant angle of elevation, the height of the trajectory above or below the gun position for each scale distance from o. Since this is in map language, *i.e.*, contours, a direct comparison of altitudes is possible for any point along the line of fire, the ground altitude being read on the map through the chart, the corresponding trajectory altitude being read on the chart.

It will be noted that lines drawn from o to the graduations will cut the curves representing altitudes greater than the gun, twice if at all. Curves representing lower altitudes are cut only once.

The altitude of the gun may be added mentally to the altitudes of the completed chart or the chart may be renumbered for each gun position with the sum of these altitudes as shown in Fig. 2.

The method of use proposed by Mr. Merriam differs somewhat from that described in the text, a method of counting contours being used instead of a comparison of the numbered contours on the map and chart. Mr. Merriam further-more demonstrated that this method is applicable to problems of visibility and exhibited a panoramic sketch constructed entirely from a contour map. This sketch checked very closely with observations made on the terrain.

RODNEY—A VETERAN ARTILLERY HORSE

Battery "D," 3rd Field Artillery,
Fort Myer, Virginia, March 27, 1916.

FROM: C. O. Battery "D," 3rd Field Artillery.
TO: The Adjutant General, U. S. Army, Washington, D. C.
(Through Military Channels.)
SUBJECT: Feeding and Stabling of Horse "Rodney."

1. In August, 1910, while the Battery was absent in the field there was left behind at Fort Myer an old horse, name, "Rodney," who had faithfully done his work in the organization for many years, and who through age and other infirmities was unable to further pull his bit. Through ignorance of a man left behind in charge of quarters he showed the horse to an Inspector, who came to the post, and as a result the horse was inspected, condemned and ordered sold. The men of the battery heard of the matter just in time to have a representative present at the sale and bid the horse in, as they could not bear to see the old fellow sold outside the service. He brought something like $120, which was subscribed and paid by the men of the organization.

2. Since that time this horse has remained a pet and an inspiration to the men of the battery and a favorite among officers, and has been fed, groomed and cared for by the battery. He is reputed to be thirty years old. His D/L was probably sent in to the Q.M.G.O., when he was sold, as it cannot be located.

3. This horse is an inspiration and though unable to accompany the battery in the field, should be cared for at the post, as has been done in the case of other "retired" animals (old "Putnam" and old "Foxhall," both of the 3rd Field Artillery).

4. It is requested that authority be granted to stable, forage and care for this animal wherever he may be for the balance of his life.

CAPT. CHAS. G. MORTIMER, 3rd F. A.

This letter with its nineteen subsequent indorsements caused the issuance of orders necessary to insure proper care and forage for this horse during the remainder of his life. The following history was prepared in 1916 from all information obtainable at that time.

HISTORY OF "RODNEY"

The horse known as "Rodney" was transferred to Light Battery A, 2nd Artillery, on November 2, 1896, at Fort Riley, Kansas, from Light Battery E, 1st Artillery, with the rest of the horses of the latter battery. His previous history is not known. At that time, he was about eight years old, 15.3 hands high, and his weight was about 1250 pounds. His color was dark bay with black points, and he was an unusually handsome animal. In breeding, he was an excellent type of the graded thoroughbred of probably the second generation. He had the fine features, the courage, activity and endurance of the thoroughbred, and the size, conformation, power and serene disposition of draft stock. The long fetlocks and the thick coat of hair in winter, together with the characteristic conformation of the Clydesdale, left little doubt that he came from this strain.

He soon attracted attention in Battery A by his intelligence, his power, and his willingness. At rapid drills or when the draft was difficult, his broken harness was an evidence of his superior efforts. During the succeeding fourteen years, till the day of his sale, he was literally a "wheel horse." He was never sick, and he was never known to refuse a feed or a task. He was petted by the men who looked after him with genuine affection and with a confidence that was born of experience in many difficult situations.

When Light Battery A went to Cuba as "Grimes' Battery," with the 5th Army Corps in 1898, it was at once ordered to El Poso. The road had been churned into deep mud and was well-nigh impassable for the heavy artillery carriages. To meet this situation, Captain Grimes took his two most powerful horses, which were "Rodney" and his mate, "Shaw," and pulled the carriages out of the mud holes and ditches whenever they became stalled. It was a remarkable and an exhausting service, but it was rendered with a fidelity that secured the prompt passage of the battery to its position for action. The significance of this performance not only to the battery, but to other troops, was far-reaching in stress of events then taking place.

When the battery changed position, it marched in rear of Battery K, 1st Artillery. One of the carriages of the leading battery became bogged, so that the column could not proceed. Captain Grimes sent for "Rodney" and "Shaw." When they arrived, the driver, seeing the exhausted condition of the stalled team, had these horses unhitched, and with his single pair, drew the carriage from its unfortunate position. It was no doubt distasteful to Battery K, to have their carriage rescued by horses from another battery, but they soon realized that such animals as "Rodney" and his mate were rarely found, and their resentment soon gave place to a generous admiration. Thus, all during the trying days before Santiago, "Rodney" served his country by putting guns where they were wanted, in the face of great obstacles, and he earned a place in the nation's gratitude no less than the men who served the guns after they were in position. Without his service, the story of Grimes' battery might easily have been shadowed by delays that would have deprived the Army of its fire when needed.

After the Santiago Campaign, "Rodney" again served with his battery in Cuba from January, 1899, to April, 1902. In 1903, he accompanied the battery on a march of 700 miles from Chickamauga Park, Georgia, to Fort Myer, Virginia. Throughout this long, continuous march, averaging 21 miles a day, he did not lose a day from his place in the "wheel," and he reached Fort Myer in as good condition as when he started. In the succeeding years, he marched thousands of miles and participated in maneuvers in various parts of the country. He outlasted all of his fellows. Few animals have rendered as much service and many came and went while he was still doing duty. Thus, for the investment in his purchase and maintenance, he proved an unusual economy for the government.

The battery became successively, the 3rd Battery, Field Artillery, and Battery D,* 3rd Field Artillery, and the equipment experienced radical differences in model. In all changes of name, matériel and personnel, "Rodney" stood out as one of the elements that foster pride of arm and about which the affections of soldiers cling. At length it became evident that the long marches and the strain of heavy draft were too great a tax on his willing but waning strength. Age and years of faithful service had brought declining vitality and a merciful consideration made his relief a necessity. There was never any thought, however, that he should go to a huckster's cart or spend his last days in a dray or a dump wagon, with scant food and perhaps brutal treatment. Human nature will assert itself and with soldiers, the human element must be reckoned with. When he was condemned and sold, the men in the battery contributed from their small pay the price of $107, to which a zealous dealer forced them, and bought him for the battery. No contribution was ever made more generously, and the spirit which they manifested was a tribute, not only to their old friend, but to the loyalty that made them one of our most efficient fighting units. Men who will not forsake a faithful horse may be depended upon to defend their flag and to maintain the best traditions of a battery whose history is rich in the service of its country.

For a long time, he was given the task of hoisting the grain and hay into the forage loft and so well did he know his duties, that he required no control but the voice. During the years since his retirement, he has subsisted largely on grazing, so that the value of the food consumed has been small. He has richly deserved whatever of kindness and gratitude his masters may show, and the formal recognition of his retirement and maintenance during the few remaining years of his life would not only be appropriate, but it would show to the world that our government is great enough to recognize and reward true merit wherever it is found.

* Battery D, 3rd Field Artillery, referred to above, later became Battery A, 16th Field Artillery. "Rodney" died at Fort Myer, Va., at an age of about 30 years.

AN ARTILLERY FIRING AND TERRAIN TABLE

BY CAPTAIN H. H. RISTINE, F.A. (DOL)

THERE follows a description of an artillery firing and terrain table, which was constructed by the author for use in the instruction of officers of the 148th Field Artillery in the various methods of fire. It is thought that all officers detailed to the National Guard as instructors will agree that one of the biggest problems they are confronted with in their work is that of giving their officers sufficient firing instruction, in the limited time available, to enable them to handle a firing battery on the range during the Field Training Period. To cover the Training Regulations having to do with the various aspects of the conduct of fire sufficiently well for all officers to have a fair working knowledge of that subject is manifestly impossible in the fifteen or twenty hours which can be allotted to this subject in the weekly officers' schools during the Armory Training Period. Further, to devote more than that number of hours to firing instruction would result in some other subject of almost equal value being neglected. Hence the terrain table described in this article was worked out in an effort to arrive at some method of instruction in firing which would cover the ground, that is, allow some instruction in all methods of fire (time, percussion bracket, and percussion precision, both axial and lateral observation) and at the same time afford a demonstration of what would actually result from the commands given. The use of the table in this instruction has proven very gratifying in its results in the 148th Field Artillery considering the time which was available for its use.

It has been found that the best method to follow is to require each new officer to familiarize himself with the sequence of commands, appropriate brackets, and a few of the other fundamentals, before starting the course. Thereafter, the first session should be devoted to a general explanation of the different kinds of fire, reasons for size of brackets, usual procedure at the firing point, axial and lateral observation, etc., with only enough time being spent on each of the above to give the officers a general idea of the subject. All other periods can be spent firing problems on the terrain table, starting off with the simplest situations involving axial observation, shell with platoon salvos, guns and observation posts at about the same distances from the target. For the benefit of the officers having no previous experience each step is explained in detail and the reasons therefore given. Officers with previous experience should be selected to fire the first problems, although it is thought advisable to start the newer officers as soon as possible in order that they may acquire confidence and facility in making observations and giving commands. After a number of these basic problems, the situations should gradually be made more difficult—battery salvos, shrapnel, and the observation post moved nearer to the target. It is thought inadvisable, however, to fire with lateral observation until all officers have a fair idea of the technic of fire with axial observation, as it will invariably result in the less experienced officers becoming confused. At least five sessions should be devoted to fire with axial observation, after which the most simple lateral problems should be started using small angles "i", guns and observation post at the same range, firing platoon salvos or even single guns, and with plenty of explanation. It might be said here that the best results have been obtained by "leading" the officer firing. In all problems absolute compliance with the regulations governing should be insisted upon and special care should be exercised to see that the officers form the habit of giving their commands in their proper form and sequence. In conjunction with the terrain table, the use of a blackboard on which to diagram points as they arise, will be found to save time and make explanations more clear. From the simple lateral problems others should follow which gradually increase the difficulties of observation and handling.

The foregoing has had to do only with time fire and percussion bracket adjustment, the instruction in which, I believe, should consume about two-thirds of the total time allotted to firing in the officers' schools. The remaining time should be spent on percussion-precision instruction with perhaps one period at the end devoted to a review of all methods. The same procedure should be followed in the percussion-precision sessions as was previously followed. In other words, the problems should start with the simplest axial situations and gradually increase in difficulty until all of the different kinds of problems have been covered. Before any attempt is made to use the terrain table in this instruction, at least one period should be devoted to an explanation of dispersion, dispersion scales, probable error, phi and omega tables, and the use of the firing tables. Naturally these subjects can only be skimmed over in that time, but if they are constantly referred to and explained during the subsequent firing instruction when using the table, it will be found that the officers will gain a fair idea of their application after only a few sessions.

With the reduced ammunition allowances for Regular Army officers, it is thought that some such table as described herein would afford an ideal way for them to keep their "hands in." Further, officers newly commissioned could pick up some valuable points about firing before going out on the range to scatter their meager allowance about the landscape. It is believed that the best feature of this table is that it affords a method of firing instruction in which all the different kinds of fire and observation may be used, whereas only axial firing can be simulated with any success in blackboard and smoke-bomb instruction.

I desire to acknowledge that the idea for the terrain and firing table described in this article was first inspired by the article by Major Clift Andrus, F. A., appearing in the November-December, 1924, issue of THE FIELD ARTILLERY JOURNAL, although it is hardly thought that Major Andrus will recognize his child in the description that follows:

GENERAL

The terrain part of this firing table is the same as the conventional sand table used in mapping instruction, etc. It represents to scale (Plates I and V) a piece of terrain five hundred yards wide by six hundred yards deep with hills, valleys, streams, houses, roads, and other features shown. Around the table has been erected a screen in order that nothing but the terrain may be seen by the officer firing. The guns are assumed to be on a line which is normal to the middle of the front of the table, and the observation post may be at any point within ninety degrees of that line. For convenience the approximate angles "i" are marked off on the floor by lines numbered to correspond to the mil values. The officer firing should be required to be seated in order that he will see the terrain as he actually would on the range, and not from above as would be the case if he stood to make his observations. By observing seated his eyes are only slightly above the level of the table. Field glasses or the battery commander's telescope should be used in order to accustom the officers to their use.

About eighteen inches above the sides of the table and parallel to them are two side rails upon which the range slide travels from the front of the table to the rear, and *vice versa*. Due to the construction of the range slide it is necessary that the slide rails project beyond the front and rear edges of the table for a distance of about two feet. A detailed description of the range slide and all of its attachments, together with an explanation of their use, follows.

THE RANGE SLIDE

The range slide is made up of two parallel members about eighteen inches apart and joined by two crosspieces attached securely, thereby making a rigid frame about eight feet by eighteen inches. On the under side of each joining crosspiece are mounted two flat one-way rollers. These rollers are so placed that each pair is exactly perpendicular to the long members of the range slide and the two pairs consequently parallel. The rollers run in two tracks on the upper surfaces of the side rails of the terrain table (28 Plate II, Plate III). The range slide is pulled backward and forward* on its rollers by four wires attached to it at points immediately above the tracks (Plates III and IV). The wires are brought through a series of pulleys to a drum (20 Plate I, 14 Plate II) which is turned by a crank (24 Plate I), this drum being at the right of the operator's position. The pulleys through which the two rear wires work are shown in Plate II as numbers 22 and 24. From these pulleys the wires extend to others directly above them and are brought together at a point about ten feet above the drum, which will be designated as the range slide drum. From this junction a single wire extends to the drum, to which it is attached. It is seen that by turning the crank the wire is wound around the drum and the range slide, with all of its attachments, is pulled to the rear on its tracks and rollers. Similarly the two wires attached to the forward member of the range slide are passed through pulleys at the front and under the table, where they are joined (Plate V), and from which point a single wire passes to the rear to a pulley immediately beneath the range slide drum. From this pulley the wire extends upward to the drum. It is likewise seen that by turning the drum crank this wire will be wound around the drum and the range slide will be pulled forward from the operator's position. The two wires are attached at opposite ends of the drum and so wound that while one winds onto the drum the other unwinds. In order to compensate for the stretching of the wires and consequent unequal pull on the right and left sides of the range slide, it was found necessary to interpose three turn-buckles in the wire system. Two of the turn-buckles are attached to the range slide (Plates III and IV), one on either side to equalize the pull, and one is placed immediately below the junction of the two rear wires above the range slide drum. The function of the latter is to take up the slack due to the stretching of the wires. After using several different kinds of wires, it was found that the eight-strand steel insulated wire similar to the Field Artillery twisted pair field wire was most satisfactory due to its strength and lack of tendency to stretch.

THE DEFLECTION SLIDE

The deflection slide operates on the rear member of the range slide in such manner that it may be run from one side of the table to the other. It is mounted on four rollers similar to those on which the range slide works. Thirteen Plate III gives the best view of the deflection slide, although it may also be seen in Plates I, II, and

* All directions in this description are taken from the operator's position at the rear of the table.

IV. It will be noted that on the front and rear sides of the rear member of the range slide, guides have been placed to keep the deflection slide in place during its travel. It will also be noted that the rear guide has an additional strip attached to its upper side which projects slightly forward over the bottom piece of the deflection slide (Plate IV). This flange has much the same function as the upper roller paths of the French 75-mm. gun since two rollers have been placed on the rear top side of the bottom piece of the deflection slide which operate on the under side of the flange. This was found necessary due to the upward pull of the bursts on the sheaf arm.

To each end of the deflection slide is attached a wire by means of which the deflection slide is moved to the right or left to any desired position. These wires pass through pulleys (23 Plate II) to drums (deflection slide drums) located near the center of the front member of the range slide (5 Plate II). These drums are rotated by the action of a quarter horse power motor (11 Plate II). The motor is mounted on a small platform in such a manner that the motor shaft projects forward between two 12-inch wheels which themselves are fastened securely to the forward ends of the two drums, and of course rotate with them. At the rear end of the motor platform at a point about eight inches in rear of the motor the platform is pivoted (16 Plate II). On the under side of the platform beneath the forward end of the motor are two rollers. Thus it is seen that (Plate II), if the motor is moved to the right, the

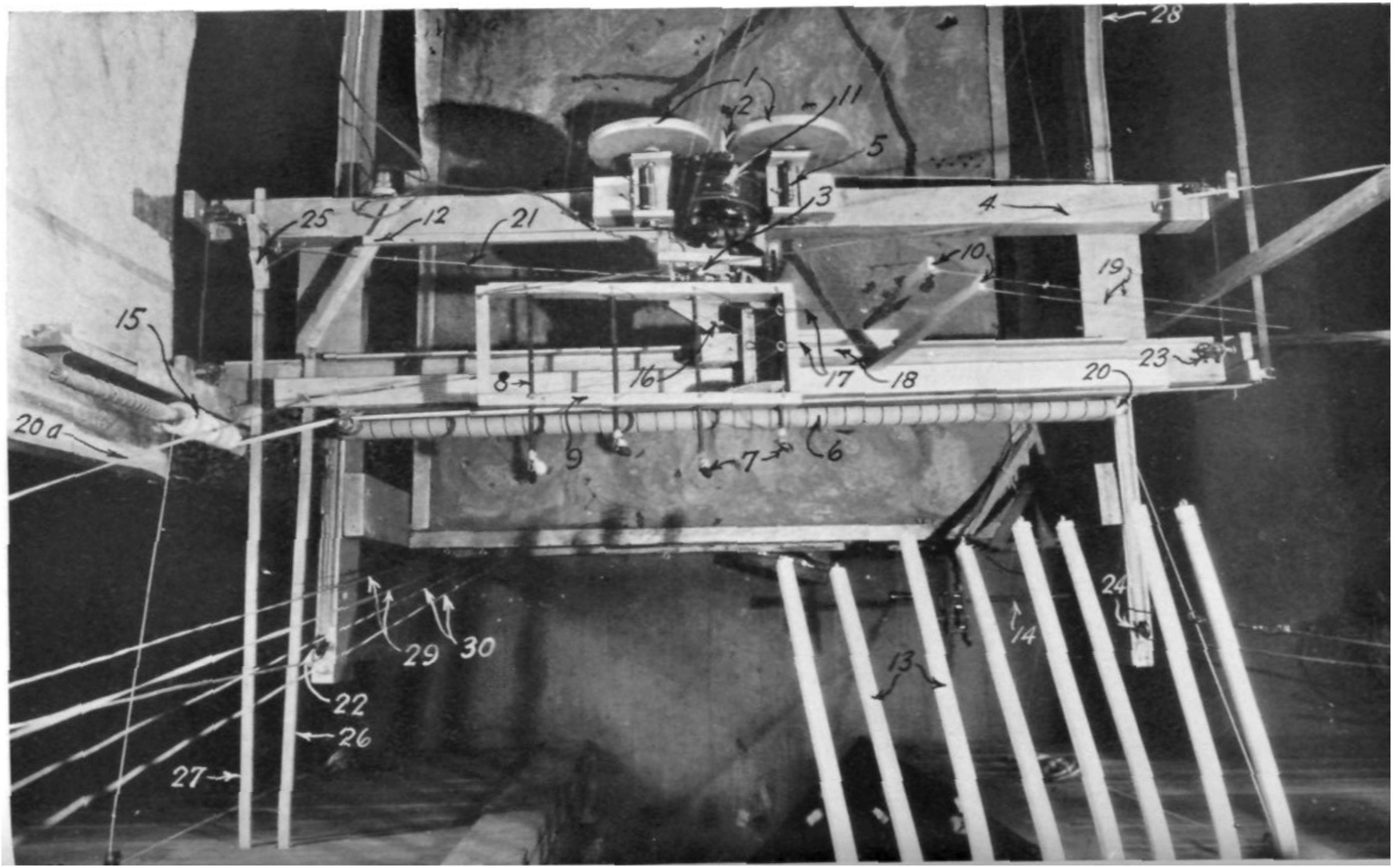
PLATE I

1. Range scale roller.
2. Range and elevation scales (tapes).
3. Sheaf arm.
4. Dispersion control levers.
5. Dispersion scale (for percussion precision fire only).
6. Deflection fan.
7. Cord for lowering sheaf arm.
8. Twelve-inch wheel driven by motor and operating deflection slide drum.
9. Cable by which range slide is pulled to the rear.
10. Bursts (graze and air).
11. Cord for raising sheaf arm.
12. Deflection index, attached to deflection slide immediately beneath bursts of No. 4 gun.
13. Cord for operating dispersion levers.
14. Cord operating upper deflection fan roller.
15. Dispersion cords.
16. Width of sheaf scale.
17. Cords to which bursts of Nos. 3 and 4 guns are attached.
18. Motor switch control rod.
19. Rod for changing position of motor.
20. Drum around which range slide cables are wound.
21. Cords for changing position of sheaf arm (same as 7 and 11).
22. Cords for operating dispersion levers (same as 13).
23. Electric wires leading to motor.
24. Crank operating range slide cable drum.
25. Roller over which range and elevation scales work.

