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EDITED BY

ARTHUR F. CASSELS

LIEUTENANT-COLONEL (FIELD ARTILLERY), UNITED STATES ARMY, RETIRED

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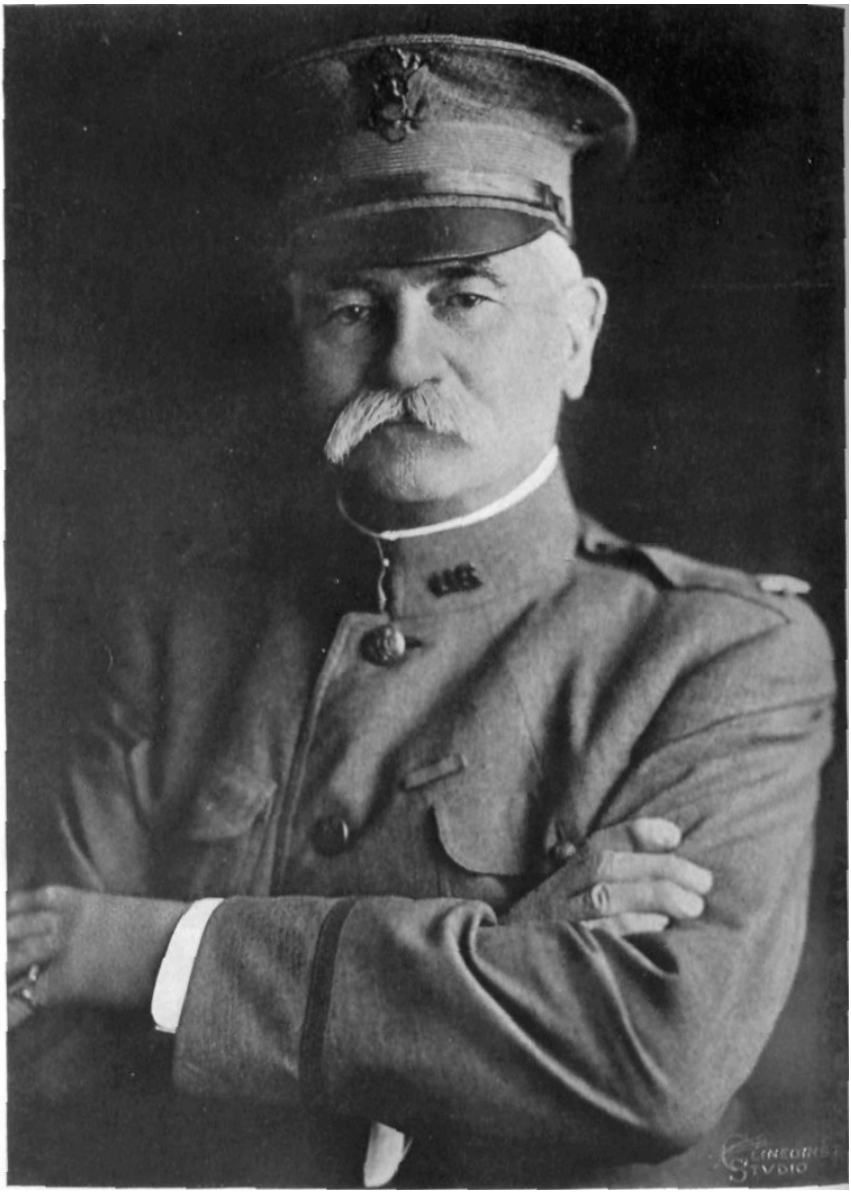

BRIGADIER-GENERAL ELI D. HOYLE, U. S. ARMY, RETIRED
Died July 27, 1921

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SOME FEATURES OF THE ACCOMPANYING GUN

BY LIEUTENANT COLONEL C. DEEMS, JR., FIELD ARTILLERY, U. S. ARMY

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INTRODUCTORY

WE are well along in the third year after the actual close of the World War, and, as yet, the Army at large has not accepted a definite, authorized policy and tactical doctrine relating to the use of the accompanying gun. It seems, therefore, time that this subject be opened up to the fullest discussion of artillerymen and infantrymen alike, with a view to bringing out the more salient points, interesting and important to these two intimately related combat arms. This article is presented in the hope, therefore, that the opinions of the writer may elicit friendly discussion of this subject on the part of others, and thus (by their expressions of opinion) open the way to a more complete understanding of the technical and tactical features involved.

That the subject is a broad one, and is recognized in battle application from the highest front line commanders to the lowest, may be understood better, perhaps, by relating in brief, the following incidents:

In the latter part of October, 1918, the German and American lines in the operating area of the First Army were engaged in desperate struggle. Daily, almost, thrusts of importance occurred. With a view to assisting a particular local operation, the artillery brigade commander called upon his regimental commanders to have certain accompanying guns detailed to report to the infantry regimental commanders for use with their assaulting battalions. In the case considered, the infantry regimental commander objected very much to the presence of the gun (though the terrain was suitable for its technical use), giving as his reason that the fighting was already severe and that as soon as it opened fire it would draw such a response from the German artillery that his men would suffer in casualties far more than could be compensated for by any good that the accompanying gun might be able to do in the destruction of targets assigned to it; moreover, the infantry battalion commander felt that he did not desire to be hampered with another tactical unit

to direct, since he had already all that he could be expected to manœuvre, including his rifle companies, his attached machine guns and auxiliary weapons. Here, in battle, it was manifest that a part of the artillery (that arm whose sole reason for existence is being able to aid its infantry in its advance) was not at all welcomed by its companion arm.

But, along the same front, at a somewhat earlier date, a different situation entirely was presented. In this case, a young officer in command of an accompanying gun did most excellent work, among other things knocking out several hostile machine guns. He secured the most wonderful confidence of the troops that he was supporting, but this very confidence in the assumed powers of the artillery weapon combined with his own ability placed him in an exceedingly embarrassing position. After the objective line was reached and it was determined that the advance for the day was terminated, the battalion commander of the infantry to which he was attached asked that he keep his gun all night with them, so that this weapon could be used to lay a protective barrage in front of the infantry battalion in case of a counter-attack during the night. The reception of the artillery in this case by its companion arm was literally too enthusiastic, and the young artillery officer communicated with his regimental commander explaining that he was expected to lay a defensive barrage four hundred metres in length with his single piece!

After the Armistice certain division exercises and manœuvres were held in France for the purpose of continuing necessary training. In one of these cases, in the execution of his plan, the highest commander used accompanying guns. It so happened that the terrain was not technically suitable for such use, and that in actual battle the guns probably would have been destroyed early by hostile fire; moreover, they could have remained initially with the batteries to which they belonged and have covered by their fire at suitable ranges the advance of their infantry from a fully protected position and from which the very best observation of fire could also be maintained. It was not a case where the physical presence of the guns could add to the morale of the infantry by advancing with them; in fact, their certain early destruction in the presence of the infantry would have tended to have lowered the morale of the very arm that the artillery was expected to support. At the critique these points were brought out by the umpires. The defense was made that combat instructions issued from Headquarters of the A.E.F. called for accompanying guns in the advance of a division, that these instructions were to be construed as orders, and that not to have accompanying guns present and used as such was a violation therefore of orders from higher authority. It seems that a more logical view to have been taken would have been this: general principles of special tactics should be

accepted as such, to be violated when necessary in the particular cases that indicated such action. Such is the true application of military art.

These three incidents which are quoted will show that we may expect extreme cases to appear in the application of any tactical doctrine, and that to settle on a doctrine relating to the accompanying gun we must not give individual instance too much weight; also, in the acceptance of an opinion, it is well to remember the experience of the one from whom it issues, as well as his reliability of judgment as they form factors of the greatest weight.

THE ACCOMPANYING GUN

The use of the above phrase has been applied in the recent war to an augmented section of a 75 mm. battery detailed away from its own organization and temporarily under the direct orders of an infantry commander, usually the major of an assaulting battalion, for such immediate use as the infantry commander may direct.

FUNCTION OF THE ACCOMPANYING GUN

As an artillery weapon, it is on hand to be called into action, in general during the attack, to demolish any target that is holding up the advance of the infantry and for which the infanry weapons and infantry auxiliaries are insufficient to gain prompt success.

ELEMENT OF TIME IN RELATION TO THE USE OF THE ACCOMPANYING GUN

The time factor is the greatest argument for the use of the accompanying gun provided this gun is tactically so located and is technically prepared to perform its function sufficiently rapidly to relieve the infantry in its delay incident to the resistance that this piece is expected to overcome. Every minute of stoppage in the infantry advance is measured in human lives that are lost, which fact, in itself, results in greater difficulty in resuming the advance again, due to the loss in infantry man power. Unless the accompanying gun is able to overcome the resistance more promptly than by other means available, then its use seems hardly justifiable, since the quickest and surest means at hand are desired. This has brought up the most natural questions as to whether the divisional artillery is able to properly support its infantry without actually detailing accompanying guns with the infantry assault battalions, and whether a supporting battery located under cover farther to the rear can respond more quickly to the infantry demands.

The essential period of time then is the elapsed time from the moment when our own infantry advance is temporarily stopped by some feature (machine-gun nest, armed pill-box, etc.) of the enemy's

defense up to the moment when this hostile target is destroyed by our accompanying gun or some element of the divisional artillery, which fact will permit our infantry to resume the local advance.

A series of experimental firings was conducted in France, under conditions made as nearly like those of battle as possible, and averages were kept of the elapsed times from the stoppage of the infantry advance and getting the message sent from the front lines asking for help, up to the moment of the total destruction of the target by both accompanying gun and the supporting battery. Some details of these experiments will be discussed later. Suffice it to say here that under identical conditions for both the accompanying gun and a battery assigned from the divisional artillery, the average of all these tests showed that the supporting battery took 31 per cent. greater time than the accompanying gun to execute the mission, although the battery had four times the fire power.

Conclusion: Since time is the most essential element, it is seen that these experiments justify the existence of the accompanying gun.

USE OF THE ACCOMPANYING GUN IN FRANCE

The reports circulated in France prior to the Armistice, and also subsequent thereto, indicated that there were a great many failures in the use of the accompanying gun with the First Army. These failures seem to have been the result of some of the following causes:

1. Insufficient training of our own artillery in this character of open warfare. Specifically:

a. The commanders were not always able to compute data swiftly and execute the fire with a degree of speed required in such a problem. Weeks of trench warfare had caused the open warfare methods to become neglected.

b. Manœuvre ability of the 75 mm. was not used to the required capacity. Many of our younger officers had no real conception of the full flexibility of manœuvre of horsed artillery, and where rapidity of movement was indicated, it was frequently neglected through lack of training. Certain other conditions contributed to this state of affairs, notably the inferior character of the French animals supplied, as well as the fact that they had often been kept in rear echelons on picket lines, exercising, grazing and hauling ammunition, particularly during stabilization, or engaged in marches, and no opportunity had existed for the continuation of manœuvre training immediately prior to use in battle.

c. Lack of sufficient training in the rapid occupation of position with the necessary swift and accurate reconnaissance required in connection with the same. This resulted frequently in unnecessary exposure and the disabling of the section before it could be brought into efficient action.

2. Failure of the infantry commanders to fully understand the tactical use of the accompanying gun; failure to accept it as a part of their legitimate command.

3. Failure to have combined exercises between the infantry and artillery prior to battle, involving the use of the accompanying gun.

4. Failure of gun commanders to push their observation and liaison forward where they could observe the actual battle difficulties of the immediate infantry front lines, and to be instantly ready to bring their gun into action at the very earliest moment needed.

Conclusion: Prior to battle, there must be a great deal of combined manœuvre between infantry (assaulting) battalions and accompanying guns. The latter are the smallest units where combined training becomes essential. All sections of light artillery must be given much training in this duty, and, in garrison, every opportunity must be found to weld the infantry and artillery together in combined problems of this nature.

OBJECTIONS TO THE ACCOMPANYING GUN

1. From the Artillery.

a. To detail such a gun from a battery diminishes the latter's gun power by 25 per cent. and takes away a considerable part of the necessary battery "overhead" in the way of specialists, etc. This causes the remaining part of the battery to operate at less than 75 per cent. efficiency.

b. In case the accompanying gun remains away more than a few hours, it introduces such difficulty of supply including rations, forage and ammunition, that, unless the battery be freed of this responsibility, the situation is liable to become very embarrassing for the accompanying gun, since its location is often not easily determined by the artillery to which it belongs, and its own battery is liable to be quite distant.

c. Where the accompanying gun reports to the infantry and is not used, its fire power is totally lost; whereas, had it remained with its battery, it would have done its proportional gun duty in thickening the density of barrages, concentrations, etc.

d. It is often urged that in many cases the mission of the accompanying gun could have been carried out as well or better by the divisional artillery. But this statement must be qualified by the fact that the features of terrain, including positions for gun or battery, together with the character of the general sector of operations, the skill of those who conduct the fire, efficiency of liaison, location of targets with respect to the accompanying gun or unit of the divisional artillery, and the relative visibility to the accompanying gun or divisional artillery, together with the element of time necessary to

open the way for the infantry, all combine to make this assertion difficult of proof.

e. The accompanying gun, if brought into action, using direct fire, will quickly become a total loss. (Proximity to the target will often require direct fire methods due to the inability to clear a mask with a flat trajectory.) The answer to this appears to be clear. For everything gained in battle a price must be paid. The essential thing is to aid the infantry in its advance. If the use of an accompanying gun involves its loss, it is merely the price required. It is paramount that the artilleryman by suitable training, wise initiative, and quick conception of the situation responds in time to smash his target and thus relieve his infantry of temporary embarrassment even if his gun be smothered after the completion of the particular task and before safety can be found by temporary withdrawal. But it is at this point the tactical judgment of the assault battalion commander enters. He must decide whether to order his gun into action or whether (in view of later probable more complex situations) he wishes to keep it for the present in reserve. He must fully realize too that even if the gun be lost as a result of fire concentration, if it has "delivered the goods" before being put out of action, it has paid for its presence many times over.

2. From the Infantry:

a. It introduces another special arm. The commander of the assaulting battalion is already burdened too much with the number of units he is obliged to handle. His four companies and attached special units require the limit of his attention. To add another special arm handicaps rather than assists him.

b. The arrival of the accompanying gun, especially when going into action when using direct fire or where there is little cover available, draws the hostile fire of everything with the result that the infantry (already stopped and waiting for the local resistance offered by the enemy to be overcome by artillery) receives a most unwelcome additional shower of missiles and has its morale accordingly lowered, thus making a new advance more difficult to start.

ADVANTAGES OF THE ACCOMPANYING GUN

1. To the Infantry:

a. It offers the swiftest manner, in general, to overcome hostile targets which have caused a temporary stoppage of our own lines and for which the infantry auxiliary weapons are insufficient.

b. Besides strengthening the attack, it becomes a valuable assistance in case of a sudden enemy counter-attack and affords an effective method of meeting enemy tank counter-attack and of silencing the enemy heavy anti-tank guns as they are unmasked.

c. This gun, due to its range, permits a prompt and efficient

attack of the enemy in cases where our advance has been temporarily stopped at a considerable distance from the enemy's line of defense.

d. It is possible, at times, that the physical presence of the gun may aid in maintaining good morale among our own troops, and especially where high initiative and consequent success is exhibited by the gun commander.

2. To the Artillery:

a. It relieves the artillery of sending larger units (batteries) in close proximity to the front line where they might never be actually needed to overcome temporary stoppages, where they cannot be so efficiently served, where they crowd the infantry and draw hostile fire resulting in early destruction, and where, moreover, it becomes more difficult to find suitable positions for such units from which to fire.

b. It offers to young officers of initiative an opportunity to work hand and glove with the infantry on the front lines, to learn what true cooperation with the infantry means, and paves the way for a fuller realization of the front line problems of the arm that we must strain every energy to assist, thus educating our younger officers in the primary phases of whole-hearted support that must be given the infantry by the artillery whether by the accompanying gun, the infantry battery, or attached battalions or regiments of the divisional artillery.

REQUISITE OF THE ACCOMPANYING GUN

1. It must have sufficient power to crush its target promptly. The characteristic material defense of machine-gun nests, together with their location in the German lines, combined with their use of isolated 77's in protected positions, indicated that projectiles from our own 75's were the lightest calibre sufficient to successfully cope with the usual targets. Six pounders, or a similar calibre, would have been wholly insufficient.

2. The gun must be sufficiently light and have sufficient power to move across country and keep up indefinitely with the infantry. While the average advance of the infantry deployed in battle will hardly exceed a hundred metres in three to four minutes, the gun must be ready at all times to advance with the infantry in marching formation at the usual road rate; moreover, it must be able to move swiftly for its own protection during changes of position.

3. The weapon must be equipped with the necessary overhead in the way of specialists to secure reconnaissance, observation, and liaison with the infantry.