PLATE I

VIEW FROM THE OPERATOR'S POSITION AT REAR OF TABLE

PLATE II



TOP VIEW FROM A POINT IMMEDIATELY ABOVE OPERATOR'S POSITION shaft (which is wound with friction tape) will come in contact with the right 12-inch wheel, will revolve it, and the deflection slide will be moved to the right due to the wire attached to its right side being wound about the right deflection slide drum. At the same time it will be seen that the wire on the left drum will be unwound by reason of the movement of the deflection slide to the right, and the consequent pull on the wire attached to its left side. Due to the speed at which the unwinding drum is revolved, it was found necessary to construct a brake acting to retard it (6 Plate III) and thus preventing slack in the wire. On the left of the operator's position in Plate II will be seen two rods projecting through the wall at the rear (26 and 27). The right one of these rods controls the position of the motor. It will be seen that by pushing forward on this rod the motor and its platform will be moved to the left and that by pulling backward they will be moved to the right, thus allowing the revolving motor shaft to come into contact with the left and right 12-inch wheels, respectively. The left rod (27 Plate II) operates the starting switch of the motor (3 Plate II). The switch is the common single throw knife variety and is held open by a coil spring. It is closed by action of the left rod and a cord which works between the free end of the knife switch and the forward end of the rod. It

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PLATE II

1. Twelve-inch wheels which operate deflection slide drums.
2. Motor shaft (wrapped with friction tape).
3. Motor switch.
4. Cord for raising sheaf arm.
5. Right deflection slide cable drum.
6. Deflection fan (upper roller).
7. Bursts of Nos. 3 and 4 guns.
8. Burst rod of No. 1 gun.
9. Sheaf arm.
10. Dispersion control levers.
11. Motor.
12. Rod by which position of motor is changed.
13. Burst control rods.
14. Range slide cable drum.
15. Range and elevation scales.
16. Pivot of motor platform.
17. Dispersion control cords.
18. Deflection slide (bearing sheaf arm, deflection index, dispersion control mechanism, and width of sheaf scale).
19. Dispersion lever control cords.
20. Deflection fan upper roller, showing operating cord.

20a. Cord for lowering sheaf arm.

21. Motor switch control cord.
22. Range slide cable pulley (left rear).
23. Deflection slide cable pulley.
24. Range slide cable pulley (right rear).
25. Motor switch control rod brake.
26. Rod for changing position of motor.
27. Motor switch control rod.
28. Range slide roller track.
29. Cords for raising and lowering sheaf arm (same as 4 and 20a).
30. Cords for operating dispersion levers (same as 19).

is held in the closed position by the action of a brake (25 Plate II) which bears on the top of the forward end of the rod. The electric current is communicated to the motor by loose wires dropped from overhead (23 Plate I).

The deflection slide carries on its upper side the sheaf arm (3 Plate I), the width of sheaf scale (16 Plate I), the deflection index (12 Plate I), and the range dispersion mechanism (10 and 17 Plate II). These mechanisms are explained in detail under appropriate headings.

THE SHEAF ARM

Attached to the upper surface of the deflection slide is the sheaf arm (3 Plate I, 9 Plate II, and Plate IV). This is a rectangular mechanism about 23 inches long by 8 inches wide which is pivoted at its right end near the point of attachment to the deflection slide in such manner that it can be swung upward from the horizontal position through an angle of 90 degrees, or to any point within that angle. The sheaf arm carries four small rods (8 Plate II) each of which extends between the front and rear members and beyond, and works freely through them from front to rear and *vice versa*. These rods are about seven inches apart and are equally spaced along the arm, with the right, or No. 4, rod at the point of the pivot. On the rear end of each rod (8 Plate II) is a double eyelet through which two small cords (fish line) pass, having on their ends two one-half inch balls—one white and one black. These represent the air and graze bursts for each gun of a battery (7 Plate II). With the sheaf arm in the horizontal position, it is seen that the maximum width of sheaf possible to show is attained. It is also seen that by swinging the sheaf arm upward the width of sheaf is gradually decreased until, when the upright position is reached, the sheaf is entirely converged. The deflection arm is so tightly attached at the pivot that it will remain in any position placed.

Attached to the upper side of the free end of the sheaf arm is a cord (11 Plate I, 4 Plate II) which is passed to the right through an eyelet located at the top of a three-foot upright piece. From this point the cord passes to the left rear and upward to an eyelet above and slightly to the left of the operator's position, and from there downward (29 Plate II) to another eyelet on the rear of the table and thence through a hole in the floor below. On the end of the cord is attached a weight for the purpose of keeping it taut at all times. It is seen that when this cord is pulled, the sheaf arm will be raised from the horizontal toward the perpendicular position. On the under side of the free end of the sheaf arm is attached another cord (7 Plate I) by which the arm is lowered from the upright position toward the horizontal. This cord passes to the left through an eyelet near the left end of the rear member of the range slide and from there back and upward to another eyelet to the left and above the operator's position. From this point it is passed down parallel to the other cord just described. A weight is also carried at its end. By pulling this cord the sheaf arm may be moved toward the horizontal position.

WIDTH OF SHEAF SCALE

The width of sheaf scale (16 Plate I) is attached to the upper side of the deflection slide in such manner that it can be read from the operator's position, using the lower edge of the sheaf arm as the index. The scale was made up with the range slide at a position half-way between the front and rear edges of the table and with the guns twenty feet (2000 yards) in front of the table. A maximum of 70 mils width of sheaf may be shown with the guns and range slide in the positions described. Numbered divisions of ten mils are laid off on the scale, other settings being made by estimation.

It will be noted that the values given on the scale are for only one position of the guns and one range—2300 yards. Hence, if the scale is set for 60 mils width of sheaf and the range is 2000 yards, the actual width, measured from the position of the guns, is slightly more than 60 mils. Similarly if the scale is set for 60 mils and the range for 2600, the actual width would be a few mils less than 60. Owing to the construction of the scale and sheaf arm this inaccuracy is unavoidable. However, by keeping the range in mind it is possible for the operator to set the width of sheaf for any range within one or two mils, which is well within the probable error for width of sheaf. Of course with the guns 40 feet (4000 yards) in front of the table the values given on the scale are halved, or in other words, the command for change in deflection difference must be doubled before being applied to the scale. If the guns are 30 feet (3000 yards) in front of the table, the command must be multiplied by 1.5 before being applied.

Example of Use of Scale.—At the start of a problem any width of sheaf may be assumed. Let us assume that the guns are 20 feet (2000 yards) in front of the table and that the width of sheaf for the first salvo is 45 mils. The command after the first salvo has been "On No. 2 close 10." The sheaf will then be 30 mils narrower than before (3 × 10), so the next setting will be 15 (45-30) on the scale. This is set by pulling the right cord (21 Plate I) until 15 is reached on the width of sheaf scale. After the next salvo with the 15-mil sheaf, the command is "On No. 4 open 2." This command will increase the width of sheaf 6 mils (3 × 2), which is applied by pulling the left cord (21 Plate I) and thereby lowering the sheaf arm until the setting of 21 (15 + 6) is reached on the width of sheaf scale. It should be noted that so far as the width of sheaf scale is concerned, the piece upon which the deflection difference change is based is immaterial and that the only thing to be considered is the total change in width of sheaf. The change applied in deflection, as explained further on, takes care of the piece upon which the change in deflection difference has been based.

RANGE DISPERSION MECHANISM

(For Time Fire and Bracket Adjustment)

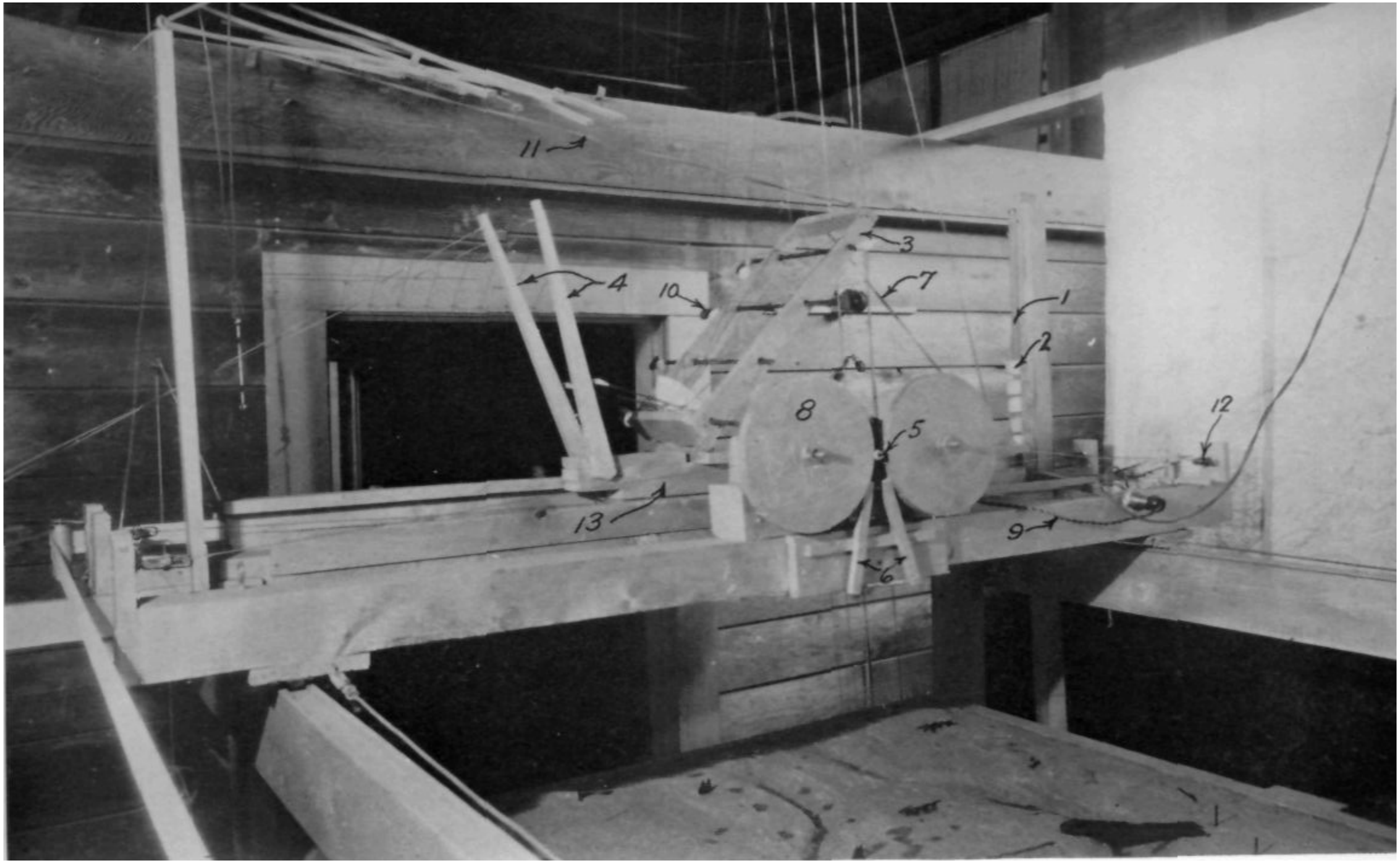
For showing dispersion in range in time fire and bracket adjustment, a mechanism is provided which changes the position (between salvos) of the burst rods which, as explained above, move freely from front to rear in the sheaf arm. This mechanism can be seen in detail in Plate IV and can best be understood by a careful examination of that illustration.

Two cords are attached to each burst rod, one of which pulls it forward and other rearward. Alternating front and rear, these cords are passed down through small eyelets to two large eyelets located on the lower cross-member of the sheaf arm, so that four cords pass through each large eyelet. Of these four cords in the rear eyelet, two pull burst rods Nos. 1 and 3 forward and the two others pull burst rods Nos. 2 and 4 rearward; the four cords in the forward eyelet work exactly opposite to the other four. (See 17 Plate II.) From each large eyelet each set of four cords is passed to the right and attached to a dispersion control lever at a point about six inches above the pivot of the lever on the deflection slide (15 Plate I, 17 Plate II). It is now seen that by moving the top of rear lever to the right, two of the burst rods will be moved forward and two rearward, and at the same time the forward lever will be moved to the left by reason of the pull of the four cords attached to it; also that at one point in the movement of the burst rods the four bursts will be abreast of each other, which will allow them to fall at the same range if the movement has been stopped at that point. Hence

PLATE III

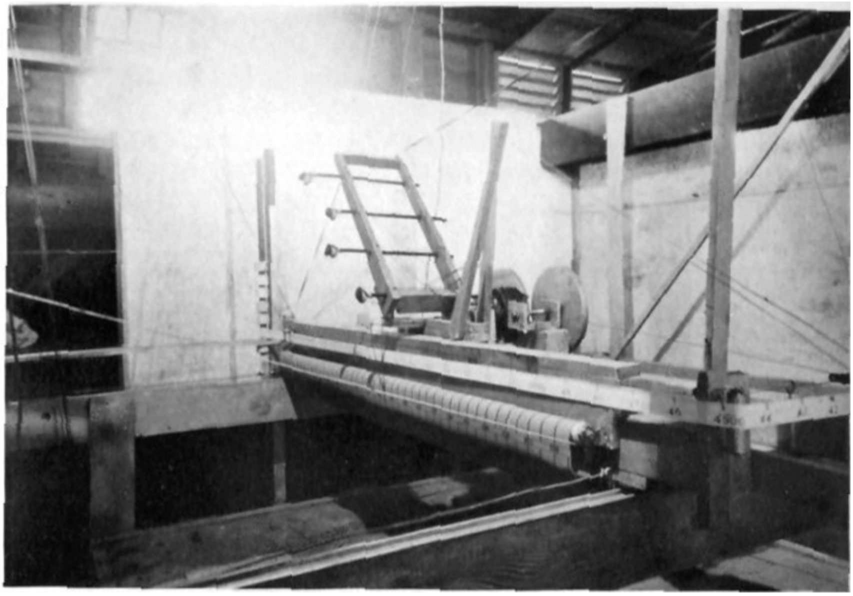
1. Range and elevation scale roller.
2. Range and elevation scales.
3. Sheaf arm.
4. Dispersion control levers.
5. Motor shaft.
6. Wheel brakes, with connecting spring.
7. Cord for lowering sheaf arm.
8. Twelve-inch wheel operating deflection slide drum.
9. Electric wire for motor.
10. Bursts of No. 2 gun.
11. Cord for raising sheaf arm.
12. Pulley for deflection slide cable.
13. Deflection slide.

PLATE III



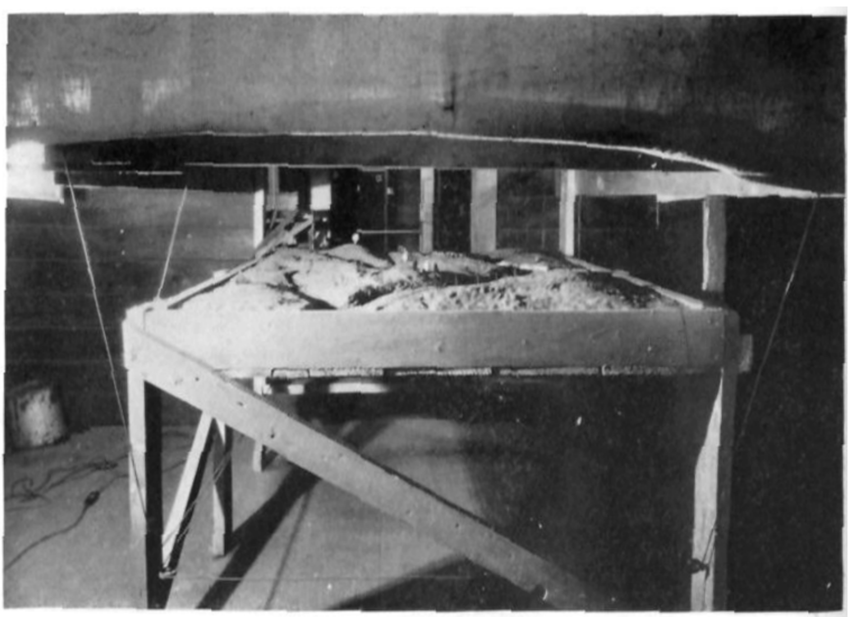
VIEW FROM THE RIGHT FRONT

PLATE IV



VIEW FROM THE RIGHT REAR SHOWING IN DETAIL THE MECHANISMS OF THE RANGE AND DEFLECTION SLIDES

PLATE V



VIEW OF TABLE FROM THE FRONT SHOWING TWO GRAZE AND TWO AIR BURSTS it will be seen that by changing the position of these dispersion control levers between each salvo, quite a bit of dispersion will result during the course of a problem. While this dispersion is more regular than would actually occur in field firing, it affords a convenient and fairly accurate method of showing inequalities in range on a firing table with all guns of the battery firing. The dispersion control levers are actuated by cords (13, 22 Plate I; 19, 30, Plate II) which are brought through a series of eyelets to the left of the operator's position in a similar manner to the cords for raising and lowering the sheaf arm.

Since photographs shown in this article were taken, four other dispersion control levers have been added to this mechanism, working in the same manner as those described, except that the cords attached to them move different combinations of burst rods. The addition of these levers enables the operator to show dispersion in problems fired almost as it would occur in actual firing.

THE DEFLECTION FAN

The deflection fan (6 Plates I and II) consists of a piece of window shade material the same width and length as the table on which has been drawn a diagram corresponding to the outer six feet of a deflection fan having a radius of twenty-six feet. Five mil divisions are shown, with each ten mils numbered. The table being constructed on a scale of one foot equals one hundred yards, the fan is so drawn that, for the divisions to be true as numbered, the guns are twenty feet in front of the front edge of the table and twenty-six feet in front of the rear edge—corresponding to the ranges 2000 yards and 2600 yards. It will be seen that for the table to be to scale for both range and deflection, it can only represent a piece of terrain 500 yards wide by 600 yards deep. However, for all axial firing its depth can represent any number of yards, although the width must remain 500 yards in order that the mil values of the fan remain true. If it is desired to assume that the guns are forty feet (4000 yards) in front of the table, it is only necessary to divide the mil values on the fan by two to obtain the correct amount. In other words, with the guns at 4000 yards each 10-mil division represents but five mils. Further, if it is desired to assume that the guns are thirty feet in front of the table (3000 yards), the mil values on the fan must be divided by 1.5. Thus it is seen with the guns forty feet in front of table, the command for change in deflection must be doubled before being applied to the fan, and with the guns at thirty feet (3000 yards) the command must be multiplied by 1.5. As stated before under "Width of Sheaf Scale," it is also necessary to multiply the commands for change in deflection difference by these same factors, since that scale was constructed with the guns assumed to be twenty feet in front of the table.