4. Indirect fire must be swiftly delivered in cases where convenient and effective, where the target is indistinct, or where, due to

hostile superiority of fire, the gun could not function in a direct fire position.

5. The ammunition to be used should ordinarily be H.E. shell for the reduction of small temporarily fixed features of the defense; shrapnel in small quantities for moments of crisis in meeting a local counter-attack or attacking exposed personnel of the enemy at any time, and gas for the local neutralization where observation of the target is not good enough to make direct hits. In rough country, reduced charges may sometimes be specially valuable.

6. There must be a liberal supply of ammunition to accompany the gun, since replenishment will be difficult. Although the American experiments in France indicated that an average expenditure of eighteen rounds was needed to thoroughly reduce each target attacked by an accompanying gun, the gun must be prepared to encounter many targets in succession under conditions of difficult observation, which will cause, therefore, the use of a considerable amount of ammunition.

TYPE OF WEAPON BEST SUITED TO PERFORM ACCOMPANYING GUN DUTIES

Many objections have been offered to the French 75 mm. as an accompanying gun. The principal ones were that it lacked the flexibility of manœuvre desired in moving across country due to its weight; that it was a poor weapon for direct fire on small targets beyond 800 to 1000 metres, due to its lack of a telescopic sight; that its size and the number of animals required for its manœuvre made it such a conspicuous target to hostile fire that it could not actually operate from a direct fire position. However, it did have the necessary power, and in some cases actually rendered most efficient service in spite of its faults.

Since we had no weapons specially designed to perform the duties of the accompanying gun, and had no tactical unit permanently assigned to such duty, many officers in France felt that an opportunity was offered to place in use the 75 mm. mountain guns that we had on hand. It is understood that some were sent over for that purpose though their tactical use in such capacity is unknown to the writer. It is believed that such a gun fires a sufficiently heavy projectile to perform the duties expected, though the velocity is relatively low. Its advantages would be that it can be transported conveniently to the scene of action in more than one way: it could be used either packed as originally designed (but this introduces the disadvantage of maintaining it as mountain artillery, and also would not permit swift changes of position), attaching shafts to it for ordinary use (which would only permit of rapid changes of position if the cannoneeers and others were mounted), and having light carriages

made for the transportation of ammunition, or bringing it up with its ammunition and gun detachment near to its place of use in trucks and having it drawn by hand by the cannoneers, together with its ammunition carriers on wheels to its place of use on the line (this latter method, however, being open again to the objection that no swift changes of position away from roads can be made). The above ideas are generally objectionable because of the introduction of a material change in the divisional organization merely to meet a more or less special case.

It has often been stated that the tank will be the accompanying gun of the future. If this be so, then the following conditions must be considered:

a. The tank must carry a gun of 75 mm. calibre to perform the work. This condition can only be met in heavy tanks, not at present assigned to the division.

b. The heavy tank moves relatively slowly as compared with horsed artillery, changing position at a run, and is a more vulnerable artillery target at such a time.

c. Initial cost of a heavy tank as compared with a section of light artillery is considered to be economically greatly in favor of the horsed artillery.

d. Due to the large target the heavy tank presents when used for direct fire, and the fact that in order to do the accurate work demanded of the accompanying gun, it must fire from a stationary position, it would last a much shorter time than a field artillery piece when exposed to enemy artillery fire.

e. Due to the conditions mentioned in *d* the tank must, when used as an accompanying gun, be prepared to take up masked positions for indirect fire, introducing therefore the necessity of attaching additional vehicles for the observation party, etc., and making the unit too bulky for its mission.

f. It has been claimed that no accompanying guns will be needed because the heavy tanks will take the local strong points when the infantry is held up. This statement is overoptimistic in that it presupposes that heavy tanks will always be present—a condition the infantry cannot expect, since they are not a part of the divisional troops—and that they can, if present, always advance in the face of anti-tank gun and artillery fire.

g. The tactical position of the accompanying gun is usually behind the infantry firing line—sometimes practically with it—whereas the tactical use of tanks with infantry should be preceding it or with the advanced elements of the infantry firing line.

For the reasons as set forth above it is maintained that the tank as at present constructed and tactically used does not find its rôle ever as an accompanying gun.

Rapid progress is being made in the motorization of some 75 mm. batteries. Whether they be ultimately organized as self-contained units with ammunition vehicles complete, or whether they be tractor hauled, they should be expected to perform all the duties of light artillery and be prepared for use in both masked positions and for direct fire. They will have certain advantages in presenting a smaller target due to the absence of animals. Whether they will be able to effect changes of position across the inequalities of average country as rapidly as horse-drawn artillery is a matter to be thoroughly tested. At any rate, if needed, they must be prepared to perform the duties of the accompanying gun, and they should be qualified for such use.

The auxiliary weapons of the infantry were not entirely satisfactory as used in Europe. It is desired to replace the one-pounders and the light Stokes mortars by a suitable howitzer which will combine the efficiency of both. It appears that the Ordnance Department is developing such a weapon. If adopted of sufficiently large calibre capable of swift enough movement across country, it will, in itself, largely replace the accompanying gun of the World War. But, even then, it is quite conceivable that for the solution of knotty problems, the field artillery will be called upon to assist, and it must be prepared to use the means at hand to effect the solution. For that reason, it is believed that for a long time to come, after the adoption and issue to the infantry of such an auxiliary weapon, the field artillery must be prepared to furnish and use in battle the accompanying gun.

Conclusion: The existing principle to-day is this: Until the infantry is actually armed with an auxiliary weapon of sufficient calibre and mobility to take the place of the 75-mm. gun of the field artillery, the latter must train its officers and men in combined exercises with the infantry to such a degree that the highest coöperation and efficiency can be secured in the tactics and technic of the accompanying gun as used in France, and as it may be used in the future in even more open manœuvre.

TACTICS AND TECHNIC OF THE ACCOMPANYING GUN

A few brief points on this subject only can be mentioned in this short paper. Like any art it must be learned by application. Too often in the past the lieutenant of artillery has felt that his place was relegated to ranks or the specific duties of reconnaissance officer or executive officer. Tactical initiative was not presented to him. For the training of young, highly qualified field artillery officers of initiative the command of an accompanying gun offers a wide field. Such a gun commander should have the technical qualifications of a battery commander in the selection of positions, rapid reconnaissance, swift computation of firing data and skill in the

conduct of the unit at a rapid gait over broken terrain. He has the intense satisfaction of having a command that is his very own during the period of its employment. His is the honor to respond to an emergency call. At that time he will probably go with no slow, measured gait; he must gain his position swiftly. The dash of the cavalry must be exhibited as he manœuvres from place to place; the skill of the sharpshooter must be applied in immediately spotting and hitting his target; the judgment and technic of the artilleryman must appear as he selects his position, computes firing data, determines his fuze and projectile and issues his firing commands. Tactical initiative is truly his at times, though he be but a subaltern.

In the case of a prepared assault, when Lieutenant A with an accompanying gun is directed by his battery commander to report to Colonel B commanding the Blank Regiment of Infantry at such a place and at such an hour, for duty with the Infantry, all the responsibilities of command come into play so far as Lieutenant A is concerned. It is assumed that his captain (Captain C) has foreseen such a possibility and that everything has been previously prepared. Lieutenant A knows which section is to be assigned to him and he has often commanded it at manœuvres. Captain C has designated certain men belonging to the battery headquarters who are to accompany the detached section and has assigned an extra caisson to Lieutenant A's command which is all organized so far as personnel and matériel are concerned. Lieutenant A immediately acquires all the information necessary to find his way promptly to Colonel B's headquarters, and if wire or wireless communication can be had, reports at once to Colonel B for orders as to where to conduct the artillery section. Lieutenant A should see that the men have not less than three days' rations of some kind with them, has them fill their canteens, checks up personal equipment if there be time (especially gas masks), inspects his animals and their equipment, carries forage for them wherever it can be packed, sees that he has the ammunition desired—principally shell with some gas and shrapnel—and then advises his small command of the destination and expected duty and moves out.

When Lieutenant A reports at Colonel B's headquarters, it is expected that Colonel B will tell him that Major D commands his assaulting battalion and that Lieutenant A will come under Major D's orders at once. Lieutenant A reports, if possible, by telephone to Major D, getting information as to where to have his section report. Lieutenant A then joins Major D to receive his orders as to his disposition prior to the assault and also at H hour, and to learn as much as possible about the details of the formal attack. If Lieutenant A has the time and opportunity he should accomplish all possible in the way of a preliminary reconnaissance with his special

detail and chief of section. It is quite probable that in order to save time Lieutenant A will never report in person to the infantry regimental headquarters, but will proceed direct to Major D.

Cases occurred in France where the commander of the accompanying gun reported with his section to infantry regimental headquarters and was held there until the tactical developments indicated the need for his use on the front line. This is essentially wrong in principle. The function of the accompanying gun is primarily one of emergency. It must be near at hand to seize the golden opportunity. Its place is to coöperate with the assaulting battalion by fire action *at the earliest instant needed*.*

Let us go back to Lieutenant A. He has made himself as familiar as possible with the situation and the orders relating thereto. He reassures himself by inspection as to the condition of his command and arranges, if possible, locally for forage and ration supply, and also for his resupply of ammunition.

When H hour arrives, he should be with Major D and have his detachment under near cover, and suitable liaison with them established. From this time on battle tactics apply.

The watchful activity of the accompanying gun has been compared to a cat which is seeking to capture a mouse (the individual target of the enemy to be attacked), which in turn is being preyed upon by a dog (the enemy's artillery or other weapons). The accompanying gun therefore keeps under cover as much as possible, moves from mask to mask swiftly as it proceeds by bounds behind the steady advance of the assaulting lines, and, when it does come into action, fairly pounces upon its target with a deluge of accurately directed fire. As soon as it accomplishes the necessary destruction, it hides at once from its adversary to proceed by bounds once more under cover.

Our infantry line progresses steadily at first, but before long something happens. Major D may see that one of his companies has slowed up its advance. Perhaps he gets a message from Captain E, commanding this company, to the effect that a hostile machine-gun nest and some advanced single pieces of artillery are holding him up; that the auxiliary weapons on the line are insufficient to smother this hostile fire; that if the machine-gun nest at Brown's Farm is destroyed he can advance. Major D feels that the moment has arrived to use the assistance that Lieutenant A can give. The chance is at least good that the acompanying gun can put out the machine-gun nest before the enemy advanced pieces can destroy

* In this discussion "the assaulting battalion" is frequently referred to. Where the infantry regiment attacks with two battalions in the front line, it is quite probable that an accompanying gun will be assigned to each battalion. In such case the same principles apply.

Lieutenant A's command. To Lieutenant A he gives the simple order, "Destroy the hostile machine-gun nest near Brown's Farm." Here is where our infantry commanders have sometimes failed. They have felt the burden of the presence of the accompanying gun as an additional unit because they have attempted to order the position that the accompanying gun should take up, the manner of going into it and even the type of projectile to be used. These are fundamentally matters of artillery technic. Designation of the objective in the mission is the duty of the infantry battalion commander; the manner of the destruction of the target is wholly an artillery affair.

It may happen that the major is unable to designate the objective, but does know that part of his line is being severely punished by machine-gun fire, we will assume. In this case it is quite proper for him to order Lieutenant A to discover by reconnaissance the source of this hostile fire and to silence it. Major D can use his accompanying gun with little worry to himself if he will remember to give it a mission, and entrust the details of execution to his artillery subordinate.

The case may come up where Lieutenant A has left Major D in order to conduct the fire of his piece. Here, particularly, Lieutenant A is expected to exercise initiative and judgment. Let us assume that he is fortunate enough to destroy the target assigned, but another one is discovered. His own infantry line is not moving forward as rapidly as it should. He knows that they are in trouble. In such a case his duty is plain. He does not seek further orders of Major D; instead, he pounces on the new target.

In observing the handling of accompanying guns, it has been noted that there is a tendency for them to lag. A gun is assigned a target, successfully destroys it, and then turns to the attack of other targets. Here is where the initiative and judgment of Lieutenant A again comes into play. The key for his own action must be his own infantry. The moment they advance at a normal rate he knows that for a time, at least, they are able to continue on their mission. The emergency has probably ceased. Lieutenant A must therefore seek to gain cover with his gun and be ready to quickly make his next bound forward to remain in close touch with his advancing infantry. But the artilleryman sometimes makes a mistake at this point. After destroying the targets which have held up his infantry, in the keenness of the game he seeks other targets to destroy and fails to observe the advance of his own infantry. They get too far ahead, and although he has been doing effective work, he is left in a position unable to answer the later emergency call of the infantry.

And so the battle proceeds. If the enemy be using an elastic

scheme of defense, there will be no early closing with him in a wall of defense; and when he does stop and stand effectively, he will hold off by fire, as a general rule, our own troops at a considerable distance, until they can be re-formed and a penetration effected by some formal attack. When our infantry advance ceases, the rule is always applied of immediately attacking by gun fire those minor local elements which are discovered and which at the time seem to be effecting the most harm.

The idea should not be gained that the accompanying gun is reserved for use until our infantry is locally stopped in its advance. On the contrary, it is there to see that the infantry is not stopped. As soon as the infantry is threatened with stoppage the accompanying gun is brought into play, if possible, to prevent it. For that reason, the rôle played by Lieutenant A is a most difficult one. He should be near Major D to get orders first hand and to be aware of Major D's orders as they are issued to his various units; yet Lieutenant A must conduct his own constant reconnaissance of the front in order to be aware of the conditions there; moreover, his desire too is to remain near his gun so that he can conduct the fire thereof at the earliest moment.

The tactical handling of the accompanying gun in a counterattack must be considered, since it is quite possible that the stoppage of our infantry will invite a local counter-offensive on the part of the enemy. In this case, the target of the accompanying gun automatically becomes that feature of the enemy's line which is doing, or threatens to do, the greatest damage to our own infantry. This will very likely become the enemy's infantry which will issue from cover in waves of thin lines. If our divisional artillery is alert, and has maintained forward observers with the advance, they will be prompt in seeing the situation and lending their aid by centring a storm of bursting artillery projectiles on the advancing hostile lines. Here, again, is an opportunity for the accompanying gun to shine. It is nearest of all the artillery, its observation is probably the best, its liaison and interior communication should be the promptest and the surest. It is in a position to accurately observe those surges forward in the advancing hostile infantry line which threaten first to reach our defense. These particular tongues are selected as targets. In the normal case they may be expected to be several in number and not located directly in front of our accompanying gun. This is a great advantage to the defense because it offers a murderous opportunity for Lieutenant A to employ diagonal fire on an animate target of relatively great depth, with shrapnel fired at a short range, where the beaten area is of extensive dimensions.

The movement forward in the prepared assault has been discussed as well as conditions relating to the counter-attack. In the

reconnoitre the accompanying gun may also be properly used. In such a case it is quite probable that it may be quickly detached (perhaps according to a prearranged understanding) during the advance guard action. The principles of its use do not differ essentially from those in the prepared assault. In the rencontre there will be less opportunity for reconnaissance, but the situations permitting of bold, aggressive action should be more numerous.

While the accompanying gun never seeks exposure and neither attempts foolhardy nor spectacular plays, and is successfully operated best by stealthy moves forward, still it must be prepared to act in the boldest and most aggressive manner that the situation demands. Battles are won by taking proper chances; so local success is also developed. In the attack, Lieutenant A carries a slogan in his heart: "Our infantry *must* advance: my duty is to give swift assistance to insure it." In meeting the counter-attack it is: "The enemy *must* be stopped: my duty is to effect it." Ever must he be ready boldly to take his punishment when it comes, in the knowledge that before he is crushed, he will have been able by his technical and tactical skill to have effected more damage than he has received, and that he has justified his existence before paying the price. Under these conditions only will our infantry recognize that the accompanying gun is a valuable aid; under these conditions only will the gun commander feel that his duty is well done.

In the handling of the accompanying gun, next most important to the lieutenant in command is the chief of section. The latter must be a man of great ability for his station, capable of performing the same duties as the lieutenant in case this officer becomes a casualty. This means that he must be a true leader, capable of computation of firing data, and having an unusually good knowledge of artillery technic. The battery commander must, therefore, be willing to give up his best section for this duty and this unit must be made to feel that selection for this hazardous enterprise is one of the highest military honors that can fall upon it.

It seems that there are conditions of weather in which the accompanying gun can be operated to peculiar advantage, especially in the element of local surprise atacks; *e.g.*, during heavy rains and during snowstorms. In such cases the divisional artillery will be under a serious handicap due to difficulty of observation, and it must be assumed that field artillery fire will be observed always when there is any possibility of effecting it. The smaller artillery front line unit will be at an advantage too in obtaining concealment at short ranges during bad weather.