The deflection fan is attached at both ends to springless curtain rollers, one roller being mounted on the rear face of the rear member of the range slide (Plate IV) and the other being mounted on the under side. Around the right end of the under roller is wound a strong cord attached at one end to the roller and at the other to an extension on the stationary right side-rail. When the range slide is drawn to the rear, the action of the cord will be to turn the under roller and thereby wind the fan around that roller. Attached similarly to the upper roller is another cord (14 Plate I) which is passed to the rear (Plates II and IV) through a pulley on the wall. A weight is attached to the free end of this cord. The range slide being at its extreme forward position, the deflection fan is wound around the upper roller and extends to the lower roller. When the range slide is moved to the rear by turning the crank of the range slide drum, the under roller is revolved as explained above, gradually unwinding the fan from the upper roller and winding it about the lower roller until the fan has been transferred from the upper to the lower roller when the range slide has reached its extreme rear position. This movement of unrolling the upper roller winds the cord attached to its right end around it. When the range slide is moved forward the action of this cord and its weight is to revolve the upper roller, and the fan is again wound onto the upper roller, proportional in amount to the movement of the range slide. It is seen that this winding and unwinding of the deflection fan is such that the mil values given on it are always true for that part of the terrain immediately under it.

THE DEFLECTION INDEX

The deflection index (12 Plate I) is a wire pointer attached to the deflection slide at a point immediately below the burst rod of No. 4 gun. It extends downward so that readings can be taken from it on the deflection fan by the operator. The index being attached to the deflection slide, any movement of that slide will change the position of the index, and the amount of change may be read by the operator in mils on the deflection fan. It will be noted that the deflection index is nothing more nor less than an indicator for the position of No. 4 gun for direction.

Example of use of deflection index: Assume that the index has been placed on the 110-mil division of the fan at the start of the problem; axial observation; guns twenty feet (2000 yards) in front of the table; and the rear edge of the table 4000 yards. (As stated before, the table may be given any assumed depth desired when axial observation is used—in this case 2000 yards.) The command after the observation of the first salvo is "Right 30, on No. 1 close 5, 2800." The range is first set off so that the mil values on the fan will be correct; the motor is started by pulling the motor switch control rod (27 Plate II); the motor position control rod is pushed forward, thereby revolving the left deflection slide drum and pulling the deflection slide to the left (to the right from the position of the officer firing); the movement of the deflection slide is allowed to continue until it has arrived at the 65-mil division on the fan, thereby having moved 45 mils to the left. This 45 mils is the amount that No. 4 gun must be moved to the left (from the operator's position), 30 mils being the amount of the deflection shift and 15 mils being the added amount caused by closing 5 on No. 1. The sheaf is then narrowed 15 mils by raising the sheaf arm. Thus the exact commands have been applied and the next salvo will show the officer firing the problem a sheaf fifteen mils narrower and No. 1 gun moved thirty mils to the right, No. 2 gun thirty-five mils, No. 3 gun forty, and No. 4 gun forty-five.

RANGE AND ELEVATION SCALE MECHANISM

The range and elevation scales, seven in number (2 Plate I), are non-stretchable cotton tapes with the ranges and elevations stamped on them. These tapes are attached to and wound around a roller (1 Plate I), which is located on the left rear of the range slide. This roller is attached to a slide which may be moved up or down in such manner that the scale desired is brought to its proper place before being unwound. All scales but the one in use remain wound. Attached to the roller is a cord which extends to the rear to a pulley on the wall and thence downward. This cord carries on its free end a weight (Plate II). When the tape is unwound the cord is wound around the roller and the action of the weight keeps the tape taut. The desired scale having been brought to its proper place (level with the motor switch control rod), it is unwound and passed across the rear face of the range slide to the scale roller (25 Plate I), from which point it is passed forward to an extension at the front of the right side rail, where it is made fast. When the range slide is moved to the rear, the scale, being secured at the front, will be further unwound an amount corresponding to the movement of the range slide, and the range or elevation may be read off at the scale index (5 Plate I). If the range slide is moved forward, the scale is wound onto the roller at the left by action of the roller cord and weight.

OPERATION OF BURSTS

As stated previously, each burst rod carries at its rear end a double eyelet. Through each eyelet is passed a small cord having on its end a covered lead weight (ball-shaped, one-half inch diameter) to represent a burst—one black to represent a graze and one white to represent an air burst. From the eight bursts (two to each burst rod) the small cords are passed upward to the ceiling and through eight eyelets. (See 17 Plate I, Plates II, III, IV, for the details of this mechanism.) From these eyelets the cords pass back to the rear ends of the eight burst control rods (13 Plate II, Plate III) where they are attached. The eight burst control rods are pivoted on the joist above the door (Plate III) at a point about eighteen inches from their forward ends. Each burst control rod is about seven feet long. To the forward end of each of these rods is attached another cord which passes downward to an eyelet (one for each cord) above the door (Plate III) and thence hangs free for some three feet. Each cord carries a light weight at its free end. By pulling these cords it will be seen that the bursts may be lowered to any desired height above the terrain. When the cord is released the weight of the pivoted burst control rod will raise the burst to the position shown in Plates I, II, III, and IV.

DISPERSION IN PERCUSSION PRECISION FIRE

The dispersion mechanism used in time fire and bracket adjustment is not used in percussion precision fire. Instead a range dispersion scale has been placed on the rear face of the range slide (5 Plate I, Plate IV) so that one-half of the dispersion scale is on each side of the range scale index. Each of the eight zones of the dispersion scale is numbered and the mid-point of the zone is shown by a perpendicular line (Plates I and IV), which line may be considered a sub-index for the range and elevation scales. The probable error for 3600 yards, shell Mk I, fuze Mk V, was used in constructing the dispersion scale so it is not strictly accurate for other ranges. However, the operator may take into consideration the elevation announced and make estimated corrections for the change in the value for the probable error.

Use of the dispersion scale: One hundred disks are kept in a box at the operator's position. The disks are numbered to correspond to the percentages of a range dispersion scale, that is, two are numbered "1" for the two per cent. zone short; seven are numbered "2" for the seven per cent. zone short; sixteen are numbered "3" for the sixteen per cent. zone short, etc. When the elevation is announced by the officer firing the problem, the operator draws as many numbers from the box as there are rounds to be fired. He then places the elevation on the scale (tape) opposite the numbers of the dispersion scale corresponding to the numbers drawn, by changing the position of the range slide. Thus the exact dispersion to be expected may be shown in percussion precision fire at ranges in the vicinity of 3600 yards. For other ranges the dispersion can be shown, as stated above, with a fair degree of accuracy by keeping the elevation in mind, and correcting the dispersion scale accordingly by estimation. A rubber dispersion scale could be used which would be extended automatically as the range increased, but this would necessitate an intricate mechanism which is not thought necessary, as the dispersion scale as constructed has been found to give accurate results, using the phi and omega values given in the range tables. Of course the table must be to scale both for elevations and deflection for percussion precision fire.

TRAINING SWISS MOUNTAIN ARTILLERY RECRUITS

FURNISHED BY THE MILITARY INTELLIGENCE DIVISION, G.S.

MUCH has been written in the past of the efficiency of the Swiss military system; in fact, it has often been held up as a model upon which our own system might be modeled profitably.

That it is efficient would seem to be shown by the following account of a practice march of the Mountain Artillery Recruit School as a grand finale of the course of training of the 360 recruits which were allotted this year to the Mountain Branch of the Artillery arm.

The recruits were organized into three batteries and a battalion headquarters. The march commenced on July 2 at 4:30 A.M. and terminated on the evening of July 9 and was made through the difficult mountain terrain just east of Berne in the vicinity of the Lake of Thun. The command aggregated 18 officers, 360 men, and 184 horses and mules. As a general rule the batteries alternated in leading the march, the other batteries following at fifteen-minute intervals.

The route entered the Gemmi Pass almost immediately where the first casualty occurred. A pack horse of the first battery slipped and fell, getting his two left feet over the side of the trail where he hung for several minutes while the lead and follow-up men did their best to get him back on the trail. Fortunately, this delay enabled the pack animals in the three zigzags of the trail underneath to be gotten out of the way, so that in his final struggles, as he toppled over, he fell clear of the men and horses winding up from below. He rolled down at first sideways and finally end over end, crossing the trail three times in a fall of about 150 feet, and finally lodged head downward on a steep slope just at the edge of a precipice of some 600 feet, where he was anchored with ropes to prevent his falling further, carrying further destruction to the other batteries which had to pass underneath. His neck and other bones had been broken in the fall so that he was quite dead. As a punishment and warning example to the men, his leader and follow-up men were required to carry his load of about 200 pounds for the rest of the day's march over the mountains.

The summit of the pass was reached by the leading battery at 9:00A.M. where the real difficulty of the day's march began. The plateau of the summit of the pass, several miles in length, was covered with deep snow, very treacherous and difficult. The feet of the animals were constantly breaking through the soft snow and the men had great difficulty in pulling them out. Through this part of the pass every endeavor was made to improve the trail but without much success. The guns were dismounted from the backs of the animals and held with rope-trails, but at best the progress was very laborious and slow, so that it required five hours of very hard work on the part of everyone to cover the few miles until the noon halt was reached. Here hot tea was served to the men from the fireless cookers which are a part of the mountain battery's equipment, and the horses were also fed.

It is a rule in the Swiss Mountain Artillery to save up both rations and forage so that extra meals may be given to both men and animals on long climbs through the mountains.

Following three hours of steep descent, the command reached the lower ground at 6 o'clock with thirteen kilometers to go to the objective of the day's march. After an hour's halt for supper for the men and animals, the last stage was made to the night's camp which was reached at 10:00 P.M. by the last battery, making a total day's march of seventeen hours including two halts of an hour each. The command bivouaced for the night on a grassy plot near the railway station, the officers being quartered in several of the small hotels. Marching into camp, the batteries were reviewed by the commander, the young recruits executing "eyes right" with a grimness and determination which provoked most favorable comment from the observers. Not a man had fallen out and the only casualties had been one horse killed and one severely wounded.

The second day's march was over a mountain road paralleling a valley and was of some twenty kilometers in length. After reveille at 7:00 A.M., the morning hours were devoted to cleaning equipment and preparing for the march which was begun at 11:00 A.M., the objective being reached at 4:30 P.M. The heat was very oppressive and little air was stirring so that the men and animals suffered more fatigue on this day's march than on the much longer one of the first day.

The unusually good comradeship existing between the officers and men of the Swiss Army was illustrated by several instances of the officers assisting tired men with their packs and rifles. The noon meal this day, carried as usual in the fireless cookers, consisted of oatmeal soup, supplemented by bread and raw bacon carried in the men's haversacks. Raw bacon is considered a great delicacy by the Swiss.

The third day's march, over a difficult pass, was begun in the cool of the morning at 5:00 A.M., the ascent being comparatively easy, but the descent extremely difficult as the trail was narrow and so muddy and in places so rocky that at first sight it did not seem possible to get the animals down without accident. In the descent, the two "steering straps," fastened on to the rear part of the horses' harness and held by one and in some cases by two follow-up men, were the only means of saving the animals from losing their balance and toppling headforemost. The trail was much too narrow to permit the guns to be set up so that the heavy weights had to be carried by the animals for the entire distance. Camp was reached at 2:30 P.M.

The fourth march was expected to be so difficult that a working party of six officers and forty men was sent out at 5:00 P.M.

The next morning a heavy rain was falling which greatly hampered the work of preparing the trail and of advancing supplies for crossing the pass. Convoys were sent up to the advance base both morning and afternoon, every horse and mule carrying two bales of straw (90 pounds each) or hay (100 pounds each) or its equivalent.

By noon the next day all the stores for the crossing had been accumulated at the advance base.

The following morning the passage of the pass was commenced. The ascent was so arranged that the gunners of the third battery should accompany and assist the leaders of the leading battery, while the gunners of the leading battery should descend and assist the leaders of the third battery, while both joined in assisting the intermediate battery. In addition to these general precautions, six officers with an appropriate number of men were assigned to direct the passage of the six places of special difficulty and danger.

The first two danger spots consisted of the passage of very steep, snow-covered slopes, which at the continued melting temperature threatened to break down. The third was a crossing of a waterfall which had been covered over with snow and ice and which threatened to break and tumble down, but most of which had been cut away with infinite labor and difficulty. The fourth place consisted of a narrow ledge of rock cut out from the face of a precipice down the centre of which fell a sheet of water which could not be diverted. The principal difficulty here was that the animals had to take the sheet of water in their faces. If they tried to dodge it on the side of the rock, their packs would be torn off, and, if they tried to dodge it on the outside, they were bound to go over the edge. In passing this place every animal had a man on each side of his head with two guiding him from the rear. The fifth difficulty was rounding a rocky promontory where a sharp turn and a steep ascent had to be made at the same time. The danger here was that if the horse struggled to get ahead he would force his leader, who had been on the outside, off the precipice. The sixth and last of the difficult places was a very steep and slippery pass of bare rock, where, if the horse slipped, there was every probability that he would go tumbling over the precipice.

In the ascent, and in fact in all the work, a great contrast was noted between the conduct of the horses and the mules. In every place of danger the horses showed evident signs of excitement and sense of panic, while the mules remained calm and unconcerned. In the opinion of the Swiss officers, there was no comparison between the suitability of the horse and the mule for mountain battery work. The mule, however, is regarded with great disfavor by the Swiss peasant and, as a consequence, as the Government cannot afford to keep animals of its own, they are forced to use horses for most of the mountain work.

The ascent of the pass and the corresponding descent were made without accident due to the excellent preliminary arrangements made by the battalion. Camp was reached by the leading battery at 5 o'clock in the afternoon, where the command bivouaced for the night. Lacking enclosures, picket lines were set up formed by ironbound sticks driven into the ground to the depth of a foot and a half with the tops about three feet above the ground. The feed was on one side and although the picket line was unusually low from an American standpoint, the animals had evidently been trained to stay on their own side.

After the animals had been cared for and the guns thoroughly cleaned, the men proceeded to build a shelter-tent camp. The sheltertent pieces are five feet square and pitched at right angles with each other. Five to eight of these sections were put up together, with the opening in one of the middle sections, the ends being lashed down. The tent was floored with large strips of canvas over which pine boughs were spread to form a mattress. Each man carries a blanket, beds being made up for three men with one blanket underneath and two over. The men sleep crosswise the length of the tents, which were so pitched that the side for the head was the higher. Supper for the men consisted of oatmeal soup and a meat stew, each man carrying his own bread. After supper bonfires were lighted by each battery, about which the men gathered and sang the songs of their native villages.

TRIANGULATION AS A METHOD FOR FIGURING FIRING DATA

BY LIEUTENANT EVERETT LEWY, F.A.-RES.

DUE perhaps to a thought that triangulation always involves so much careful work and the expenditure of so much time that it is not of much practical importance for Field Artillery in situations of movement, it is believed that less attention has been paid to it in connection with the figuring of original artillery data than might be justified. As a matter of fact, by means of a few comparatively simple adaptations, triangulation can be made of real practical assistance in many situations when computing data, and can frequently aid materially in saving ammunition and in producing quicker and more accurate results. It is the purpose of this article to point out methods of adapting triangulation to artillery work, especially in the situations where it is impractical to measure any distances, to show when they can be used and to briefly touch on the advantages and disadvantages of these methods of figuring data.

All the applications of triangulation given here are based on one method or problem and on one geometric truth. In order to make this article more intelligible and to give a basis for understanding its practical applications, an approach to this method will be made from a theoretical point of view.

The first and most important prerequisite to the use of triangulation is that two observation posts be available from each of which, the other observation post, the guns, target and aiming point are visible. Later in the article the distance the two observation posts must be apart for the most accurate work will be considered. For purposes of the theoretical discussion let it suffice to say that where neither the target nor aiming point is more than 2000 meters from the observation posts, a distance of 100 meters from one observation post to the other will give quite accurate results. Let us assume that we have set up a plane table at one of the observation posts, which we shall call OP_1, and that we have clamped the table in any convenient position. We pick out and mark on our paper any convenient point—O_1—(see Figs. 1 and 2). We swing the alidade around O_1 and sight at the guns, target, aiming point and other observation post and draw these four rays from O_1. Then we take the plane table to our second observation post (OP_2) and orient by back-sighting on OP_1—that is by laying the alidade on the O_1–OP_2 line and turning the table till the alidade points at OP_1—and clamp the table in place.

We now pick *any* point on the O_1–OP_2, line and call it O_2, being careful, however, to have it close enough to O_1 for all our points to be on the paper. Swinging our alidade about O_2 we again sight at the guns, target and aiming point and draw the rays. Where the O_2-gun line intersects the O_1-gun line is point G, which represents the guns (see Fig.

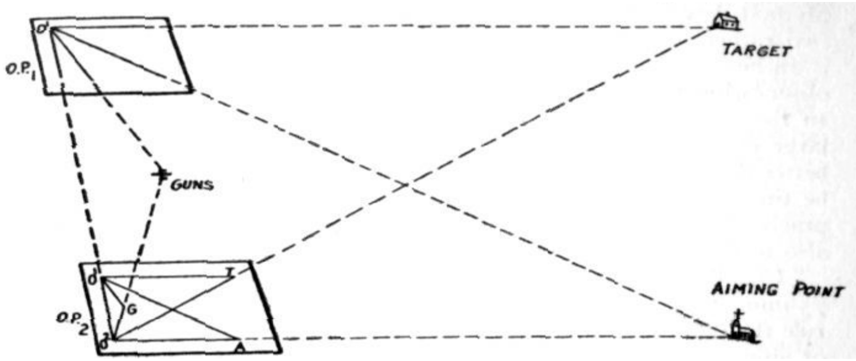


FIGURE I

2), where the O_2-target line intersects the O_1-target line is point T, representing the target and in a like manner we find point P, representing the aiming point. On the paper then we have an accurate map, made by triangulation, showing the two observation posts, the guns, target and aiming point. *Since we have measured no distances* and since we chose

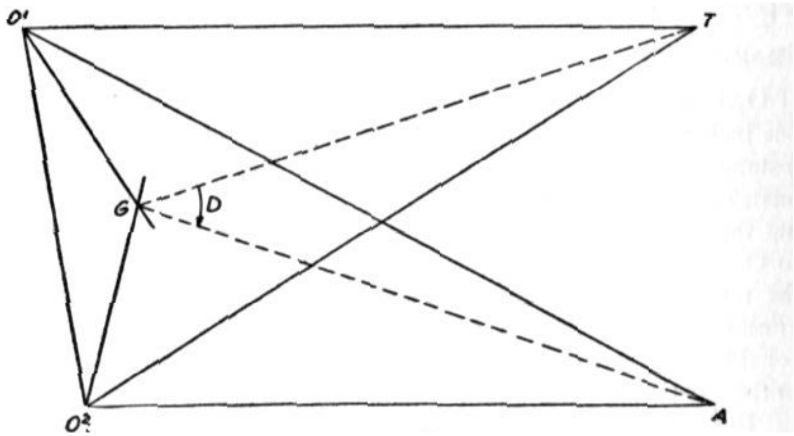


FIGURE II

for O_2 *any* point on the O_1–OP_2 line, we do not know what the scale of our map is. Each map of this sort we make, however, has *some* scale, the ratio of O_1–O_2 to the real distance OP_1–OP_2, but we do not know what the scale is and so far as deflection is concerned, we do not care. *Angles measure the same no matter what the scale,* and we are not now using the map to measure a distance. The sole purpose at present is to obtain the deflection, an angle. This we do by drawing G–T and G–P and measuring the clockwise angle between the two lines at G with a protractor.