Conclusion: To be effective, the accompanying gun must be a highly trained unit, capable of swift manœuvre. Its commander must be an officer of superior ability. In the advance the gun finds

its rôle in destroying those targets that delay the progress of our infantry, seeking to put them out of action before our line is actually stopped; in the enemy counter-attack it aids in preventing the hostile lines reaching our own. Though stealthy in advance by bounds, when placed in action it operates with speed, boldness and aggressiveness to deluge its target with a crushing fire. Effective coöperation and coördination with the infantry will require much training with them. The ideal tactical situation is found when the gun, gun commander and infantry commander are in close proximity, and this condition should be maintained as closely as probable manœuvre and other existing features will permit; if this situation be not reasonably well maintained, then the gun will encounter the same difficulties of liaison as the divisional artillery meets, and it will fail in its mission.

DISCUSSION OF THE TESTS RELATING TO THE TACTICAL AND TECHNICAL USE OF THE ACCOMPANYING GUN AS MADE BY OUR ARMY IN FRANCE

From the reports published, it appears that in the series of problems the infantry was deployed and advanced as in battle supported by the artillery. The assaulting battalion had an accompanying gun attached; the infantry regiment was further supported by the divisional artillery in position, batteries of which had previously registered on some point of the terrain prior to the designation of the target. Usual liaison was maintained. A message was originated from the infantry front lines indicating that they had been stopped and that their auxiliary weapons were insufficient to reduce the target and they requested assistance. Umpires were present to see that battle conditions were observed. The test became a comparative one as to whether a battery of the divisional artillery or the accompanying gun could destroy the target first after the infantry line requested assistance.

The targets were separate for the two units firing, but sufficiently close to each other to make the situations practically identical; furthermore, the targets were arranged, each in three separate sections, so that it would probably take three separate hits to put each target out of action—this was to eliminate unusual effect by chance shots. Firing was continued until all of each target was knocked down. Percussion shrapnel was used so that the chance hits of shell fragments would not enter as a disturbing factor.

There was no way in these tests to represent such a variable element as the effect of the enemy's fire; it might have been allpowerful

or nil. As the report reads: "This particular element has been eliminated with the result that the supporting battery has not had to contend with frequent, or even occasional destruction of communications, as often occurs in battle; its liaison has, therefore, been supernormal. The accompanying gun has had the same advantage in respect to lines of communication, but, owing to its close liaison if well placed, the destruction of its lines by enemy fire would be a matter of less moment."

Averaging and comparing the data resulting from the various problems brings out the following interesting points:

1. Gun commanders chose and used indirect laying in 80 per cent. of the cases.

2. The supporting battery had twice as many failures as the accompanying gun.

3. The battery used, on an average, more than four times as much ammunition as the accompanying gun to accomplish the same mission. (The averages were 76 and 18 rounds, respectively.)

4. The time from the origin of the message in the front line to the actual destruction of the target was 31 per cent. longer for the battery than for the gun, although the time to get the message from the front line to the first shot from both battery and gun averaged very much the same.

5. The actual time consumed in firing is very much less for the accompanying gun than for the battery, due to better observation, shorter time of flight, and fewer number of pieces firing.

There is not space here to discuss the various problems. As a matter of interest, some of the data relating to one of the most successful ones from the standpoint of the accompanying gun (Problem No. 5) is presented herewith.

Targets: Machine Guns.

Accompanying Gun used direct fire.

Battery of divisional artillery used indirect fire.

10:03:15—Infantry line held up by fire from machine-gun nest; position located.

10:08:00—Message sent from front line company commander by runner, giving location of the machine-gun nest.

10:10:00—Message received at the Battalion P.C.

10:11:50—Message transmitted to infantry regimental P.C. and to the gun commander.

Times of receipt of request for fire.

Gun: 10:11:50.

Bat.: 10:12:20.

Times of opening fire:

Gun: 10:20:00.
Bat.: 10:13:30.
Elapsed time to open fire:
Gun: 8 min. 10 sec.
Bat.: 1 min. 10 sec.
Time of completion of fire (targets destroyed):
Gun: 10:21:00.
Bat.: 10:30:00. (Target *not* destroyed.)
Elapsed time of firing:
Gun: 1 min.
Bat.: 16 min. and 30 sec.—when firing was ordered stopped as target had not been destroyed.
Salvos or volleys fired:
Gun: 5.
Bat.: 31.
Ammunition expended—rounds.
Gun: 5.
Bat.: 122.
Adjusted ranges—metres:
Gun: 900.
Bat.: 2500–2600.
(Percussion shrapnel used in lieu of shell.)
Salvos with which first effect was obtained:
(Number of rounds.)
Gun: 3.
(3).
Bat.: Never.

The greatest fault to find with this problem from the standpoint of the accompanying gun is that it took 8 minutes and 10 seconds for the gun to commence firing after its commander received orders to go into action. This time included identifying the target and moving the gun into a suitable place from which it could open direct fire. As a matter of fact the time was reported as being really very fast under the circumstances. All the advantages of communication were with the supporting battery which had perfect wire service, the lines for which were paid out into the original infantry position and a forward observer was utilized. As the advance of the infantry continued an artillery liaison officer and detail worked with forward infantry elements. "Visibility was poor, due to fog and rain." This fact gave a great technical advantage to the supporting battery since direct firing with a non-telescopic sight at such a range with low visibility made a difficult problem for the accompanying gun. Again, the supporting battery had the advantage not only of being already in position, but had actually already also registered on

another target in the same sector of fire. In battle, one of the greatest difficulties is to maintain a long wire line laid along the ground. Shell fragments and other missiles break it constantly. The supporting battery in this case was not subjected to these disadvantages. Its wire communication was permitted to remain in perfect order. On the other hand, the accompanying gun used sight defilade. It would have been spotted by its flashes very soon by the enemy; its protection would have been its rapid demolition of the target and running the gun back quickly under cover into the ravine from which it had gone into action. It could not have remained long where it was.

The experiments showed the difficulties of finding suitable positions from which to fire over a mask at the shorter ranges. "A battery seen is a battery lost" had been preached so much that it must have had its influence in causing the gun commanders to seek a masked position for firing in the majority of cases. Another recurring situation seems to have had its influence too. The guns were hidden behind masks and their advance was by rapid bounds. The natural tendency when waiting under cover behind some mask is to try to use that mask to cover the firing position in case the gun receives an order to go into battery at once.

REMARKS

Perhaps one of the greatest qualifications of a successful accompanying gun commander is that he be a good emergency engineer. In the case of a prepared assault from an occupied position, it is very probable that the first real problem of Lieutenant A is to secure prompt passage for his command across the trenches that have just been occupied. In this case he must arrange to have proper material on hand to effect this. He must be able to tell at a glance the best and quickest way to effect the passage of streams, ravines and other obstacles; whether to unhitch the animals and to manhandle the piece; whether to make use of prolonges; or, whether to cut away earth to quickly form a ramp.

It may be set down as an axiom, that, to perform the work expected of him, an accompanying gun commander must have a thorough knowledge of infantry minor tactics. He must know what manœuvres to expect from given formations. He must be able to recognize at once whether an infantry line is wavering in its advance, and if he believes that the time has come for him to act, it is his duty to notify the commander of the assault battalion (if with him) that there is a proper target at hand. In these days when divisions are serving together, the accompanying gun commanders should be selected from each battery to drill and manœuvre with the infantry battalion and to make the intimate acquaintance of the battalion

commander to whom Lieutenant A is likely to report in an emergency. The proper coördinated tactical use of the accompanying gun with the infantry is an art in itself; it can only be learned in time of peace by extensive training.

It is believed that enough has been set forth herein to indicate that there is a field for development of better and systematic training of our younger officers in battle initiative. It appears the proper place to extend this is in the technical schools of our branch by the use of applied problems. These problems should be executed in combination with highly trained infantry. But these problems should have a far more reaching effect than merely training the individual—they should become the basis of our tactical doctrine in its application to the accompanying gun.

In view of the fact that a battery loses 25 per cent. of its fire power by detaching from it an accompanying gun, the suggestion has been made that a special battery should be maintained as a part of brigade headquarters, having sufficient overhead so that all of its guns might be simultaneously detached for duty as accompanying guns. This battery would form a reserve battery for special missions also, and, if needed, might be used for immediate replacements of men and matériel for the regiments. But this is a matter of reorganization. This paper is intended to meet the situations that are sure to confront us under existing conditions, and the point suggested is therefore dismissed at this time.

GENERAL CONCLUSIONS

It is an error to assume that our battle experience with accompanying guns has been sufficient to warrant the dictum that they are wrong in principle and that the duty designed for them can be performed by another unit. Moreover, the other unit may have particular work of a very different nature to carry on. The inexperience of so many accompanying gun commanders in this particular duty performed in France should cause us to hesitate before condemning the accompanying gun as a tactical entity on their verdict as to its possibilities in action.