We could of course actually find the deflection by the Plane Table Method described in the preceding paragraph, but that method has two rather serious disadvantages. In the first place, a plane table is rather a cumbersome and conspicuous instrument to use at an observation post, which is of necessity within sight of the enemy. In the second place, the method is not very accurate. Even if a large plane table is used and we do very neat work, an accuracy of better than ten mils cannot be expected. Since, however, there may be times when it is desirable to use the plane table method, a few practical suggestions might be of use, especially since they apply also to the actual method ordinarily used.

Usually because of the collinator sight used on the French 75-mm. gun, a forward aiming point is picked, and as a general rule the observation posts are nearer to the guns than to the target or aiming point. Consequently if O_1 is placed near one end of the paper, the work can be done on a larger scale than if O_1 is in the center. In order to know the maximum distance, we can place O_2 from O_1 (the greater the distance the larger the scale and the more accurate the work) we must consider the approximate ratio of the distance from OP_1 to the target, to the distance OP_1–OP_2 between the two observation posts, and also keep in mind the size of the paper. For example: If the distance OP_1–target is 2000 meters and the distance OP_1–OP_2 is 100 meters, the ratio is $\frac{2000}{100}$, or 20 to 1. If O_1 is 20 inches from the far edge of the paper, we can place O_2 one inch from O_1 and get our intersections on the paper. Since the distances which form the ratio are merely guessed, we may make a mistake in locating O_2, which will be apparent immediately on drawing the first rays. If this happens, we merely pick a new O_2 nearer to O_1. If it happens that the aiming point is farther from O_1 than the target is, we consider in making our ratio the distance OP_1–aiming point instead of OP_1–target. In all this work we of course consider the relative directions of the guns, target and aiming point in the location of O_1 and in the original orienting of the board.

In plane table operations involving the use of a short base line, great care must be taken in orienting on that line, bearing in mind that the line of sight passes through the location of the points on the paper and not merely through the approximate previous set up of the table. This may be taken care of by properly located stakes, or by picking up distant points on the line as in backsighting.

Before going into the really practical applications of the theory just presented, it seems best for the sake of completeness to finish the mathematical analysis of it. It has perhaps occurred to the reader that if the deflection can be determined graphically merely from the knowledge of six angles measured at OP_1 and OP_2, that the deflection is a function of these six angles, that is, that the deflection can be determined from a formula involving as unknowns these six angles and only these six angles. The deflection *is* such a function. If T_1, A_1 and G_1 are the angles in mils measured at OP_1 clockwise from OP_2 to the target, aiming point and guns, respectively, and t_1, a_1 and g_1 the corresponding angles measured at OP_2 clockwise from OP_1, then the following formula is true*:

$$\text{Deflection} = 3200 - (G_1 - g_1) \pm \arc\sin \frac{K_1 \sin(a_1 - g_1)}{\sqrt{1 - 2K_1 \cos(a_1 - g_1) + K_1^2}} \pm \arc\sin \frac{K_2 \sin(G_1 - T_1)}{\sqrt{1 - 2K_2 \cos(G_1 - T_1) + K_2^2}}.$$

$$\text{Where } K_1 = -\frac{\sin A_1 \sin(G_1 - g_1)}{\sin G_1 \sin(a_1 - A_1)} \text{ and } K_2 = -\frac{\sin t_1 \sin(G_1 - g_1)}{\sin g_1 \sin(t_1 - T_1)}.$$

The use of such a formula as it stands is obviously quite out of the question for field artillery work, although it has some topographical interest.

Now that the theoretical aspect of the method has been more or less thoroughly gone into, we shall consider the practical means of using it, which will be necessary to get the quickest and most accurate results. The instruments necessary for best use of the method are one or two aiming circles or battery commander's telescopes, a large plane table or drawing board (the 18 × 24 issue plane table is large enough to give quite accurate results, yet small enough not to be too cumbersome in the field), paper to fit the board, one or more very hard pencils, a large (24 or 30-inch) and really *straight* straight-edge and a large protractor. If an accuracy of 5 mils is desired a 12-inch—30 centimeter—diameter protractor should be used. It is graduated every 10 mils, but angles of 3 or 5 mils can be measured by interpolation. Everything but the aiming circles is taken to a quiet, sheltered and defiladed spot. The aiming circle or battery commander's scope is set up at one of the observation posts—OP_1—and the angles to the guns, target and aiming point (known as G_1, T_1 and P_1) are measured clockwise from the opposite observation post. If two instruments are available the corresponding angles are measured at the same time at OP_2. If not, the one

* The author is indebted to Cadet Lieutenant Archie Blake of the University of Chicago, R.O.T.C., for the method of deriving this formula. The derivation is long and complicated and interesting only from the mathematical point of view, hence it is not published here. The author will send this derivation to anyone on request.

Mr. Louis Kassel of the University of Chicago has derived this formula in a somewhat different form, but his formula is also too complicated for field artillery use.

instrument is then taken to the other observation post from OP_1 for the measurement of t_1, g_1 and a_1. If one instrument is used, the precaution of sighting at two distant points from OP_1, which is mentioned in connection with the use of the plane table, should be observed. A point on the line in the direction of OP_2 is picked up, the instrument is turned 3200 mils and another point is picked up and of course a stake is left where the instrument was. Only a few seconds are lost in taking this precaution.

With the data in hand the observer proceeds to the quiet defiladed spot and plots his results on the drawing board or plane table (see Fig. 2). First a point somewhere near one end is picked for O_1. The same considerations govern the choice of location of this point as do when using the plane table method already described. From O_1, the line O_1–O_2 is drawn in such a direction that the line from O_1 to T will run approximately parallel to the long edge of the paper. This direction for O_1–O_2 is obtained from angle T_1. When this line is drawn we carefully place the center of the protractor on O_1 and the edge along O_1–O_2 and measure the three angles T_1, G_1 and P_1, using the clockwise reading on the protractor. The rays are drawn connecting the three marks to O_1. O_2 is now picked somewhere along O_1–O_2, the distance from O_1 being determined by the ratio of the distance OP_1–target to OP_1–OP_2 as in the plane table method. With O_2 as a center we measure our three angles t_1, g_1 and a_1 and draw the rays. From the intersections we get points T, A and G. By connecting G to T and to A we get our deflection angle which we measure to the nearest three mils with the protractor. To avoid confusion the edge of the protractor is always placed along G–T and the clockwise angle read. When this is transformed to plateau and drum, the work is finished.

Even though no aiming point is mutually visible from the two observation posts and the guns, very good results may be obtained with this method by using one of the observation posts as the original aiming point. When this is done it is usually best to lay the other three guns parallel to the base piece and then to have each gun pick an aiming point of its own and mark the base deflection. By using one of the observation posts as an aiming point, we greatly increase the possible location of the observation posts.

Another practical aspect of the method we have not yet considered is its use in connection with finding the range. We have assumed so far that we did not know the distance OP_1–OP_2. If it is practical to measure or estimate this distance, we can get the range by the use of the following formula almost to the accuracy that the distance OP_1–OP_2 was measured or estimated:

$$\text{Range} = (G - T)\,\frac{OP_1 - OP_2}{O_1 - O_2}.$$

G–T is the distance *on the map* we made from the guns to the target.

O_1–O_2 is the distance *on the map* we made from OP_1 to OP_2.

OP_1–OP_2 is the distance measured or estimated on the ground from OP_1–OP_2. This formula is true because our map is similar to the actual figure on the ground.

A cord or wire of known length, extended from one observation post, perpendicular to the OP_1–OP_2 line and measured in mils from the other observation post, provides a rapid method of determining the distance OP_1–OP_2. By this means we could frequently find the range to enough greater accuracy to justify the slight extra work involved.

We have not considered in detail the limitations of triangulation nor the conditions under which it works to best advantage. Since its claims for consideration are based on its accuracy, simplicity and speed, a statement of results obtained in actual experiment and a comparison of these results with those obtainable by our present methods seems in point.

Assuming that we have done the work as described above, the degree of accuracy of the results will depend mainly on three things: the care and accuracy of the man doing the work, the ratio of the distances OP_1–aiming point and OP_1–target to the distance OP_1–OP_2 (hereinafter referred to as the Ratio), and the scale of our map. This latter in turn depends on the distance O_1–O_2 which is determined by the size of the paper.

As to the first, it is axiomatic that no work of any sort in gunnery should be done unless the care and accuracy of the worker are the greatest compatible with the conditions and time limits at hand. The results secured by the author in experimenting with the method were obtained by an officer of average ability as nearly as possible under actual field conditions. No problem was allotted more than ten minutes' time from the setting up of instruments to the final announcing of deflection in plateau and drum. In order to check the accuracy of the method the target in each case was picked within sight of the gun position so that the actual deflection could be measured at the guns by the battalion commander's scope.

The second consideration which affects the accuracy, the Ratio, is by far the most important. As the distance OP_1–OP_2 increases, the Ratio decreases and the work becomes more accurate, due to the angle of intersection of the rays. The distance OP_1–OP_2 is limited by two factors: first, the number of mutually visible points from which the guns, target and aiming point can be seen, and second, the amount of time it will take if only one instrument is available to go to both places for measurement. If two instruments are available this last consideration is not so important, since due to the simplicity of the data (the value of three angles) visual signalling of one sort or another may be resorted to with rapid results.

To be more specific the following results were obtained: Whichever of the two distances OP_1–target or OP_1–aiming point was the greater was used as the numerator of the Ratio. With a distance to the target of 2000 meters and a distance between observation posts of 100 meters, a Ratio of 20 to 1, the results were accurate to the nearest five mils. With greater ranges the same accuracy was maintained so long as the Ratio was not over 20 to 1—for instance, for a distance of 3600 meters the observation posts had to be 180 meters apart for work of this accuracy. When the Ratio was 30 to 1, the work was done to an accuracy of from 5 to 8 mils. With a Ratio of 40 to 1, an accuracy of better than 10 mils could not be expected. Work of this accuracy often will not be worth the extra time necessary to do it. If the distance to the target or aiming point is say 4000 meters and we are more or less in a hurry, it would be better not to attempt the triangulation method unless we can find two suitable observation posts 160 meters apart or thereabout. This phase of the subject will be considered later.

The scale of the map, which is determined by the size of the paper, is our third consideration. The results given above were obtained with an 18 × 24 plane table which carries paper 14½ × 20. If a very large drawing board or plane table which carries 20 × 36 paper is available even more accurate results can be obtained, especially with the larger Ratios. With the small table which is part of the sketching kit the possible error was about half again as great, 8, 10 and 15 or 20 mils for Ratios of 20 to 1, 30 to 1 and 40 to 1, respectively. For the smaller Ratios, 10 to 1 and smaller, which we get in connection with bilateral observation, work on the small table is quite satisfactory.

It must be borne in mind that the error given above is merely the error of the method and does not include the probable error of the guns themselves nor the possible error due to inaccuracies in figuring drift and windage.

How do these results compare with those obtainable by our present methods, considering not only the relative accuracy, but also the comparative simplicity, speed and availability of the methods?

Let us first consider availability. The reader knows enough of the principles of the method to judge for himself how often it can be used. The conditions precedent to its use: two mutually visible points from each of which the guns, targets and aiming point are visible; ten minutes' time; and the possession at that time of certain instruments, are sufficiently simple for triangulation often to be of service. It is presented here for what it is worth to be used when the conditions are proper. Throughout the following discussion we shall assume that conditions are such that the method can be used.

Now as to accuracy. The error in figuring the angle itself under most conditions will vary from 5 to 8 mils. In addition to this we must consider a possible error, even if we are careful, of from 3 to 5 mils from inaccuracies in figuring windage and drift. The chances that these all will add together instead of neutralizing each other and that we should get the greatest error in each are so slight as to be almost negligible. We may then safely consider our deflection figured to an accuracy of from 7 to 10 mils if the work has been done correctly and with average care. In our first salvo, firing at say a 20-mil target, we are almost certain to get not one, but two or perhaps three shots in line with it. Certainly on our second salvo we shall be that close. In bilateral observation the work will be even more accurate due to the size of the denominator OP_1–OP_2 in the Ratio.

The reader can judge for himself the simplicity of the method. It involves the measuring of three angles at one point and three at another with an aiming circle, the exercise of a little judgment, the drawing of nine lines and the measuring of six or seven angles with a protractor.

In regard to relative speed it must be borne in mind that *the time between commencing fire and obtaining the final adjustment is of immensely more value than the time consumed in figuring data before fire commences*. Also when data is hastily figured a good deal of the time saved by hasty work is directly lost by the firing of wasted salvos. As far as height of burst is concerned, it rarely happens that in two salvos it cannot be adjusted close enough to zero mils to obtain range sensings, provided the deflection is correct. We have scarcely touched on ammunition saving. If we can fire each problem with only one less salvo than we now require and still get our adjustment nearly as fast as at present, the savings in ammunition will be quite worth considering. In shell fire, which is probably more common than shrapnel, the savings are even greater. In bilateral observation triangulation is probably more effective than in any other case. The distance between the observation posts makes the Ratio smaller and the work quite accurate; while in bilateral observation by the means usually employed, the deflection adjustment is difficult to obtain. Since by triangulation it takes but ten or fifteen minutes at the most to figure initial deflection and only one or two (by measuring two more angles) to figure deflection to other targets, these savings usually will be quite compatible with tactically effective fire.

A COURSE AT THE ARTILLERY CENTER AT METZ

OPINIONS OF AN INFANTRYMAN

BY BREVET LIEUTENANT-COLONEL E. CROSS, FRENCH INFANTRY

[This article appeared in the December, 1926, issue of the *Revue d'Artillerie*, Translation by Captain L. V. Warner, F. A.—EDITOR.]

THE Center welcomes us warmly. A spirit of good fellowship facilitates instruction, promotes a sympathetic atmosphere and courteous discussion, as it should in such a gathering of gray-haired, experienced comrades of all arms.

About forty lieutenant colonels, colonels and generals belonging to all branches, and coming from all parts of France, gathered at Metz for five weeks, to work together, to listen, to debate, to instruct themselves, and to hear expressed, as a conclusion, the artillery doctrine. The plan was simple, the conception logical, the program rational, and let us add admirably realized. Do not think that the artillery is parading at the center its special science or complicated technic. It is first of all a center of tactical studies; and whoever mentions tactics, thinks irresistibly of infantry. In fact, infantry is the branch most discussed here. An infantryman not satisfied with the course would be very unreasonable, since the course deals especially with the infantry. The student sees the artillery action only through that of the infantry. This feature appears in each discussion, daily, forcefully, with the increasing regularity of a hammer driving in a tack.

The infantryman, who remembers his details with the artillery before the war, realizes with pleasure that this time he is understood and admitted. He remembers that formerly the artilleryman talked to him particularly of artillery firing, figures, and technic. He remembers that these technical discussions regularly provoked bitter argument. To-day the artilleryman rarely discusses guns. In return, he has an artillery doctrine. Evidently there has been a war. Alas! For the infantry, too, there has been a war. This course would make one believe that the infantry profited less by it than did the artillery. But let us not anticipate.

The artilleryman asks the infantryman a very simple question: "Tell us what you want and we will do all that is possible to give it to you."

To answer this apparently good-natured question, infantrymen must first agree upon *what may be asked of the artillery*. It is a very difficult problem. Suppose that after mutual concessions among the infantrymen, this harmony has been realized. A thing still more difficult for the infantry is the *way to ask it*.

Of course it is not a question of requiring all infantrymen to have, in the same particular case, the same tactical solution requiring the same use of artillery. In "military art," as our ancestors said, personality is a factor, and fortunately so. But, however great an artist one may be, there are possibilities and impossibilities which constitute, whether one wishes it or not, certain fixed principles of a problem. A commander who ignores these "possibilities" and "impossibilities" or simply forgets them in a map problem or in battle, is not in a position intelligently to use his artillery.

Among these elements of possibility and impossibility there is one which is present in all discussions and in all conferences, it is the *time element:* rapidity of movement if it concerns change of position, rapidity of execution if it concerns conduct of fire. The artilleryman is always apologetic: "I am sorry—— I was unable to do it better or quicker—perhaps in going to the heart of the matter—or with better equipment—I could have gained time."

This delay for which he is apologetic may be a few minutes, three or four for example, for fire on a sudden target, a half hour for the change of position of an advance guard group, a few hours for the destruction of a dugout or one or two days for a large preparation. But whatever the circumstances, the artilleryman always looks upon himself as an inadequate associate of the too exacting infantryman who hurries him and at times jostles him. He always has the appearance of a person in slow motion.

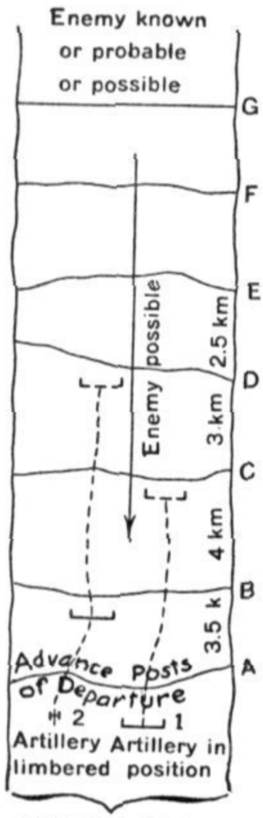
It is easy to understand why the infantryman in the midst of a hard fight is anxious to see prompt and accurate delivery of a heavy fire by his own artillery. However, the infantryman should be more reasonable in granting necessary delay in the execution of this fire. The artilleryman feels that he is continually "in tow."

Where one remembers the coöperation of 1918, the unity of views of doctrine and action which existed between these two friendly brothers, the artillery and the infantry, one wonders if the artillery would not by chance have become more timorous, or whether the infantry would not have grown more bold. Was not the infantry adopting a policy of acceleration analogous to that which led it from the wise regulations of 1875 to the errors of the 1914 offensive? The question is delicate, perhaps bold, perhaps embarrassing. However, we will treat only the side which pertains to our discussion, remembering that this is the modest voice of an infantryman who intercedes for the artilleryman.

The work at Metz takes up first the study of a defensive organization, then the study of all phases of the offensive from the approach march to the attack on a strongly organized position.

In the discussion of the time element, the approach march was the phase which most frequently contrasted the "haste" of the infantry and the "delay" of the artillery. The approach march! These three words caused faces to light up; at last, a subject of discussion. Apparently it is far from being exhausted or solved. Officers at Metz from all parts of France and the colonies say that the approach march is the favorite theme and exercise periodically repeated and discussed at length in all garrison schools. It is the theme of tactical instruction.

Let us see how they study the approach march at Metz, without quoting too many regulations. However the reader should read first the paragraph of the regulations which treat this question (large units: Nos. 88, 89, 148, 149, 150, 172, 173. Infantry: Nos. 72 to 76. Artillery: No. 83). Otherwise, he will realize at the end that he has forgotten the principles.



DIVISION FRONT in this case 6 km

Sketch No. 1

"The approach begins when the army corps, marching to battle, enters a zone where it can be reached by enemy artillery."

The march is made *by day*, since contact with the enemy or enemy shell fire is possible, probable, or certain.

We know that if we have Germans in front of us, they will place well forward, behind simple screens of infantry or cavalry, heavy long-range corps or army artillery. This is a part of their "inhaltendes gefecht."

The head of our advance guard may there be under fire from these guns at a distance of from 15 to 20 kilometers.

We must prepare to combat this distant danger. In front of this heavy artillery there may be light artillery, machine guns, rifles, etc.

This in general is what we must expect to encounter. With such valuable information, how are we going to organize?

From all the opinions gathered from those who have come to Metz and from the instruction given at the artillery center, there flowed a sort of unity of doctrine for the execution of this march. It is a standard operation, conveniently simple, but its value is purely theoretical and abstract. It is a simple school formula, good in itself, but must be adapted to each particular case.

Let us see first in what it consists. For simplicity we will apply the operation to a division.

Before engaging his advance guard infantry in a zone of terrain, before making what is called a bound, the division commander wants the zone beaten by artillery fire. (See sketch No. 1.)

Before the jump-off, he will have placed a part of his artillery behind his advance posts to support the infantry to B.

At what distance has he chosen B? Exactly at a reasonable range for this supporting artillery. If B is at a range of from 3000 to 4000, the artillery will have to fire at 4000 to 5000. This is to provide a margin of safety since the firing will have to be executed without the help of a telephone.

To support the advance between B and C another fraction of artillery will have followed the infantry and will go into position near B.

Then the one which has been behind A, will go into position behind C, etc.

It is apparent that the division commander will have divided his supporting artillery in two parts which will leapfrog each other, one being always in position.

Let us note here, that under the old system of four groups per regiment of 75's, this operation was more easily executed. Actually with three groups it is necessary to divide one of them into two units which leapfrog each other. It is true that other systems exist which obviate this division of a group. Moreover, division commanders often wish to be supported at all times by more than half of the division artillery. Later, we will take up systems which involve even the use of 155's.

For the present we will confine our study to the simple system already explained.

The principal rôle of the division commander is to "indicate the successive lines to be reached" to trace on the map his ladder from which he will climb from rung to rung, and to divide his 75 artillery. He indicates to everyone his mission, fixes the zero hour and launches his division into space.

How simple it is!

So simple that everyone is won over, everyone from the young candidates at the Ecole de Guerre to the veterans on the artillery board at Metz.

Unfortunately, no sooner is the system started than it has a stoppage. Everything goes well up to B. The artillery No. 2, which was limbered and whose reconnaissance party was marching with the head of the advance guard, goes into position very quickly behind B. The infantry can make the next bound whenever it wishes. But at C, everything falls down. The artillery No. 1 which has six to seven kilometers to cover, which must unlimber and limber again, calmly demands three hours time. This makes the anxious and eager infantryman jump with rage.

This eager infantryman has long ago arrived at C. According to his temperament his advance from B to C has taken an hour, an hour and a half or two hours. To allow the artilleryman three hours, the infantryman must have the moral courage to wait at C and thereby be accused of cowardice. He paws the ground with impatience; he curses the artilleryman who again excuses himself: "I can do no better, even if the roads over which I must pass are not shelled."

Thus the question of *speed of the approach march* presents itself at six kilometers from the jumping-off point. One can even say that the question of *tactical speed* in general is presented.

If you had been present at conferences of the board at Metz you could have heard expressed (in such a courteous manner) such varied opinions as these:

THE DARING INFANTRYMAN: "You are not going to make me wait motionless for two hours at C. The artilleryman has only to trot or to move out on time to make everything right."

THE CAUTIOUS INFANTRYMAN: "The artilleryman arrives when he can. I shall wait for him and I shall leave only after having seen him and after he will have assured me that his pieces are in position to support my new bound. I have time I am in no hurry."

The artilleryman heartily agrees with this infantryman, but

THE STAFF OFFICER intervenes: "Your movement will be too slow. The higher command cannot allow you to delay for hours. With that system you will not advance fifteen kilometers a day. You will mark time."

THE DARING INFANTRYMAN: "Bravo!"

THE CAUTIOUS INFANTRYMAN: "If you have special reasons for moving rapidly, tell me. I will march as you wish, with or without artillery."

THE ARTILLERYMAN: "And I will trot. I will even gallop if you want——"

THE STAFF OFFICER: "Exaggerate nothing. But remind yourself that we are in an offensive movement. That is very important to meet the enemy and to beat him as soon as possible. Time works for him. He is reinforcing himself, organizing, perhaps digging trenches, placing barbed wire——"

THE CAUTIOUS INFANTRYMAN: "I am not impressed by such trenches and barbed wire that the enemy can prepare because I will have made in a day only 12 or 15 kilometers rather than 25, as in 1914. It requires time to strongly organize terrain. Moreover, when I arrive in front of this barbed wire, it will be you, Mr. Staff Officer, who will halt me for hours, perhaps days, to prepare your attack, as you say. Then let me stay at C for one, two or three hours; it is not very important to you, but it is very important to me, since I have a difficult and dangerous job, and prefer to go slowly."

THE STAFF OFFICER (who is a wit): "You poor infantryman, with such logic, you risk having my general sent to Limoges!"

It is only a joke. Everyone laughs, but reflects that this statement might have some significance.

The repartee continues, the objections multiply, but the best arguments produce no effect and after verification the chart of bounds satisfies no one.

In discussing the whole, the instructor does not lose sight of the "possibilities" of artillery.

He would be very willing to find a formula agreeable to all, as a point of doctrine. He reviews all the arguments, weighs them, compares them, combines them and proposes a solution capable of calming the daring infantryman and permitting the artilleryman to accomplish his mission. He remarks:

"I believe that the infantryman will not have to wait too long at C. Even if he is not exposed to shell fire, the march across fields will be slow. From B to C, at a rate of two kilometers per hour, it will take at least two hours. At B, he will have liaisons to establish, units to regroup; a halt of a half hour or three-quarters of an hour will be very useful to him. As a basis of calculation, I will estimate the infantryman's rate of march at two kilometers per hour. This will give the artillery time to make its bounds. What do the infantrymen say about that?

THE DARING INFANTRYMAN: "Too slow."

THE CAUTIOUS INFANTRYMAN: "I prefer that we do not even speak of rate of march."

THE ARTILLERYMAN—etc.

But no one is convinced. On the way out, everyone resumes the argument and the question seems insoluble.

It is in fact insoluble, because it is poorly presented. *Poorly presented in form and poorly presented in spirit*.

The question is poorly presented *in its form,* that is to say: first, in the wording of orders; next, in the manner of asking artillery coöperation.

We have an excuse. If in spite of four years of war, we must repeat this exercise so frequently to learn it, must discuss it until we are confused, and must finally end with the question unsettled, it is because we lack open warfare experience. During the war we were little concerned with the approach march, while we were in the trenches a few meters distant from the enemy. At the end of the war, during the pursuit, only a few units experienced the joy of running after the enemy. Most officers have only their memories of August, 1914, to resort to as a standard in visualizing all tactics.

Let us not be astonished then if the discussion wanders.

Nevertheless, we must go back to 1914 to find positive elements of doctrine and proofs, something more precise and real than the speculative disputes of our peace-time exercises.

Those who long for realities and who have not the advantage of being able to base their opinion on personal experiences, may find these realities in recently published articles on the early battles of the war. It is sufficient to study the military reviews to see what was considered as good tactics in 1914.

Here is one of the articles ("Revue d'Infanterie: 1st March, 1926, Colonel Etienne") which better than the others, gives this information. It is the account of the operation of August 22, 1914, by the 40th Division, which relates one of the mishaps of the 6th Corps (a crack corps moreover) during its first battle. We shall review only the essential part of it. It is necessary to read the entire article to appreciate all its sinister value.

The situation involved the probable encounter with the enemy. The enemy was supposed to be fifteen or twenty kilometers away. In reality the distance was less. (See sketch No. 2.)

The 40th Division was to take up an advance guard position, facing the east, on the right of the 12th and 42nd Divisions, which were marching to the northeast.

Knowing the tactics at that time, we may guess the orders of the 40th Division: A single objective, which was to be reached at the end of the movement, two columns, two routes, two advance guards, and forward. On the road, after a third of the distance had been covered, the artillery was to leave the column and take up a position of waiting, facing the east. That was at least the preconceived plan. The reality was quite different.

This order would give us only negative information. It is more interesting to study those of the General of the 34th German Division. This German General must have been the *cautious infantryman* type.

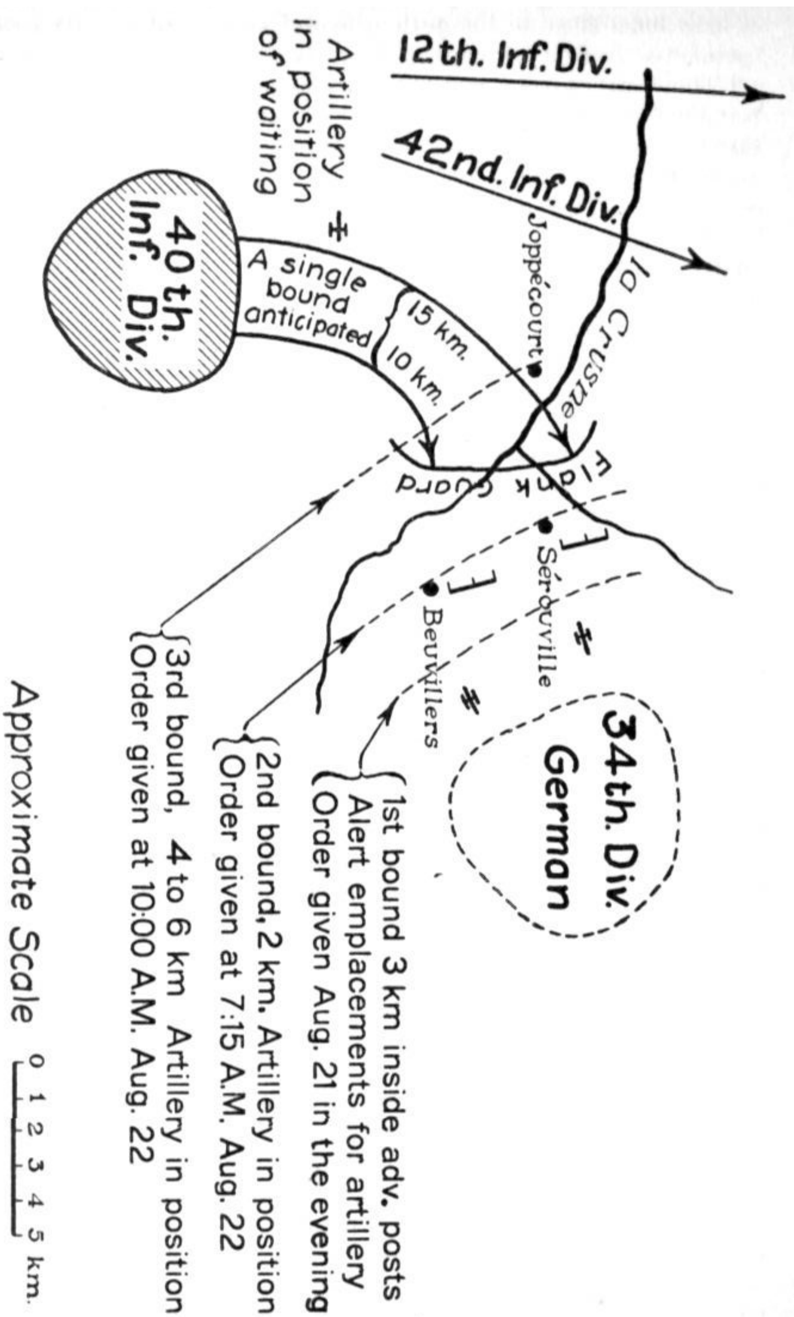
The evening of the 21st he gave a brief first order. The morning of the 22nd he placed his advance guard on the *line of departure* which was almost his line of outposts, and there he halted. The halt lasted three-quarters of an hour.

There was a General who halted before jumping off. A temperament quite different from that of the French command at that time (see 40th Division), a temperament which we are to-day trying to revive.

At 7:15 the German General ordered the second bound, two kilometers, supported by artillery in position. At ten o'clock he ordered the third bound.

The execution of a bound of two kilometers and the halt at the second objective *required three hours*.

After that the battle!


12th. Inf. Div.
42nd. Inf. Div.
Artillery in position of waiting
40th. Inf. Div.
A single bound anticipated
15 km.
10 km.
la Crusne
Joppécourt
Flank Guard
Sérouville
Beuvillers
34th. Div. German
1st bound 3 km inside adv. posts
Alert emplacements for artillery
Order given Aug. 21 in the evening
2nd bound, 2 km. Artillery in position
Order given at 7:15 A.M. Aug. 22
3rd bound, 4 to 6 km Artillery in position
Order given at 10:00 A.M. Aug. 22
Approximate Scale
0 1 2 3 4 5 km.

Sketch No. 2

What a lesson of method and prudence. The time factor was of little importance to this man who had been waiting forty-four years for the 22nd of August, 1914. He started late, in broad daylight and covered five kilometers! Can anyone say that he did not have the offensive sense? Previous to August 2nd, 1914, he would have completed such a maneuver by ten o'clock in the morning.

What a lesson in terrain study! His first rushes were from two to three kilometers and this third from four to six. Why? Simply because he had to cross the Crusne cut. Before making this capital rush he prudently assured himself of a solid line of departure resting on two villages.

What a lesson in the art of preparing orders. Do you think, that on the evening of the 21st, he gave a long order of twelve or fifteen paragraphs, with five or six objectives to attain, and twenty kilometers to cover in order to show how he conceived his learned and profound maneuver? Not at all. His order of the evening of the 21st simply carried the approach as far as the advance posts. From that point he planned to issue orders consistent with the *changing situation*.

Can we say that he did not have a "purpose" or a plan of maneuver? We should be very naïve to think that.

Let us not protest, as usual, that this is a special case. It is merely a question of an approach march, such as we conceive nine out of ten times in our exercises. It is a case which emphasizes the contrast of mentalities of the two adversaries in 1914.

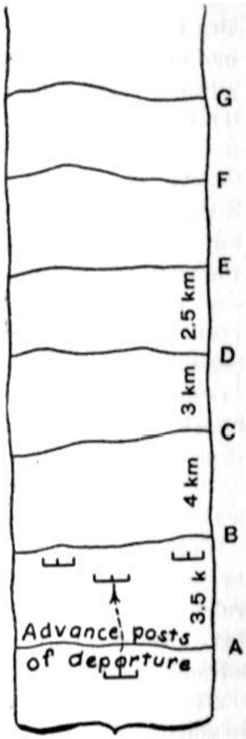
The lesson is evident. Ordinarily it is ridiculous to draw up the day before a maneuver which extends throughout the following day, over fifteen or twenty kilometers of terrain. To construct a scale of bounds twelve or twenty-four hours in advance is to apply clumsily a scheme, which like all schemes is of value only when adapted to changing existing conditions.

That the commanding general prepare this chart of bounds (or objectives) for himself to use in his preliminary speculations, well and good; that he use it to study his maneuvers for the following day, yes; but to fix it in a rigid time schedule, and especially to publish it in orders, No!

How then can we approach the question?

Let us admit that we trace on the map, as a study, "our successive objectives," all our own lines as far as the enemy. That may not be very fair since we expect to meet the enemy at any moment. Let us suppose that we are obliged to trace lines up to G (see sketch No. 3). We shall have outlined our job.

If we then examine the various bars of our chart, A, B, C, D, E, etc., we will soon see that they do not all have the same value. We shall find one of them which will have an exceptional meaning because it will be distinguished either by the terrain: cut, line of crests, woods, etc.,—by an interesting hour, or by a necessity for maneuver: liaison with the neighboring divisions of infantry, protection of a flank, etc. . . . Finally, and especially it may be distinguished by this capital consideration that, marching on the enemy by daylight, we would prefer to meet him on such and such a line, and *perhaps wait for him there*.



DIVISION FRONT in this case 6 km

Sketch No. 3

That is the bar of our chart which will govern our maneuver and dominate the first part of our day. That is the line to be fixed by the division commander, that one and no other, especially not half a dozen others. Moreover, that line should be near.

If that line is too far to reach in one bound, it will not be the objective of our first order. We give it a position of first importance in our intentions but a second or third position in our execution. In applying the same reasoning to the terrain that separates us from our line, we look for and find the new intermediate line on which we *wish to feel strong*. Following the example of the German General we concentrate our first order on this intermediate line.

Thus we shall be concerned with only a small concrete operation for which we can easily determine our dispositions, our rate of march, and the length of our halt. We will use the artillery according to the *needs of the moment* and not in accordance with the leapfrog formula.

Let us take up again the chart of bounds (sketch No. 3). Suppose that the line of first importance, which the division commander has determined by the process just indicated is at E, thirteen kilometers from the line of departure.

Is he going to draw up, the night before, a plan governing his operations as far as that point? No, it is too far. (This, however, is what is done in all our present peace-time maneuvers.)

He will choose a line which will be, for him, of only secondary importance. For the division, however, it is the first objective, and the only one in question from the beginning. Let us now suppose that the division commander who is the cautious infantryman type, wishes to have all the 75's support the infantry attack on the line C.

He will specify that the necessary halt be made at B in order to allow the 75's time to get into position.

Suppose, for example, he had left a group behind A in order to support the approach beyond the advance posts. In that case he would have to wait for this group to rejoin him before he could leave B, unless it appeared safe enough to have this group rejoin him during the time that the infantry went from B to C. The order that he gives to his division will cover this first part of the maneuver *and only that*. It is a phase of the approach march to be settled in advance. It is short, simple, and easily understood by everyone. This in general explains a division bound: infantry, artillery, communications, observation and command.

Afterwards, in order to reach his line of first importance, the division commander must make other dispositions. He will plan another maneuver which will require new orders. If he feels that the arrival at E demands extreme caution, he will specify the necessary halt at D in order to fix his dispositions to know exactly the position of his infantry, to put all his artillery (75's and 155's) in position, reëstablish his communications, assure his flanks, etc. . . . briefly, to feel guarded against any adventure and to be ready to attack. This halt may last two or three hours or perhaps more. It depends on the arrival of the artillery.

Then to go to F, G, etc. Let us stop the story there. It becomes a fantasy; it is no longer tactics.

The successive problems of a battle must be solved as they arise by specific formulæ (we speak of a division) and not by a general rule, such as: "the commander of division artillery must always have a third, a half, two-thirds of the artillery ready to support the advance guard."

To do this is to give the artillery a theoretical problem difficult to solve. It is crafty but, if I may be permitted to say it, not very honest. It may be called "passing the buck."

As for the infantryman, whether he is daring or cautions he will be very happy to climb the bound "ladder" only one or two rungs at a time. He will be rid of the preoccupations of a time schedule, of the rate of march and the length of halt. These problems are not within his sphere, as they concern only the calculations of the General and his staff. The infantryman will solve them automatically because the phase will be short and the order precise.

The staff officer of the Metz Center will tell us that these mutilated and successive orders are insufficient for the orientation of the entire division on "the intentions of the commander" and that in order to direct troops general orders of operation are necessary. We shall answer him that the long halts are very helpful to him. The command and the staffs gain precious and necessary time for reflection. Moreover, there we come to the question of conception and drawing up of orders. That would be a very interesting chapter to study but beside the subject.

As for the very daring infantryman, he will find that our attitude is very stiff and formal and our operations are too slow. But why is he in such a hurry to end the maneuver at noon. Could he, by chance, believe that offensive is a synonym of speed? We are going to try to prove to him the contrary.