At present the Field Artillery must be prepared to furnish accompanying guns whenever demanded and they must be operated with a high degree of skill or they are liable to failure. Even after the armament of the infantry howitzer company is possibly changed, the accompanying gun furnished by the artillery will still have a tactical place which may, sometimes, due to the local features or weather conditions prove of superior importance.

The recent war has fully demonstrated the urgent need of our field artillery being in intimate tactical manœuvre harmony with the infantry. The accompanying gun is the lowest unit which coöperates

directly with the infantry. It affords a superior means of training our younger officers in esprit, technic, manœuvre ability, infantry coördination and initiative. Through it we gain the fundamental professional intimacy which must permeate the infantry and field artillery for successful coöperation.

Advantages of the accompanying gun have been demonstrated by its close liaison with the infantry permitting a rapid and accurate designation of targets; observer close to the gun, rendering adjustment easy; short range giving small probable vertical error and quicker and more demoralizing effect on the enemy; moral support to our own infantry due to proximity and close liaison. Where the accompanying gun has been successful in battle, the resulting confidence of the infantry in its own artillery has been so marked as to materially raise the infantry morale.

Reasonable tests have shown that when infantry is stopped by hostile local fire the swiftest way to overcome the enemy is by the accompanying gun. When time becomes the dominant factor in the determination of the loss of man power and the inability or ability to advance, whatever means can furnish relief most swiftly to the harassed infantry becomes an imperative necessity.

Therefore we must accept the accompanying gun as a battle expectation, train for its skilled use, teach our younger officers to glory in being assigned to such a command, and, incidentally thus train them to be material for battery commanders of initiative, familiar with the needs of our infantry and imbued with the necessity for true aggressiveness in the handling of their commands in battle.

ARTILLERY DEVELOPMENT IN THE GREAT WAR*

BY LIEUTENANT GENERAL SIR NOEL BIRCH, K.C.M.G., C.B., COLONEL COMMANDANT, ROYAL ARTILLERY

[EDITOR'S NOTE.—*It should be noted, in connection with the following article, that the British Field Artillery Brigade corresponds to our Battalion. A British battery is commanded by a major, with a captain as second in command, and the brigade by a lieutenant colonel*.]

"FOUR years of scientific warfare have seen a consistent and progressive development in the power and influence of artillery, both in the actual fighting battle and in all the stages which lead up to it. Despite the handicap under which we started the war, British artillery has played a large part in that development, and of late has dominated the enemy's artillery to an ever-increasing degree. The influence of this fact upon the morale, both of our own and the enemy's troops, could scarcely be exaggerated."—Extract from the Dispatch from the Field Marshal, Commanding-in-Chief, British Armies in France, dated the 21st of December, 1918.

Volumes might be written on the subject of this article, but the time is not yet ripe. We are too near the events of the Great War to see them as our descendants will see them, without prejudice and with fuller knowledge of the facts as a whole.

I shall not refer to demands for artillery matériel previous to 1916, but propose to give, first, the reasons which prompted Field Marshal Lord Haig to ask for so many guns, and some idea of the work he required them to carry out; secondly, to describe the organization and the staff machinery set up to handle the enormous mass of artillery which came into being over and above the amount allotted to divisions; and thirdly, to state briefly the innovations introduced and the scientific progress made by the British artillery during the war.

I

THE NECESSARY ARTILLERY AND ITS RÔLE

Guns and ammunition cannot be made in a day. Before construction can begin, jigs[1] and gauges have to be manufactured and machinery either made or adapted for the purpose, and this takes a

* Reprint from *The Army Quarterly* (London, England), October, 1920.

1 A jig is an appliance to hold the work and guide the tool, or tools, in repetition work, so as to ensure that all parts machined on the same jig are interchangeable.

long time. Other points concerning manufacture which are not always appreciated by the layman are that the adoption of any technical improvement, either in the construction of the gun or of the ammunition, immediately reduces total output for a considerable period, and that when a new gun or howitzer has been made, it has to go through extended firing tests, and, in most cases, travelling trials, before it is fit to take the field. The history of this war proves as former wars have often proved, that improvised artillery matériel is the reverse of satisfactory.

The British Artillery owes a great deal to Major General Sir Stanley von Donop. It was due to his foresight and initiative that the 9.2″ Mark I. Howitzer was introduced, probably the best and most reliable weapon the British put into the field, and the only modern heavy howitzer available at the outbreak of war. It was in 1908 that he first began advocating the use of the heavy howitzer in the field, and in July, 1914, the first 9.2″ Mark I. Howitzer, designed and constructed under von Donop's guidance, passed its test. This weapon gave comparatively little trouble in the shops, which cannot be said of some of its more hastily designed brothers.

In 1916, when the Field Marshal submitted a fresh programme of construction, orders for artillery matériel which had been given in July, 1915, were nearly completed. As at that date the early delivery of more guns and ammunition was a matter of vital importance, in view of the fact that the British line was being lengthened and new troops were arriving in France, he selected the latest "Marks" of existing models, adopting this policy in order to facilitate construction and to ensure uniformity in design. The elimination of a variety of existing natures of guns was not therefore immediately practicable.

In submitting his programme, however, the Field Marshal insisted that every endeavor should be made as time went on to increase the range and accuracy of our guns, and that there should be no cessation of research and no finality of design. But in 1916 quality had to give way to quantity.

The two main principles on which the construction programme was based were as follows:

1. Having ascertained from the best information available the number of guns per division in the German Army and the increase the enemy was aiming at, to ask for such a number as would give the British a decisive fighting superiority.

2. Heavy guns only to be used for work that heavy howitzers could not do.

The preference for the howitzer over the gun caused a certain amount of criticism at the time, some of it uninstructed and some

hardly to be called disinterested, but the reasons for laying down the second principle were both clear and sound.

The "life" of the howitzer—that is to say the number of rounds that can be fired from it before it becomes unserviceable from wear—is far longer than that of a gun. For example:

The 6″ Gun, Mark VII., has an average life of 1500 rounds.

The 6″ Howitzer, 26 cwt., has an average life of 10,000 rounds.

The 9.2″ Gun, Mark X., has an average life of 500 rounds.

The 9.2″ Howitzer, Mark I., has an average life of 7000 rounds.

As every weapon had to go back to England to be relined and generally renovated, it is obvious that the second principle was not only sound, but necessary from a manufacturing point of view. This, however, was by no means the only reason. The howitzer is much easier to place in position in the field. Many can be sited in a comparatively limited area owing to the high line of departure of the shell, and the problem of crest clearance is rarely met with.

Howitzers have less range than guns of a similar shell power, but are more mobile, and, when fired at horizontal targets their accuracy is, generally speaking, greater.

The continuous artillery battle which began on the Somme and culminated as it did in the defeat of the enemy's guns (vide Field Marshal Lord Haig's Dispatch of the 10th of April, 1919) would have been impossible if the proportion of medium and heavy howitzers to heavy guns had not been large. His demand worked out to be 70 per cent. howitzers and 30 per cent. guns, but these proportions were never quite reached, owing to the delay in the delivery of the heavy guns. This delay was no fault of the Ministry of Munitions, as gun plant had to be diverted after orders had been placed for the manufacture of the anti-submarine guns for merchantmen.

There were 486 guns and howitzers in the original Expeditionary Force, 24 of which were of medium calibre, and on the day of the Armistice there were less than 6437 guns and howitzers of all natures in France (exclusive of anti-aircraft artillery and mortars), of which 2211 were medium and heavy artillery. This number was below Lord Haig's original demand, but it must be remembered that the Ministry of Munitions was obliged to supply other theatres and other nations with artillery matériel; and further, that in the last year of the war men were not available to man more guns.

The work which Lord Haig required his artillery to perform was, briefly, to destroy the enemy and to protect his own armies. Various kinds of fire were made use of in attempting to attain this high ideal. To dominate the enemy's artillery continuous counter-battery work was employed. The "barrage" covered our infantry in the attack. Harassing fire by day and night did much to make the enemy's roads

and paths difficult to use, and often delayed and even stopped the bringing up of his rations. How science and experience helped to develop these and other methods of fire will be told later.

II

ORGANIZATION AND STAFF MACHINERY

It will be plain to any student of war tactics that, other things being equal, the commander who can rapidly concentrate masses of artillery when and where he chooses has a great advantage over the adversary who is unable to do so. Napoleon taught Europe that artillery should be employed in masses in order to prepare for decisive action. The victories of Friedland, Austerlitz and Wagram can be largely ascribed to his having observed this cardinal principle, which means concentration at the right time and at the decisive point.