* * * * * *

We have said that the question is poorly presented *in its spirit*. When one thinks of the first engagements of August, 1914 (by that we mean approaches, contact and engagements), when one studies the accounts mentioned above of which the 22nd of August to the 40th Division is a typical example, when one recalls certain memories of the opening days of the war, he becomes proud and astounded at the same time. How beautiful our offensive would have been if it had been less wild! What a very few things it lacked to make it stronger: a little circumspection, a little more method, a little deeper echelonment, a little more time to place the artillery and to orient the command. That is to say, a little less speed!*

It is hard to say it, but it is on account of having neglected all these little things, that on the 22nd of August, not only the 40th Division, but also the entire 6th Corps found itself too crowded together when the fog lifted between eight and ten o'clock. Because the Corps engaged itself with too much precipitation in the morning it was retreating in the evening.

May we be spared other examples that we could cite. Inasmuch as we all know a great number, the exaggerated tactical speed at the beginning of the war rests among our imperishable memories.

Our offensive policy consisted of one simple formula: movement. This stimulus, added to a lack of knowledge of the effects of fire, had intoxicated all of us. From the top to the bottom of the ladder the fear of appearing timorous in any tactical situation led each one of us *to do something immediately in the way of movement to the front*. The specter of 1870 haunted us, rightly no doubt, but unjustly. In short, we had the mentality of one vanquished who wishes to convince himself that he is not afraid, in principle a very respectable mentality but sometimes dangerous.

And we went on in this manner, the offensive requiring movement and the movement accelerating the offensive, turning in a vicious circle, with the belief well anchored in our minds that the operations would be brief and the war short.

Shall we risk a citation taken at random from among a thousand?

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* It is hardly necessary to say that here we are considering only the conduct of operations and not the questions of instruction and matériel.

An eminent lecturer, whose name we will not mention out of respect to his memory, wrote in March, 1914: "It is understood that the attack must hit before it parries, must expose itself before it covers itself, and that it runs risks, that vigor and rapidity count and that the factor of time is important. *This rapidity is the tangible sign of moral power*. Happy is the infantry who has this ardent instinctive urge to movement."

This partisan of speed expressed the official doctrine of that period. He only paraphrased the regulation of 1913.*

"The engagement begins from the first contact."

"The engagement always constitutes a critical period whose duration should be short."

We know what this policy has cost. These sad reminders of 1914 should be superfluous. There is to-day, however, a renewed tendency to commit these errors. In the combination of fire and movement, movement again takes the preponderance. Openly; or discreetly, always in good faith, the infantry (and the cavalry) is made to move forward with an acceleration which if we are not careful will lead us to the inconsiderate speed of 1914.

Some theorists have again taken up their pens and have again found their pre-war expressions. It would be discourteous to cite names and articles, for opinions are free, but each one of us can verify this tendency in following the military reviews. Up to now only the artillerymen, happily checked by technical impossibilities, have not submitted to this acceleration.

As usual, theoretical and practical soldiers march in pairs. It is easy to gather concurring opinions on this subject among the officers assembled at Metz and Mailly. The same tactical acceleration is present at these meetings because of a lack of time and instructors. We have so few meetings on the terrain that it is necessary to utilize the time hurriedly.

It is certainly unpleasant to criticize thus those who are in trouble. A colonel, a man of experience, was saying at Metz:

"It is true. I was obliged to react against speed. The young officers, and curiously, those who have fought in the war, went off like fools and finished off a maneuver in five seconds. Fire power did not count with them. I wanted to calm them and I drove them to an opposite fault. In order not to go too fast they now marked time in endless halts, caused by ridiculous suppositions. They went to sleep and I was obliged to push them."

Another regimental commander had the same opinion under different circumstances. The infantryman to whom one overemphasizes the necessity of operating with the artilleryman, ends

* The regulations of 1913 foresaw in battle only two phases: the engagement and the attack.

by stopping before a single machine gun. From the beginning of any contact when any resistance is pointed out to him, he invariably answers, "I ask the support of the artillery." And he waits. The task is evidently difficult: precisely because it is a question of teaching the mind. It is the entire formation of the tactical sense that is in question. It is necessary to learn to use the halts during the maneuver (halts similar to those imposed by fire during the war): to think, reflect, study the situation, reason it out, ask where you are, examine many times your conscience, calculate and prepare the blow that you are going to inflict upon the enemy. The halt which appears as time lost will then be time gained.

And if it is a question of an approach march, the artilleryman will have time to arrive.

It is necessary to teach the young that except in very rare exceptions *offensive does not mean speed*. Momentum breaks itself against the barriers of fire power. The offensive is doubtless movement, but it is especially reflection, will power, and good sense.

It is on that account that the application of it is difficult. It is easy to repeat, "forward and quickly."

We have said above, that in finding ourselves best placed at such and such an hour in such and such a place we could stop there, suspend our march and there await the enemy. The daring infantryman has probably cried out at this heresy, at this lack of offensive spirit, at such an abdication of initiative. Nonsense! But it was the current practice applied by the Germans on their entire front, except in their marching flank in August, 1914. Let's remember it.

We may even say that the head of an advance guard should stop at the time it makes first contact with a machine gun. That is what they did in 1918. What else could they have done? The duration of the halt? It is the field of fire of these machine guns which will determine it. We have known some halts which have lasted whole days in the plains north of Laon in October, 1918. And here the enemy was retreating!

Instead of pushing the battalion commander in our exercises to answer invariably, "I outflank," "I turn," "I attack." Let's give him time to examine the situation. Let's recognize his right to say that he can halt because he is better able to calculate his blow while halted than while marching. An offensive mission does not exclude in any way defensive halts, because "force" and prudence are not contradictory when one has a well-tempered character.

Let us recognize the right of the advance guard commander and by extension that of all the infantrymen to await their artillery as long as necessary. Let us recall that soon after the first contacts in 1914 General Headquarters had to send us severe notes:

That of the 16th of August for example: "The attack will be much less costly if it will be more carefully prepared by the artillery." That of the 24th of August insisting on the necessity of the artillery preparation: "Every time that the infantry was thrown into action without artillery preparation, the infantry fell in the fire of machine guns and suffered heavy casualties which could have been avoided."

* * * * * *

We could stop here this already long discussion, but since it is a question of defending an idea, it is necessary to show another of its aspects.

We have already pointed out the 1914 opinion on the duration of the war: brief operations and short war.

Speculative studies, technical exercises and the experiences of big maneuvers made us believe that the *tactical operations would be rapid while the strategical operations would be slow*.

We admitted that it was simple to execute in twelve hours a division attack and in twenty-four hours an attack by an army corps. On the other hand, it appeared very difficult to us to transport in time five or six divisions to a point on the front in the northeast where necessity (success or failure) demanded their intervention. Because of this slowness of strategic movements, the utility of an army reserve was questioned. Not that it was necessary in principle, but because the railroad service of that period required from six to eight days to transport a reserve army 200 or 300 kilometers. Where then was the front to be at the end of a week with the tactical speed that we were anticipating?

In 1918 our opinion was exactly the opposite: *We knew that tactical operations were slow and that by comparison the strategic operations were fast*.

It is evident that good reasons caused such a radical change in opinion after the four years of war. We have simply learned the value of fire power. We know that it does not affect transportation in the rear areas, that is to say, does not affect strategic operations. It is true that in this case movement alone accelerates the offensive. On the other hand, in tactical operations on the field of battle, it is fire power which becomes the regulator, the moderator of movement.

Before the war we added to this misunderstanding a moral excitant: speed in the offensive. We now add to understanding a new moderating quality, circumspection. It is a balanced advice that the infantryman of 1918 should transmit as a pass-word to the young generations. If these young men (who are as impulsive as we were in 1913) find this advice annoying, we shall tell them that circumspect does not mean timorous and that we no longer need to convince ourselves that we are not afraid.

The next war will perhaps differ from the last more than 1914 differed from 1870. Will speed play a greater rôle? It is possible. Trucks, airplanes and wireless are factors of speed.

However great the strategic speed, we must inevitably return to a circumspect speed when we enter the zone of possible death. This tactical speed will probably be even more diminished in the next war because the means of killing will have become perfected.

But this is a digression from the original topic: the time necessary for an artilleryman to do his work. These reflections, however, will have served as a moral argument. It is well to have thus discussed the time element in general; it may reassure us in our solution of the more specific problem. We know that from the time that we enter the battle, the two inseparable brothers, the artilleryman and the infantryman who *should wait for each other, can wait for each other, because they have the time to wait for each other*.

FOREIGN MILITARY JOURNALS
A CURRENT RÉSUMÉ

ENGLAND

"Journal of the Royal Artillery," January, 1927

"Administration in the Field as Affecting a Division," by Colonel F. D. Logan, C.M.G., D.S.O., is an admirable boiling down of the essentials of a big subject. Administration, especially in so far as it affects the supply of ammunition, is of primary importance to every field artilleryman. The subject is well treated here. However, Colonel Logan deals naturally with the British organization and uses the British nomenclature. This confuses the American officer and the article is of principal value to a student of this subject.

The résumé emphasizes the fact that the strain on roads during any future mobile war of the first class will be enormous and that traffic in the future is likely to be even a more difficult problem than in the past.

"War Exhaustion," by Major W. G. Lindsell, D.S.O., O.B.E., M.C. This is a general article of peculiar interest to the Field Artillery in its discussion of the war exhaustion of matériel. Apparently every nation finds itself in an embarrassing position in this respect and the following quotations from Major Lindsell's article should interest every officer who is in any way involved in the eventual preparation for war on a great scale within the restrictions of a peace-time budget:

> "The solution of the problem of how to prevent exhaustion of our own raw materials is much more difficult. The two outstanding factors in this connection are finance and time. * * *
>
> "As regards reserves held in peace in preparation for mobilization. The end of the last war found us in possession of vast quantities of war material of all sorts. Much of this material was of course part worn or actually worn out from use, much of it again was obsolescent; but after deducting the worn-out and the obsolete there was probably enough left to equip an army of the 1918 scale with thoroughly efficient material and something over for future maintenance purposes. At first sight a very satisfactory state of affairs, we could reduce our army to peace-time dimensions while still retaining the munitions equipment to expand again to 70 divisions. But difficulties at once arose. There was no storage space available to hold even a fraction of this vast

accumulation; many types of stores rapidly deteriorate if held too long in stock; enormous numbers of men would be required as caretakers to look after this equipment and prevent deterioration. Here finance steps in. The urgent cry for economy made the building of storage accommodation and the provision of caretakers out of the questeion. There was nothing for it but to scrap vast quantities of potential war reserves. In consequence we are no longer in a position to send a vast army to take part in a continental war, the munitions supply for such an army will again take months to organize and reach a stage of mass production."

"The Evolution of Artillery in the Great War," by Major A. F. Brooke, D.S.O., is the conclusion of an article which has been running in this Journal for some time. Other installments have already been treated. Major Brooke's conclusion is as follows:

"5. CONCLUSION

"Periods of peace produce a tendency to increase mobility at the expense of fire power, whilst war has always demonstrated that mobility is dependent on fire power in the field of battle. In our training and preparation for war, the retarding effects of hostile fire power cannot be reproduced, whilst younger generations are unable to imagine accurately its effect. The necessity for the employment of our own fire-producing arms as the primary method of maintaining mobility, is not brought home to us, we fail to realize the degree to which our mobility depends on them, and are only struck by the loss of mobility enforced by the handling of such cumbersome arms.

"We are, therefore, faced with the grave danger of repeating former errors by sacrificing fire power to mobility. If we can avoid this evil we shall have learnt to apply the primary lesson of the great war."

There is nothing startling in these conclusions, although they will strike a responsive cord in the hearts of most field artillerymen. The requirements of mobility and fire power are not, however, always reconcilable and the best practice will probably continue to be a workable compromise.

"Shinga" by "Kurungarei." This is of the type of article which makes so many British technical publications fascinating. The far-flung British Empire offers an extreme variety of service and adventure to its officers and the fact continually crops out in little personal touches of adventure which relieve the monotony of technical articles.

"Shinga" has no particular applicability to the Artillery service. It is a recital of the arrest of a petty African chieftain who, in common with many of us, disliked paying taxes. The total casualties of this expedition were one. However, the article has more flavor of war and will perhaps teach more to the young officer than an infinity of statistics boiled down from the experiences of the great war.

THE FIELD ARTILLERY JOURNAL has recognized the readability of similar articles and old issues will reveal something of the same sort in the stories of small adventures in the Philippines and Panama by our own officers.

Other articles in this same issue are listed for the information of officers who may be particularly interested in any one of them. They are:

"The Regiment and Wireless Communication."
"Predicted Shooting."
"Anti-tank Defense and Close Support."
"The Future of the Regiment."
"An Answer to the Tank."
"Royal Horse Artillery. Evolution or Dissolution."
"The Royal Regiment of Artillery."
"Artillery in the Offensive."
"Motorization of a Division."
"Ypres. The Story of a Thousand Years."

FRANCE

"Revue d'Artillerie," February-March, 1927

"The Battle at Guise." Colonel Vallarché here gives us the story of three days fighting on the Oise in the last of August, 1914. The story is told by officers and men of the 10th Army Corps who were participants, but thanks to Colonel Vallarché the gaps between these fragmentary accounts are so cleverly filled in that the unity of the writing does not suffer in the least.

Military history is filled with the doings of armies, divisions, and regiments but it is rare that we have the opportunity of following the fortunes and watching the tactics of a single company, battery or platoon in a large engagement.

The following quotation pictures an incident in the life of the 3rd Battery, 10th Artillery:

> "Captain LeBigot passed to fire for effect. With his sheaf converged he hammered on each of the enemy guns in turn

with high explosive. One by one the enemy pieces became silent; then suddenly 300 meters from our front came a burst of rifle fire. We could see the infantry creeping towards us and the flash of their rifles. They had nerve—that infantry.

"We heard the lieutenant say 'Captain shall I bring up the limbers?' 'Not yet,' was the reply. Then the command 'That crest in front—at 100 meters—fire at will.'

"We see the first rounds ricochet and burst above the pointed helmets; the whole ridge seems in eruption; suddenly silence—our caissons are empty.

"The captain commands 'Bring up the limbers,' and we depart at the walk without receiving a single shot."

"New Army Organization in Italy." Based on the new law providing for eighteen months military service, the new plans for the Italian Army call for 250,000 men at peace strength and 650,000 men on the first mobilization. The divisions are organized with three regiments of infantry. Each battalion has three rifle and one machine gun companies.

The troops are divided into corps as follows:

Number of corps	Headquarters	Divisions
1st	Turin	3
2nd	Alexandrie	3
3rd	Milan	3
4th	Verona	3
5th	Trieste	4
6th	Bologna	3
7th	Florence	2
8th	Rome	2
9th	Bari	2
10th	Naples	3
Dept. of Sicily	Palermo	2
Dept. of Sardinia	Cagliari	1
	Total	31

No mention is made of the troops in North Africa.

"A Group Portée in Morocco," by Major G. Dazier, is the story of the experience of the 3rd Group (7th and 8th Batteries) of the 313th Artillery during a period of thirteen months beginning with September, 1925.

The group formerly on the Rhine arrived at Casablanca on the 14th of September with the following equipment and personnel:

10	officers
35	noncommissioned officers
260	men
7	passenger cars
2	side cars
3	motorcycles
5	light trucks
4	repair trucks
8	gun trucks
2	emergency trucks, 4 wheel drive
10	farm tractors
10	tractor carrier trucks
21	cargo trucks

The ten tractors were old and much worn, but were replaced by new ones the following May.

The article gives in diary form the story of the march, via Rabat and Fez, to Kifane where the group went into action, thirteen days after landing in Morocco, having covered about 450 kilometers. By the end of the month three gun trucks and two tractor carrier trucks had to be evacuated for repairs.

The column travelled with the guns and tractors borne on the trucks as long as the roads were passable. When this condition ceased the guns and tractors were lowered to the ground and proceeded overland to the gun position. On very bad roads, the tractors were lowered and used to get the guns and trucks to their destination.

The group was constantly moving until November after which it remained at one place till the following May when operations were resumed. During the summer and early autumn of 1926 the batteries were used continuously and seventy kilometers does not seem to have been an extreme march for one day.

The writer has the highest opinion of the new farm tractors used during the campaign. The tractor carrier trucks seem to have been somewhat light for such rough country as Morocco. On good roads the column could employ a mean speed of about 12 kilometers per hour but this quickly fell 4 or 5 on broken ground. The use of nothing smaller than five-ton trucks is urged for portée artillery.

"Solution of Some Ballistic Problems," by Major N. Camps. Herein are treated the calculation and use of range tables in the form of graphs wherein the various elements of the trajectory are given by charts. During his discussion the writer advances the rather novel theory that the range is effected by the lateral component of the wind. The French range tables, like our own, are based on the assumption that the range is effected by the longitudinal component only and the lateral component causes simply errors in deflection. Major Camps is of the opinion that the lateral component also produces range errors due to the phenomenon in which translation of its axis is produced on a rotating cylinder by wind acting on its surface perpendicular to its axis. He cites as a basis for his theory the German rotor ships which are propelled through the water by the action of wind impinging on revolving cylinders.

"National Motor Fuels," by Captain M. Dupre, is a study of the possible substitutes available in France for gasoline. Experiments have been made with alcohols, benzols, acetylene, and various illuminating gases under pressure in cylinders. None of these seem to have proved as economical or as efficient as the carbon-monoxide gas produced by burning wood chips, charcoal, or carbonite (compressed charcoal bricks) in a gas producer attached to the vehicle itself. The number of heat units per kilogram of the above fuels is given herewith:

	Calories
Gasoline	10,500
Carbonite	8,000
Charcoal	7,000
Wood chips	3,500

During the Franco-Belgian Automotive Competition of 1925, an eight-ton truck travelled 100 kilometers on 37 kilograms of carbonite and later made the same distance on 42 kilograms of charcoal. As a result of tests in the above competition the table below has been made:

	Fuel consumption per ton-kilometer	Price of fuel per kilogram	Fuel costs per ton-kilometer
Gasoline	35 grams.	4.00 fr.	.14000 fr.
Carbonite	46 grams.	1.00 fr.	.04000 fr.
Charcoal	53 grams.	0.60 fr.	.03818 fr.
Wood chips	125 grams.	0.25 fr.	.03125 fr.

From the above it will be seen that for countries unendowed with petroleum there is a possibility of effecting considerable saving by the use of carbon-monoxide fuels. There are still many mechanical difficulties to be solved, chiefly the filtration of the gas, whose carbon dust seriously effects the lubrication and causes excessive wear. It is believed, however, that these can be solved and the writer urges that all new heavy motor vehicles in France be built for the consumption of the wood-carbon fuels, rather than gasoline.

"Revue Militaire Française," January–February, 1927

"Civil War in China," by Captain Girves, is a description of political and military conditions in that country. A feeling of nationalism, fostered by hatred of all foreigners, is rapidly growing in China. Fortunately for the white race, the civil war, which has been raging for the past ten years, has at least postponed the crystallization of this sentiment.

This civil strife is caused by the constant conflict between the North and the South. The South has been affected by contact with the occident through the port of Canton. New ideas have entered South China along with foreign merchandise. For some time a radicalism, at times approaching communism, has pervaded this region. The North, on the other hand, is more moderate and conservative in its political ideas and more inclined to submit to a strong government which assures order. The North is the home of the military party. However, in each of these two parties there is an absence of discipline. Each party is continuously disrupted by treachery.

In studying the military conditions, Captain Girves describes China as a vast reservoir of human matériel. Even though the Chinese are anti-militaristic, it is a simple matter to find a few hundred thousand men who are anxious to fight for food and loot. Under a good leader they fight very bravely. Moreover, to assure this bravery, each unit commander has always with him an executioner and his enormous axe. The Chinese soldier lives on bread, rice, and tea; and endures extremes of heat and cold.

The officers are instructed in special schools. Each independent governor opens his own school and calls in foreign instructors. The instruction is very haphazard.

The various armies are made up of mixed divisions and brigades. The better organized infantry divisions contain: 2 brigades of infantry each having 3 regiments (with 4 machine guns and 4 stokes mortars per regiment), 1 artillery group of 3 batteries (1 battery of 77's and 2 batteries of mountain guns), 4 squadrons of cavalry and 1 battalion of engineers. The total strength of all the armies is 1,930,000.

By an agreement in 1919 known as "The Arms Embargo," the foreign powers agreed to sell no arms or munitions to China. This agreement, however, was not signed by Russia or Germany; and the Chinese armies receive arms from these countries. Moreover, foreign aid has come to China in another form not forbidden by "The Arms Embargo." Foreign engineers (mostly German) with imported equipment have established 17 arsenals in China. The arsenal at Moukden is an example. This arsenal employs 8000 men and manufactures guns and cannon (up to 150-mm.), shells and cartridges.

More than in any other army, the Chinese infantry is the "Queen of battle"; the other arms are so poorly employed that they are almost worthless. The infantry formations are very dense since the inaccuracy of the artillery and the automatic rifle make such formations practicable. A few tanks are used, but they are poorly handled. The infantry does not follow them.

The artillery includes 77's, 58-mm. mountain guns and a few 150-mm. guns. The pieces are lightly sheltered as there is very little counterbattery firing. The Chinese know very little about indirect fire. Shrapnel is always fired too high, because the gunners like to see the bursts high in the air. Little judgment is used in selecting appropriate shells for the various targets. The telephone is rarely used. Since battles are usually fought near railroads, armored cars armed with 77's are frequently used.

Chinese cavalrymen own their own horses. The hope of pillage brings them into the army, and they are poorly disciplined.

All the Chinese armies possess airplanes, which play no great part in the war. The photography service is poorly organized; the bombing is inaccurate. The few aviators who have met in the air have fought with pistols.

The engineers have done well in demolition and repair work. They have established a few radio posts which are rarely used. In one battle a headquarters radio antennæ served as a picket line for the horses of staff officers.

The medical service is poorly organized. Were it not for foreign hospitals, the wounded would receive no care.

Chinese staff officers are progressing in tactical knowledge. They know how to march troops to battle and to plan simple enveloping movements. Orders are written carefully following a prescribed form.

In conclusion Captain Girves remarks that the most striking feature of these political intrigues and military operations is that nothing decisive ever happens. He does not venture to prophesy the outcome of this civil war, but feels that the day may come when these warring factions and 300,000,000 Chinese will be united by a sentiment of common hatred of the white race.

Lieutenant-Colonel Gémean discusses **"Fire Power in Morocco."** The author begins his article with a description of the mountainous terrain of the battle area. No roads suitable for artillery existed before the war and the country had not been accurately mapped.

The aviation and artillery were very much handicapped by such terrain. The aviators found few level places to land and it was difficult for them to locate enemy positions on inaccurate maps. The artillery was unable to fire by map and the terrain frequently rendered terrestrial observation impossible. The mountain artillery pieces (65, 75, 105) were, however, very valuable as accompanying guns.

The terrain, as a result, was particularly adapted to an infantry war, in which the infantry had to depend on its own fire power. The infantry's task was lightened by the new type (1924) automatic rifle. The machine guns also played an important part in this mountain warfare. They were used singly and in battery formation. Only snipers and rifle grenadiers fired individual rifles. The rifles of other troops served only to carry the bayonets. All this permitted a great saving in rifle ammunition, which simplified the transportation problem.

"The Tenth Aviation Exhibit," by P. Grimault, is a short survey of the progress made in airplane construction since the last exhibit. Unfortunately England and Italy did not send many planes to the exhibit; therefore the study is confined to French planes.

M. Grimault discusses: various changes in wing shapes; the comparative advantages of wood, aluminum and steel in airplane construction; protection against fire; and the latest type of landing gear

"Before the German Offensive against Verdun," by Lieutenant-Colonel Paquet, is a study written particularly for the instruction of intelligence officers. This study shows how detailed information from the front line has been coördinated with more general information to foretell accurately an offensive.

Lieutenant-Colonel Paquet has found his material for this study in maps, photographs, reports, and notes of the period from January 14th to February 21st, 1916. He has also used verbal information from actual participants.

In the February issue, Lieutenant-Colonel Baills concludes his article **"Evoluton of Terrain Organization from the Time of Napoleon to the Present Day."** In this and previous issues he has traced the development of terrain organization and has reviewed the September, 1924, instructions which deal with the organization of terrain. He believes that future development of artillery matériel, aviation, tanks or gas will not affect the application of these regulations. He emphasizes, however, the future necessity of more care in camouflage as protection against increased artillery power and improved aërial photography. This necessity of protection applies particularly to machine guns and other automatic weapons which will have to be placed in positions naturally concealed. He concludes, however, that these regulations are flexible enough to keep pace with future progress in offensive armament.

"Campaigns of a Division of Infantry" is continued; and **"The Three Glorious Days"** is concluded in the January number.

GERMANY

"Artilleristische Monatshefte"

"Antiaircraft Fire." To many field artillerymen, the technical problems which confront the antiaircraft artilleryman in conduct of fire are not well understood. From a casual observation of antiaircraft fire we are apt to gain the impression that antiaircraft fire is very much like field artillery fire at transient or moving targets. This is by no means the case. In an article appearing in the September-October, 1926, number of the *Artilleristische Monatshefte*, Lieutenant-Colonel v. Keller of the German Army presents a very interesting study of the fundamental principles of antiaircraft fire which should enable officers of other branches to appreciate the difficulties which confront the antiaircraft artilleryman. In comparison to field artillery fire, antiaircraft fire presents the following difficulties:

a. Inability to use visible points on the ground as an aid in the reconnaissance and observation of the target.

b. Inability to correct fire from previously observed rounds.

c. Great rapidity of movement of the target which moves at least six times faster than the fastest moving ground target confronting the field artilleryman.

d. Ability of the target to move at any instant in a three-dimensional direction.

The basis for all antiaircraft fire is a reconnaissance of the target. In this reconnaissance, the battery commander must determine the character of the target (pursuit, bombardment or observation plane), its location in the air (range, direction and altitude), and the direction and rapidity of its flight. An airplane discloses itself by the noise of its motor and propeller. This noise is usually not heard until the plane is within 6000 yards of the observer. To the naked eye, a plane is visible, under average conditions, up to 10,000 yards. Since most planes fly in the combat zone at an average altitude of 4000 yards, the observer must look for his target in that part of the sky 25° above the horizon.

The problem presented to the battery commander in antiaircraft fire is to determine the azimuth, elevation and range of the point at which a projectile will meet the plane in its continued flight. In other words, based upon his reconnaissance, he must determine:

a. Where the plane will be when his guns are ready to fire.

b. With the guns laid on and following the target, what additional allowance must be made in azimuth, elevation and range to allow for the time of flight of the projectile and the movement of target after the instant of firing.

The problem would not be so difficult if the data determined during reconnaissance varied proportionally with the elapsed time. But this is not the case, because at any instant the rapidity and direction of flight of the target, its range and the changes in azimuth and elevation, may vary within appreciable limits. To simplify the study it is first assumed that the plane flies at a fixed altitude, and uniform speed, and does not change its direction of flight.

In Fig. 1 is shown the flight triangle GP_1P_2 of a plane moving a distance

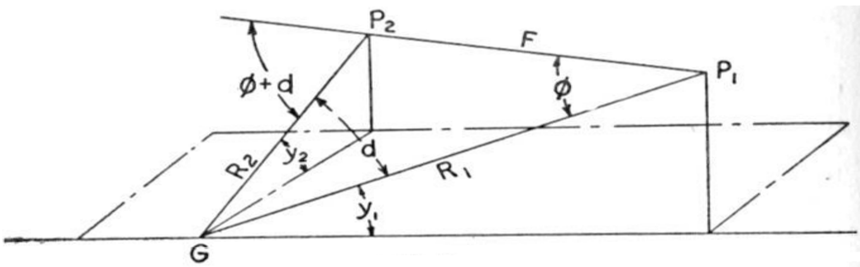


Fig. 1

F from P_1 to P_2 as observed from the gun at G. R represents the range to P, *y* the angle of elevation of the plane; Y the altitude; ø the angle of flight, *i.e.*, the angle which the direction of flight of the plane makes with the observer's line; and *d* the angular movement of the plane between consecutive measured observations. Solving the flight triangle for R_1 and R_2, we have from the law of sines:

$$R_1 = F\,\frac{\sin(ø + d)}{\sin d}$$

$$R_2 = F\,\frac{\sin ø}{\sin d}$$

Hence,

$$R_1 - R_2 = F\,\frac{\sin(ø + d)\ \sin ø}{\sin d}$$

$$= F\,\frac{\cos\left(\frac{d}{2} + ø\right)}{\cos\frac{d}{2}} \qquad (1a)$$

$$= F\cos ø - F\sin ø\tan\frac{d}{2} \qquad (1b)$$

The distance F, which the plane travels from P_1 to P_2 is equal to the speed of the plane *f*, multiplied by the elapsed time *t*, or $F = ft$, from which we get $f = \frac{F}{t}$. Now, F can be determined from the equation:

$$F^2 = R_1^{\,2} + R_2^{\,2} - 2\,R_1R_2\cos d$$

All the elements in this equation can be determined; R_1 and R_2 with the range finder, and d by measuring the angular movement of the target during the time interval t. Having determined F and R, the angle ø is obtained by the law of sines from the equation:

$$\sin ø = \frac{R_2 \sin d}{F} \tag{2}$$

The new flight angle $ø_2$ for the target at P_2 will be $ø + d$ and for a continuous flight, the flight angle $ø_n$ for any point P_n, will be:

$$ø_n = ø + d_1 + d_2 + d_3 + \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ d_{n-1}.$$

So far we have determined only the position of the target at the instant of last observation. In order to hit the target, the battery commander must predict the position of the target not only at the instant the gun is fired, but also at the instant the projectile bursts, *i.e.*, at the end of its trajectory.

In Fig. 2 let P_n be the last of a series of points to which the target has

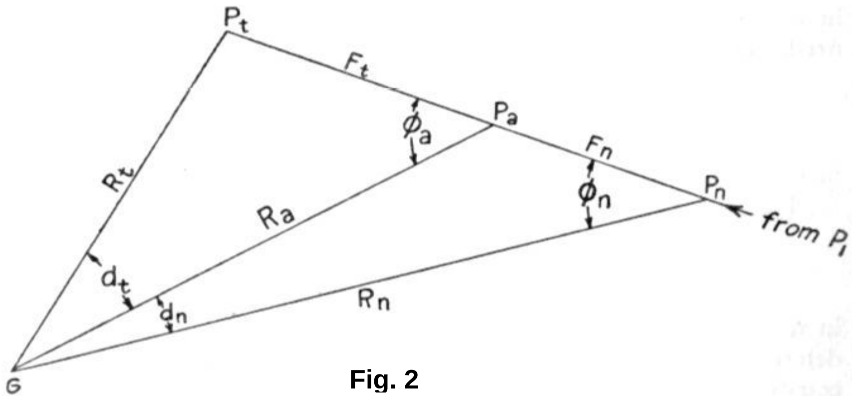


Fig. 2

been tracked in its flight from P_1. While the firing data are being announced, the gun laid and fired, the target travels from P_n to P_a. After the gun is fired, the target travels from P_a to P_t. Therefore, when the target is at P_n, the battery commander must determine and announce the data so that the projectile will meet the target at P_t. The time interval t_n during which the target travels from P_n to $P_a = F_n$ is determined by experience and depends upon the training of the battery, *i.e.*, the time it takes the gun crew to set off the data and lay the gun.

The value of d_n can be determined from the equation:

$$\tan d_n = \frac{F_n \sin ø_n}{R_n - F_n \cos\ ø_n} \tag{3}$$

Knowing d_n we can determine $ø_a = ø_n + d_n$ and from the law of sines will then obtain:

$$R_a = \frac{R_n \sin \text{ø}_n}{\sin \text{ø}_a} \qquad (4)$$

These values of d_n and R_a give use the position of the target at the instant the gun is fired. But at this instant the gun must be laid ahead of the target at a predicted point so located that the time of flight of the projectile is equal to the flight time of the plane to this point. This may be expressed mathematically by the equation:

$$\frac{F_t}{f} = \frac{R_t}{v} \text{ or } F_t = \frac{fR_t}{v}$$

in which F_t is the distance the plane will travel after the gun is fired; f is the speed of the plane; R_t is the range to the predicted point; and v is the average velocity for the predicted range.

From the law of sines:

$$F_t = \frac{R_t \sin d_t}{\sin \text{ø}_a} = \frac{fR_t}{v}$$

in which $\text{ø}_a = (\text{ø}_n + d_n)$ is the flight angle at the instant the gun is fired. Hence,

$$\sin d_t = \frac{f \sin \text{ø}_a}{v} \qquad (5)$$

in which f, sine ø_a and v are known.

Having determined d_t, we can find R_t from the law of sines:

$$R = \frac{R_a \sin \text{ø}_a}{\sin (\text{ø}_a + d_t)} \qquad (6)$$

in which R_a is the predicted range at the instant the gun is fired as determined in equation (4) and the other elements are known from equation (5).

Now if the lines GP_a and GP_t lay in a plane perpendicular to the plane of sighting, the angle d_t would measure the true deflection angle to be set off on the sight. But this is seldom the case because the plane passing through these lines is usually inclined to the plane of sighting. Hence the angle d_t must be corrected for inclination to get the true deflection angle. This is done by giving the sighting apparatus an inclination equal to the angle between the plane GP_aP_t and a plane perpendicular to the plane of sighting. This angle of inclination is determined as follows (see Fig. 3):

In the flight triangle GP_1P_2, $P_1P_2 = F$; $P_1S = P_2M = h$; $\angle P_1GS = y_1 = \angle ZCD$.

Pass the plane CZP_1G through the line GP_1 and perpendicular to the plane of sighting GP_1S. Pass the plane CYY_1D through the point P_2 and perpendicular to the plane CZP_1G, making it parallel to plane GP_1S. From P_2 drop P_2I perpendicular to the line GP_1, and through P_2I pass a plane perpendicular to the plane CZP_1G, cutting the latter in the line OI. Through OI pass a plane parallel to the horizontal plane through the gun GCDS, intersecting the perpendicular P_2M at U. Through OI also pass a plane perpendicular to the plane GCDS, intersecting the latter in the line LT. Draw lines MG and MT. Then:

$\angle P_2GM = y_2$; UM = IT = OL, all perpendicular to plane GCDS.

P_2I = the altitude of the flight triangle GP_1P_2.

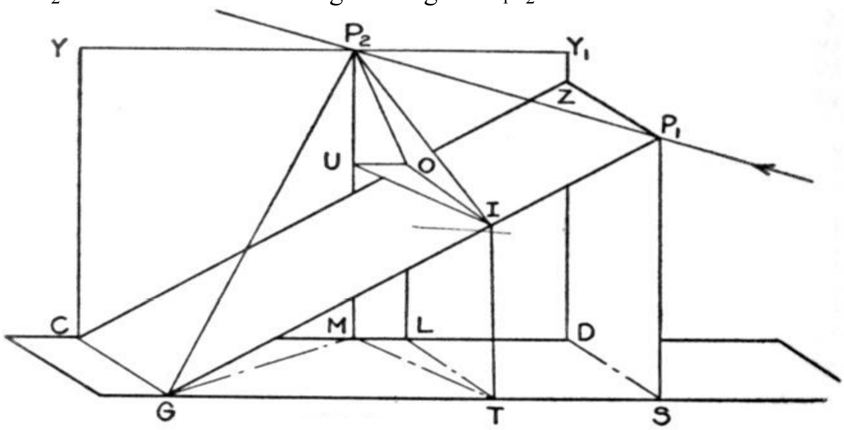


Fig. 3

P_2O is perpendicular to CZ and the plane CZP_1G.

$\angle P_2IO = v$ = inclination of plane GP_1P_2 to plane CZP_1G.

OI is parallel to LT.

Plane OUI is parallel to plane MLT, both horizontal.

$\angle UP_2O = y_1$ since P_2O is perpendicular to CZ and P_2U is perpendicular to CD.

$\angle P_2P_1G = ø$; GP_1 = range to $P_1 = R_1$.

$P_1I = F \cos ø$; $P_2I = F \sin ø$.

Now,

$$\sin v = \frac{P_2O}{P_2I} = \frac{P_2O}{F \sin ø}$$

$$P_2O = \frac{P_2U}{\cos y_1}$$

$$P_2U = h - UM = h - IT$$

$$\frac{IT}{IG} = \frac{IT}{R_1 - F \cos ø} = \sin y_1$$

$$IT = (R_1 - F \cos ø) \sin y_1$$

$$\therefore\ P_2U = h - (R_1 - F \cos ø) \sin y_1 = F \cos ø \sin y_1$$

and

$$P_2O = \frac{F \cos ø \sin y_1}{\cos y_1}$$

Substituting for P_2O in the first equation, we have

$$\sin v = \frac{F \cos ø \sin y_1}{\cos y_1 \, F \sin ø} = \cot ø \tan y_1$$

which gives us the angle of inclination, *v*.

If the plane is flying squarely across the field of observation, ø = 90°; hence, sin *v* = *o* and *v* is zero. If the plane is flying head on, ø = y_1; hence sin *v* = 1 and *v* is 90°. The inclination of the flight triangle may, therefore, vary between 0 and 90°. Beginning at 0° it will increase slowly and then more rapidly as it approaches 90°. For each consecutive position of the target, *v*

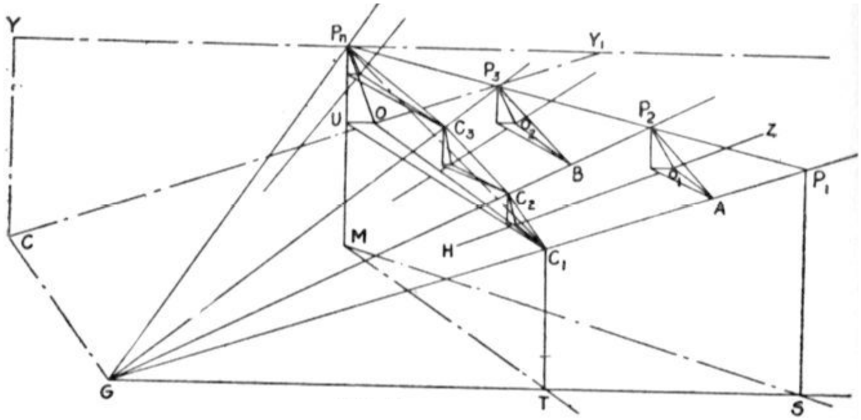


Fig. 4

will have a different value. Hence, for each of these time intervals the laying apparatus would have to be given a different inclination. The value of *v* will be changing for each new value of ø and *y*. However, if we plotted the consecutive small angles *d* while following an airplane target, the result will be a warped surface whose inclination will be represented by a curve drawn with a radius of R_n and passing through all the previous lines of sighting. The tangents to this curve will always have an inclination equal to the angle *v*.