To make quick concentration possible artillery organization must be elastic. This primary condition can only be fulfilled if the minimum number of guns required form an integral part of the unit organization.

It will be convenient to discuss the organization of the field artillery and of the heavy artillery in France separately.

It is clear that if all the field artillery belongs organically to divisions, reinforcement cannot be effected unless all or some of the guns are taken from one division to support another: the divisional organization is then dislocated and may remain so for a considerable time. In offence or active defence the infantry of a division tires and must be relieved earlier than the artillery. Therefore, during active operations on a large scale and under conditions such as obtained in France, the guns soon become separated from the rest of the division, and to bring them together again is a tedious process. Divisional artilleries are continually on the move to rejoin their formations and, in doing so, much gun-power and tractive energy are wasted. Serious administrative troubles also arise.

Our available resources in 1916 would not admit of the creation of a considerable number of fresh artillery brigades, and it thus became necessary to reduce the divisional artillery from three brigades to two, and to form a fluid reserve by organizing independent Army Field Artillery Brigades. This introduction was a success from a tactical point of view, and, although it did not entirely do away with the difficulties referred to above, there was much less separation. Moreover, reinforcement was easier and more economical.

It was originally intended that these army brigades should be grouped together, either two or three brigades forming a group. It was felt that they would be better cared for if they had a colonel

and staff to attend to their immediate wants, and to represent their case when work was too prolonged or too severe. Neither officers nor men could, however, be spared to form these group headquarters, so the project had to be dropped.

Generally speaking, the army brigade was nearer to the enemy than the heavy artillery brigade, and it certainly had a rougher time; otherwise, as will be shown, the army field artillery was similarly situated to the heavy artillery as regards administration.

To turn to the heavy artillery organization; the circumstances here were different. When Field Marshal Lord Haig succeeded to the command of the Armies in France the number of heavy batteries was not great, and the few that were in the country had only recently been organized into independent groups. No heavy artillery was permanently allotted to formations.

To obtain the necessary elasticity at the commencement of Lord Haig's tenure of comand, single batteries were moved from place to place; as soon as it became feasible the brigade system was reintroduced and the artillery brigade became the highest permanent group in the heavy artillery. Heavy artillery of all natures and army field artillery brigades were allotted to armies, and by them distributed to corps in accordance with the tactical requirements. The corps commander fought and administered his heavy artillery and army field artillery brigades. He was enabled to use his discretion as to the temporary attachment of any of these units to divisions as the situation demanded.

Organization in war depends on the possibilities of command and administration. These possibilities are limited by the capacity of one man's brain, the facilities for communication and the degree of movement that is going on. The more mobile the fighting, the fewer will be the units that can be controlled by one commander, and the greater will be the difficulty of communicating orders.

In large wars, unless the machinery of the staffs of the higher formations is so devised that the artillery apportioned to these formations can be conveniently absorbed and effectively directed, history teaches us that grand artillery tactics fail.

The following quotation from Lord Haig's Dispatch, dated the 21st of March, 1919, shows how this axiom was fulfilled:

> "In order to gain the elasticity essential to the quick concentration of guns at the decisive point, to enable the best use to be made of them and to facilitate ammunition supply and fire control, Artillery Commanders acting under Army and Corps Commanders were introduced and Staffs provided for them. This enabled the large concentration

of guns required for offensives to be quickly absorbed and efficiently directed."

Each corps commander was also provided with a brigadier general and staff to command his heavy artillery. This officer was under the direct orders of the G.O.C. of the artillery of the corps In fine, both army and corps commanders were given an instrument which they could employ as and when they liked to handle their artillery concentrations, and to be technically responsible for the efficiency of the arm.

It is an historical fact that the artillery commander always crops up in war, where artillery is, comparatively speaking, plentiful and well handled. Queen Elizabeth had her artillery commanders (these fortunate gentlemen had certain perquisites in the way of church bells after successful sieges);[2] Marlborough had his artillery train commander; Napoleon's first command of importance was that of the whole of the Jacobinic artillery in 1783, while in the following year he was appointed "General in command of the artillery of the Army of Italy," which Masséna commanded. At Friedland, where artillery played so large a part, Senarmont commanded Napoleon's guns. Alexander Dickson was Wellington's gunner, but the part played by the artillery in the Peninsular War is singularly neglected by the historian Napier.

The poor results obtained by the artillery of both sides in the 1866 campaign may be traced to the want of efficient artillery control and direction. At the battle of Konigratz, half the mass of the First Army reserve artillery did not fire a single shot.

There are, however, a few soldiers who to this day think there should be no artillery commanders in war, and some of them may have formed their opinions from the teachings of the Great German General Staff. The Germans had no permanent artillery staffs for higher formation up to the day of the Armistice. Why was this? It was failure to draw the correct lessons from history, and the conservatism and vanity of their General Staff, who were lovers of centralization—usually the negation of efficient organization. These

2 Extract from an Ordinance issued by Queen Elizabeth under her Sign-Manual: "Item—As a Town is won, whether it be by assault, per force, subtile practice, or by any other manner given up, be it Town, Castle, Pile, Church, or Bastile, or Fortress, the Chief Master of the Artillery or his Lieutenant, shall ordain that the Master-Gunners and their companies shall have the best bell within that place so won, or the church wardens shall appoint or compound with the Great Master or the Artillery and his Counsel. And that he be reported by the Provost of the Artillery, and given knowledge to the Lords and Rulers of that place so won with the Commons of the same, what that the Master of the Artillery, is Counsel, and the Master-Gunners and their Companies have determined and ordeyned by a convenable and reasonable estimation, to see and know if the Lords and Commons will hold the ordenance and appointment made."

gentlemen were too vain to learn lessons from their enemies even in the pitiless school of war.

It has already been stated that there was no artillery staff machinery for higher formations in the German Army in the campaign of 1866, but before the war of 1870 began the Germans appointed corps artillery commanders. The results were not satisfactory from the point of view of organization and command, although the early entry of artillery into action (Worth) and the large concentrations of guns (St. Privat and Sedan) were successfully achieved. The system lacked elasticity. The position of the regimental colonel who became the commanding officer of the corps field artillery on mobilization left much to be desired. He commanded the corps artillery, and not the artillery of the corps. The German regulations laid down that when more than half the batteries in the corps came into action the commander of the corps artillery assumed command of the whole of the field artillery in the corps. The guiding principles of higher artillery control were neglected, especially the need of decentralization in moving warfare.

After the Franco-German War the Germans, instead of moulding their organization and artillery command so as to get the best value out of their guns, deliberately destroyed the poor machinery then in existence.

As far as our own original little Expeditionary Force was concerned, it only possessed six 60-pounder batteries, in addition to the divisional artilleries, and the question of higher artillery command did not arise.

When the artillery staff organization was set up the success of this wise measure of decentralization was made certain by the close and willing coöperation of the whole British Service.

III

SCIENTIFIC PROGRESS

It is common knowledge that, after the fighting of the autumn of 1914, the Germans were in possession of practically all the high ground of the northern part of the Allied battle front, and therefore of the observation. This very much increased the difficulties of the British gunner. The Flying Corps and the Survey Sections came to his help; without them he would have often shot "blind."

Before this war but little shooting practice took place at night, and the serious effect of a change in meteorological conditions on the range was not fully appreciated by the regimental officer of the Field Army. A careful study of the weather, however, enabled corrections to be made in the range. Tables were supplied to battery

officers giving the necessary alterations. It may not be generally known that a gun of large calibre will sometimes vary in range by 100 yards in twenty-four hours, owing to changes of weather.

Science was also called in to ensure the correct height of burst of the shrapnel shell. The barometer and thermometer became indispensable artillery stores. For night firing electric lights were supplied for the aiming posts to make certain of the gun being on the correct line, and electric torches were supplied for gun pits.

Accuracy of fire was still further ensured to the field artillery by the establishment of calibration sections. By firing through screens the exact initial velocity of each gun was ascertained, and compensation could be given on the sights which insured the uniform shooting of every gun in the battery.

The Survey Sections supplied the artillery with excellent maps which were compiled with care and accuracy, and mounted on specially prepared boards in order to facilitate "map shooting"; further, the Survey Sections resected all batteries' positions.

The culminating result of this scientific progress was that in the Cambrai attack of November, 1917, registration was dispensed with, and surprise, so far as artillery action was concerned, was made easy. At the battle of Amiens on the 8th of August, 1918, in which over 2000 British guns were employed, practically all of them opened destructive fire from their attack positions for the first time on the actual morning of the assault.