This can be seen in Fig. 4. GP_1P_2, GP_2P_3, etc., are successive small flight triangles drawn to consecutive increments of *d*. In the flight triangle GP_1P_2, the angle P_2AO_1 = the angle *v;* in the flight triangle GP_2P_3, the angle P_3BO_2 = the angle *v,* and so on for the other small flight triangles. With R_n as a radius and G as a center, let us draw a circle cutting all the lines of sighting GP_{n-1} . . . GP_3, GP_2 and GP_1 at the points C_{n-1} . . . C_3, C_2 and C_1. The successive C points will lie in the plane P_nC_1TM and the resulting angles v in this plane will, by construction, be equal to the corresponding angles v in the plane P_nP_1SM; that is, the angle v at A will be equal to the angle v at C_1, angle at B equal to the angle at C_2, etc. The angle P_nC_1O is the average of all the angles v in the consecutive flight triangles and measures the average inclination for the large flight triangle GP_nP_1 with respect to the basic deflection plane GP_1HZ. If the target was last laid on at P_1, in order to hit it at P_n with a range R_n corresponding to GP_n, the deflection correction must be set off in the plane GC_1P_n having an inclination v equal to the angle P_nC_1O. Therefore, in addition to the determination of the deflection angle v_t and the range R_t, the battery commander must also determine the angle of inclination v of the plane in which the deflection angle must be measured.

(To be Continued.)

CURRENT FIELD ARTILLERY NOTES

Automatic Pole Support

THE automatic pole support was made desirable due to the adoption of the breast collar harness, which is not designed to transmit weight to the necks of the wheel team. Unless the pole is supported at the proper height by the automatic pole support sore necks are apt to be the result. When in proper adjustment this device is designed to hold the limber and reel pole constantly at a suitable height without support from the harness or limber and caisson props. This device is described in the Handbooks of 75-mm. matériel, Models 1897, 1916 and 1917, also of 155-mm. howitzer, Model 1918.

For various reasons, it is not always possible to get the desired adjustment with matériel in use by troops and many schemes have been devised to reduce the weight thrown on the necks of the wheel horses. Some of these are subject to the objection that the pole is rigidly supported, thus not accommodating itself to varied terrain.

A modification of the pintle, as illustrated, shows the principle of a device now under development and which appears to be of considerable promise.

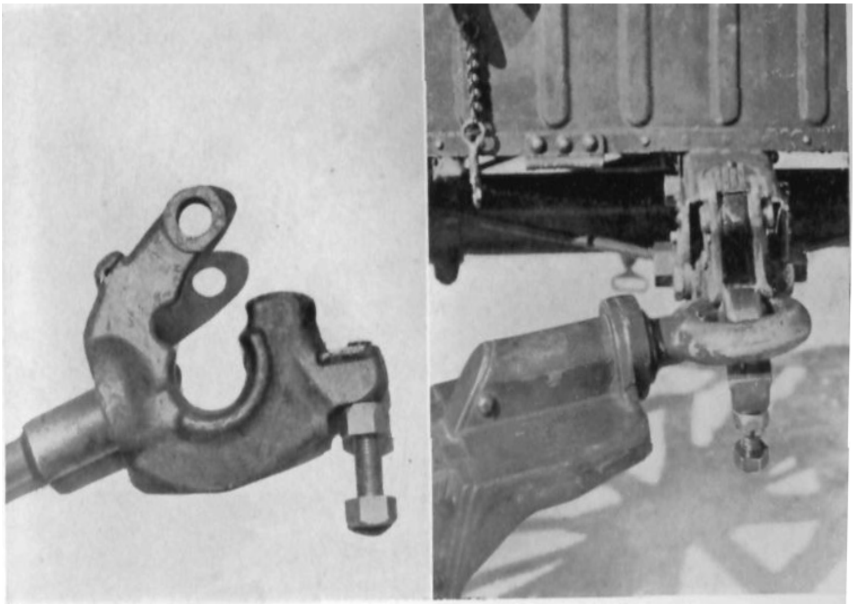
The illustrations are from photographs submitted in December, 1925, by Major W. H. Rucker then commanding the 82nd Field Artillery Battalion (Horse), in which organization the pintle modification was devised and had been given a successful test.

Prize Winning Artillery Team

At the Washington (D. C.) Horse Show, April 21, 1927, the first prize for "Artillery Pair" was awarded the entry of Battery A, 16th Field Artillery, Fort Myer, Va., Captain John Nash, commanding. The horses "Ruel" and "Goose" are bay geldings, ages seven and eight years, height 15.2 hands, weight 1250 pounds. They were issued by the Front Royal Remount Station in January, 1927. This pair defeated a well-known team of grays from the same regiment, which had won the blue ribbon for the past two years at the Madison Square Garden.

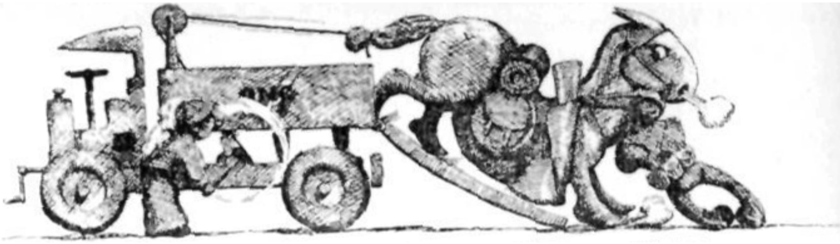
Portée Cavalry

The drawing, reproduced on a following page, was made by Lieutenant Alexander S. Bennett, F. A., as part of the decorations for a 13th Field Artillery festivity. It was then sent to the Chief of Field Artillery, who referred it to the Chief of Cavalry. It later appeared in the *Cavalry Journal*, with whose permission it

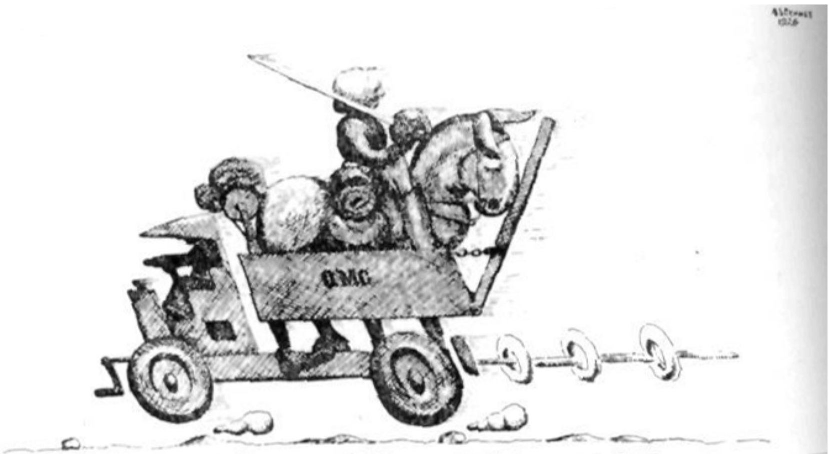


EXPERIMENTAL MODIFICATION OF LIMBER PINTLE TO IMPROVE ACTION OF AUTOMATIC POLE SUPPORT

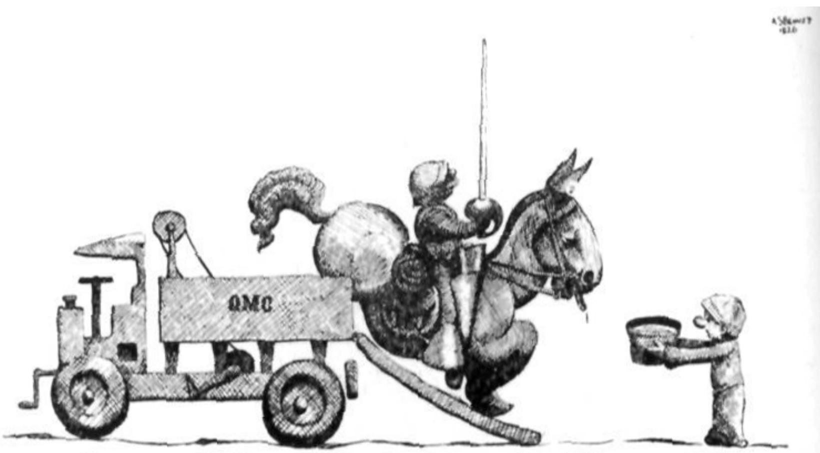
PRIZE WINNING ARTILLERY PAIR OF BATTERY A, 16TH FIELD ARTILLERY



PORTEE CAVALRY – ENTRUCKING



PORTEE CAVALRY – APPROACH MARCH



PORTEE CAVALRY – DETRUCKING

is here reprinted. Under these circumstances, it is felt that the motives prompting its publication in THE FIELD ARTILLERY JOURNAL cannot be misconstrued.

Those officers who are conversant with the Portée experiments conducted in the 13th Field Artillery, in which all reasonable and possibly some unreasonable combinations of loads and loading were tested, may recognize certain familiar ear marks and suspect that it is not necessary to go outside of our branch to identify the target. Possibly they are correct.

Army Polo Association Plans for 1927 Season

WITH the approval and enthusiastic support of Major-General Charles P. Summerall, Chief of Staff, plans are rapidly taking shape for the participation of the Army in National Polo tournaments this coming summer. General Summerall has stated that the Army will defend the national titles which it now holds. He has made it clear that no half-way measures will be tolerated; that the personnel of the team will be selected and assembled in ample time for organization and preparation; and that the best ponies must be made available for the use of the team. Accordingly, there is every prospect for an active season.

For the first time in the history of Army polo, the Army will compete in the Open Championship, which is the senior tournament played in America. The experience gained in competing in this tournament against the best players in America, mounted on their best ponies, will be invaluable and will give us a line on the players and ponies available to meet the British challenge which we anticipate receiving in 1928.

The national and international titles now held by the Army are:

1. Junior Championship of America.
2. Military Championship of Great Britain and America.
3. Championship of Hawaiian Islands.
4. Inter-circuit Championship.
5. Twelve-goal Championship.

In accordance with the policy adopted by the Central Polo Committee of retaining a nucleus of experienced players and selecting the remainder from outstanding players of the previous year, the personnel of the Army team for 1927 includes some new players. In preparation for the coming season, the following-named officers will assemble at Mitchel Field, Long Island, prior to the 10th of June:

Captain Charles H. Gerhardt, Cavalry, West Point, N. Y.
Captain George E. Huthsteiner, Cavalry, Fort Sam Houston, Tex.
Captain C. A. Wilkinson, Cavalry, Fort Riley, Kans.

Captain Peter P. Rodes, 14th Field Artillery, Ft. Sheridan, Ill.
Captain Joseph S. Tate, 16th Field Artillery, Ft. Myer, Va.
Lieutenant Guy C. Benson, 16th Field Artillery, Ft. Myer, Va.

Captain Charles H. Gerhardt has come to the fore in polo in the last four years. In 1924 he played on the Army team in the Junior Championship tournament. The following year he was a member of the Army team that won the Junior Championship. That same year he went to England with the American Army team that defeated the four representing the British Army. Last summer he again played on the Army Junior Championship team and then wound up the season on the Army-Meadowbrook team with Mr. Watson Webb, Mr. Devereaux Milburn, and Captain Peter P. Rodes as team mates.

Captain George E. Huthsteiner is no newcomer in Army polo circles. For several years he played on Regimental and Post polo teams. In 1925 he was a member of the Cavalry Division team from Fort Bliss that won both the Inter-circuit Championship and the Twelve-goal Championship.

Captain C. A. Wilkinson has been seen in action on Eastern fields before. In 1924 he was a member of the Army team that played in the Junior Championship tournament. Last summer he came east with the Fort Leavenworth team that won the Inter-circuit Championship and the Twelve-goal Championship. Prior to playing on the Fort Leavenworth team, Captain Wilkinson had considerable experience on the Pacific Coast.

Captain Peter P. Rodes, with a seven-goal handicap, is well known in the Army and Eastern polo circles. After the World War, Captain Rodes played regimental polo in the Central West and developed rapidly. In 1925 he went to England with the American Army team that won the match tournament from the British Army team. The same year he played on the Army team that won the Junior Championship from Bryn Mawr at Rumson, New Jersey. Last summer he was a member of the Army-Meadowbrook team that played in Eastern tournaments.

Captain Joseph S. Tate was a member of the Army team representing the American Forces in Germany which played in England, France and Germany. Since his return to the United States he has followed the game as a member of local teams, and last fall played on the 16th Field Artillery team at Fort Myer, Virginia.

Lieutenant Guy C. Benson was a member of the 1926 Army team that won the Junior Championship. Last fall he played on the 16th Field Artillery team at Fort Myer, Va.

Each of the above-named players has been authorized to bring to Mitchel Field five top ponies. Coming from widely separated localities where interest is high, it is felt that they should have a varied selection from which to choose their mounts. These mounts, with the nine Army team ponies wintered at the Remount Depot, Fort Royal, Virginia, would provide a total string of about thirty-nine ponies.

With the encouragement and support of the Corps Area Commanders and Commanding Officers of posts and stations where the game is played, it is felt that polo will once again take a very prominent part in Army athletics this coming summer.

The Field Artillery Board Notes

During the preceding two months, the reports on nine completed tests have been forwarded. These are:

Modified Carpenter's Chest.
Fifty-gallon Gas Drum as a Gas Tank.
Indian Motorcycle.
Best "60" Tractor.
Lighting Equipment for Tractors.
Ford Cross-country Car.
Modified McClellan Saddles.
Jack-O-Lite Lantern.

Modified Carpenter's Chest.—The issue carpenter chest for the battery and store wagon was modified by removal of partitions, which had become unsatisfactory by reason of the issue of tools for which the partitions were not suitable. The idea, of course, is to make it possible to carry in the chest, those types and numbers of tools needed, even though different makes and sizes of certain tools should be issued. In war-time, there is strong probability that it will not always, or even usually, be possible to obtain tools of exactly the same dimensions for all chests.

Fifty-gallon Gas Drum.—The object of the test has been explained in a previous issue. The final report was unfavorable to the drum. A rotary pump for the gassing of motor vehicles in the field was recommended.

Indian Motorcycle.—The test showed, as all previous tests have shown, that motorcycles are unsatisfactory in the artillery regiment. They are unreliable and difficult to get across rough, sandy or muddy terrain. Even for messenger service in the regiment, the crosscountry cars were recommended as more satisfactory. The report was unfavorable.

Best "60" Tractor.—This tractor has already been adopted as a standard for the ten-ton class. A previous progress report had shown it to be a sturdy powerful type. As predicted in the last notes, the final report was favorable, the last part of the test being as satisfactory as the first parts.

Lighting Equipment for Tractors.—About a year ago, the Board recommended the development of night lighting equipment for motor vehicles, such equipment to provide sufficient light for the drivers to see their way during night maneuvers, but to be invisible or very little visible from the air. As a first step in the development, a series of colored lenses for the issue tractor lamps, three or four different colors being provided, were tried out, but the test could not be made complete due to the lack of night flying equipment at the post air field. As far as could be determined from the tops of towers, etc., however, the colored lenses gave too great a light and would be too visible from the air. The report was unfavorable conditioned on further testing when night flying could be employed.

Ford Cross-country Car.—The final report covered both this particular make of car, the car as a type, and a basis of issue. The Ford cross-country car gave considerable mechanical trouble and was recommended for adoption only until a sturdier light car could be found. As a type, the car was satisfactory, it being believed that it will solve to a large degree the question of reconnaissance vehicles for motorized units. The type was recommended for adoption to replace the White staff and reconnaissance cars and the motorcycles for reconnaissance and messenger purposes. In addition, it was recommended that it be tried out for wire-laying purposes and that the one-ton truck chassis with the same motor be equipped with a light truck body to replace the G.M.C. and similar present issue light trucks. For wire laying it is proposed to remove the two rear seats and mount a reel in their place, the reel and seats to be so made as to be easily interchangeable. If this can be done, it will be possible to use any or all of the cars of this type in any organization for wire laying if the emergency should arise.

Since the type was recommended for adoption, a basis of issue was included in the report; that is, a tentative scheme showing the number of these cars each type of organization would need. The scheme, of course, is tentative only, as there have not been sufficient cars on hand to try it out.

Modified McClellan Saddles.—The quarter straps and cincha of the issue McClellan saddle have been removed and a cincha of the same type as that used on officers' saddles substituted. To replace the sweat leathers, a leather skirt has been attached to the side bars, again in a similar fashion to the officers' saddles. As thus modified, the saddle was recommended for new manufacture.

Jack-O-Lite Lantern.—The lantern was described in the last notes. It was found to be too cumbersome and difficult to handle,

F. W. D. TRUCK LOADED WITH THREE TONS OF DIRT ASCENDING 18º SLOPE

F. W. D. TRUCK LOADED WITH ONE AND ONE HALF TONS OF DIRT AND TOWING A 3-INCH GUN ASCENDING AN 18º SLOPE

COLEMAN TRUCK LOADED WITH THREE TONS OF DIRT AND TOWING A 155-MM. HOWITZER
ASCENDING 18º SLOPE

COLEMAN 5-TON TRUCK—SIX CYLINDER—PNEUMATIC TIRES two men being required to operate it in many cases. The light given was not as great as that of the ordinary flashlight. The report was unfavorable.

Training Regulations.—During the preceding two months, the Training Regulations Section has completed and forwarded the first rough drafts of "The Tractor Driver" and "Service of the Piece, 240-mm. Howitzer." "Dismounted Drills and Ceremonies" has been further revised. At present, the section is working on a revision of 430-70, "The Firing Battery," on "F. A. Communications" and on "Camps, Marches and Field Equipment."

Tests Not Completed.—75-mm. Guns.—The comparative test of the box-trail and split-trail 75-mm. guns will be completed in May and the report will be forwarded early in June. The new guns have done very well and seem to be sturdy, simple pieces of mechanism with excellent accuracy. The Board has not reached a final conclusion on the two types and cannot until the test is complete.

E-1 Shell, E-13 Fuze, 75-mm.—This ammunition was used to test the new 75-mm. guns. At the same time a test of the ammunition itself was made, its components being of the latest design. Two troubles were found: (1) The cartridge case separates from the projectile too easily. (2) The delay element of the fuze is not yet sufficiently reliable, as evidenced by an excessive number of duds. Otherwise, the ammunition is excellent. The fragmentation was 30 to 40 per cent. greater than the present shell, the range and accuracy were excellent, and the functioning of the super-quick element of the fuze satisfactory. The report is being written.

Smoke Shell.—A test to determine the comparative usefulness of smoke shell and shrapnel in locating "lost" rounds in difficult terrain has been instituted and three problems fired. The test is incomplete and no conclusions have been reached.

Motors.—The test of the rebuilt F.W.D., and of the Coleman trucks continues. The accompanying photos show these trucks climbing an 18° slope. The F.W.D. is shown both with and without a tow load (the latter is a 3-inch gun); and the Coleman is shown towing a 155-mm. Howitzer. A photo of the Coleman truck alone is shown, also, to give a better idea of its characteristics. The trucks have shown improved performance over the hard-tired trucks. The test is incomplete, however, and no conclusions have been reached.

Defense Against Low-flying Airplanes.—The Board has recently made a visit to Fort Benning to witness an air corps demonstration of all types. A very good idea was obtained of the methods of attack by the different types of plane, and an excellent chance was had to confer with the air corps officers. The test continues.

Firing from Air Photographs.—Work on this test has been continuous all winter and spring. A great deal of work has been done with the four-lens camera. In most respects it has proved satisfactory, but it is not capable of showing ground depth, *i.e.*, the variations in altitude of the terrain. Tests are now under way with the five-lens camera along the same line. They are incomplete.

Sound Ranging.—Sound ranging has been put upon an active status and new equipment is being furnished the 1st Observatory Battery for tests next year.

General.—The test of the experimental rolling kitchen has been completed and the report is being written. In general, this vehicle was much too heavy.

New trailers (Athey) and the McCormick-Deering tractor have been received for test. Also, a new seven-ton trailer for the 240-mm. howitzer units has arrived.