Though observation was carried out from the ground whenever practicable, the Air Force became to a great extent the real "eyes" of the artillery, and not merely the eyes, but also the scouts, the detectives and the tale bearers of bad shooting. By means of the aërial photograph camouflaged German batteries, new works, roads and paths were discovered, and accuracy of fire assured. It was useless for a battery commander to say that his guns were calibrated and clean and the ammunition properly cared for, when the tell-tale photograph showed a bad "pattern."

Not only was observation from the air accurate when stationary objects were engaged, but special progress was made in the art of engaging moving targets.

Counter-battery work, so little thought of before the war, and which, according to Ludendorff, caused the Germans much loss and great anxiety, became an exact science through the development of air photography, aërial observation, sound-ranging, flash-spotting and air-burst ranging. In every gunner office in our Armies in France sat a reconnaissance officer, whose duty it was to keep track of each German gun and to bring to notice the slightest

alteration in the terrain on his immediate front, which was constantly photographed.

As to improvemrents in artillery design, long-range modern 6″, 8″, 9.2″ and 12″ howitzers were introduced, and also the following guns:

6″ Mark XIX. on a field carriage, the 9.2″ Mark XIII., the 12″ and 14″ on railway mountings.

G.H.Q. wished the split-trail system to be gradually adopted for all light and medium natures of artillery, but this did not materialize for several reasons, two of them being that with the high rate of ammunition expenditure (it reached over twenty-three thousand tons in one day in the war), alteration in design was not easy, and that daily throughout the war the man-power problem became more difficult.

Among other improvements and innovations were the instantaneous fuze No. 106, smoke shell, gas shell, shell with large calibre head radius (long pointed shells), stream line shells, improved incendiary shells and star shells.

IV

CONCLUSION

There are people who think that wars are things of the past; we all hope so. There are others who think that tanks and aeroplanes will compose the fighting forces of the future, and that any guns not used in these machines should be relegated to the museums. A design of a shellproof tank has not yet materialized, owing to the immense weight of the armour which would be required for its protection, and until this problem is solved tanks will be largely dependent on artillery protection. The analogy of a battle of tanks with a naval battle is a bad one, especially if aërial or submarine attack be left out of account. Ships have only to reckon with guns fired from other ships, unless the fighting takes place within range of shore guns; whereas, operating as they do on dry land, tanks must always be exposed to the fire of batteries, which are mobile and usually concealed.

Of the future no one can talk with certainty, but of recent history we know something, and it is worth noting that the officers and men of the Tank Corps were the first to admit, on the evening of the 8th of August, 1918, that it was due to the supremacy of the British Artillery that their course had been an easy one that morning. Here is what the Field Marshal says on the subject in his Dispatch, dated the 10th of April, 1919:

> "As an instance of the interdependence of artillery and tanks we may take the action fought east of Amiens on the 8th of August, 1918, and following days. A very large number of tanks were employed in these operations, and they carried out their tasks in the most brilliant manner. Yet a scrutiny of the artillery ammunition returns for this period discloses the fact that in no action of similar dimensions had the expenditure of ammunition been so great."

And what good would the artillery have been on the 8th of August, without stout infantry to hold the ground which tanks, aeroplanes, cavalry and guns has assisted them to win?

In the autumn of 1918, when the enemy was in full retreat, large masses of artillery were still employed; on the 1st of November, 1918, the fine Canadian infantry attacked south of Valenciennes, supported by guns and howitzers to the number of one to a little over every two yards of the front of attack, a large proportion of the barrage being in enfilade. This was a higher percentage of guns to infantry than had ever been reached throughout the war.

So much for recent history; what mechanical improvements the future will bring no one can foretell, but they will probably be greater than most of us think. Those who are still interested in the artillery service will, however, be well advised to go forward with experiment and research, and to lay their plans for a quick and larger output of the latest patterns in the event of trouble. The gun-howitzer seems to be the weapon of the future; that is to say, a weapon longer than a howitzer but shorter than a gun, with some of the advantages of both. In future wars an enormous increase in the number of aeroplanes employed in bombing and shooting the troops on the ground must be anticipated. All artillery weapons, or nearly all, should be able, therefore, to put up an air barrage, and construction must allow for a very high-angle of elevation. All such weapons also must be capable of quick and wide traverse in order that aeroplanes and tanks can be early engaged. Here the split trail comes in. A tank travelling at the rate of twenty miles an hour should not be a difficult target for the gunner, if he is supplied with an up-to-date weapon.

Space forbids me to mention the many other directions in which improvements can be sought.

Work and foresight will, however, be of no avail unless the fighting men again display that indomitable courage and power of endurance without which no great war can be won. Let me take two examples from among many of what happened before a mastery over the enemy's artillery and aircraft was obtained. Here is an extract from the official report of a certain artillery brigade during a

period in the line in France. Probably no other brigade had a worse period, or even as bad a one:

> "The whole area was almost continuously under shellfire, and the enemy's artillery fired hundreds of rounds daily on the batteries, endeavoring to silence them. By night he made use of great quantities of gas-shell, using for the first time mustard gas. Although he was successful in knocking out during this period an average of three guns and one howitzer daily, and causing casualties to the number of 50 officers and 452 men, the tasks ordered were invariably carried out."

Another report on a battery reads as follows:

> "The battery was allotted the task of wire cutting from —— to ——, it had already received much attention from German heavy howitzers.
>
> "It was estimated that 400 rounds would be required to clear the wire, and deliberate fire was commenced. After some 50 rounds had been fired a 15-cm. howitzer battery, firing in enfilade, opened a steady and very accurate fire on the position. Each time the British battery opened fire salvoes of 15 cm. commenced, and four guns out of six were put out of action and two ammunition dumps exploded. The remaining two guns continued to fire until 400 rounds were expended; subsequent examination after the advance showed that the wire was completely cut."

Needless to say, the gallantry displayed by all ranks of the artillery did not pass unnoticed. The gunner yields to none in his admiration of the bravery of other arms, but, as this article deals with artillery, no excuse is needed for quoting the following extract from a Special Order of the Day, issued by Lord Haig on the 9th of October, 1917:

> "In preparing the way for the infantry, supporting their advance, and covering them against counter-attacks, the skill and endurance displayed by the Royal Artillery have never been surpassed, if ever equalled, in the annals of warfare. Though the nature of their duties has allowed them no rest, they have risen superior to every trial. Without their splendid devotion to duty the great successes gained would not have been possible."

THE PRINCIPLES OF BILATERAL OBSERVATION

BY MAJOR EDMUND L. GRUBER, FIELD ARTILLERY, U.S. ARMY.

IN an article "The Principles of Lateral Observation" (FIELD ARTILLERY JOURNAL, January-March, 1919) I discussed the mathematical principles upon which the observation and conduct of fire by a single lateral observer are based, and at the same time determined a convenient and rapid method of calculating the factors which, being within acceptable limits of accuracy, permitted the use of this method in operations when map data are not available, or when the operations involved in the graphical method are impracticable.

The object of this paper is to investigate in the same manner the mathematical principles upon which are based the observation and conduct of fire with two lateral observers, commonly called bilateral observation.

In figure 1, let P be the position of the piece, B the adjusting point of the target, O_1 and O_2 the positions of the two lateral observers, and S the mean point of burst of a group of shots.

Then PB = R = the correct range.

To simplify the mathematical investigation, the following initial assumptions are made: first, that the observing angles PBO_1 and PBO_2 are equal; second, that the observing distances O_1B and O_2B are equal to the range PB = R. Later, after the equations have been deduced, it will be shown what deviation from these assumed conditions is permissible without appreciable prejudice to the practical accuracy of the results.

Using the well established nomenclature, we have:

$\omega_1 = \underline{/BO_1S}$ = observed deviation of the shot S in mils at O_1

$\omega_2 = \underline{/BO_2S}$ = observed deviation of the shot S in mils at O_2

$\phi = \underline{/BPS}$ = deflection change to be made at the piece to bring the next group of shots on the line PB.

$i = \underline{/PBO_1} = PBO_2$ = observing angles for observers at O_1 and O_2.

At B draw BM $\perp$ to O_1B; BN $\perp$ to O_2B; BR $\perp$ to PB. Since

the angles ω_1, ω_2, and ø are small, the lines O_1B and O_1S, O_2B and O_2S, PB and PS may be considered parallel to each other and therefore the perpendiculars erected at B to the lines O_1B, O_2B and PB will also be perpendicular to their respective parallel line.

Let BS = X and the angle PBS = α; also RS = F = difference between the

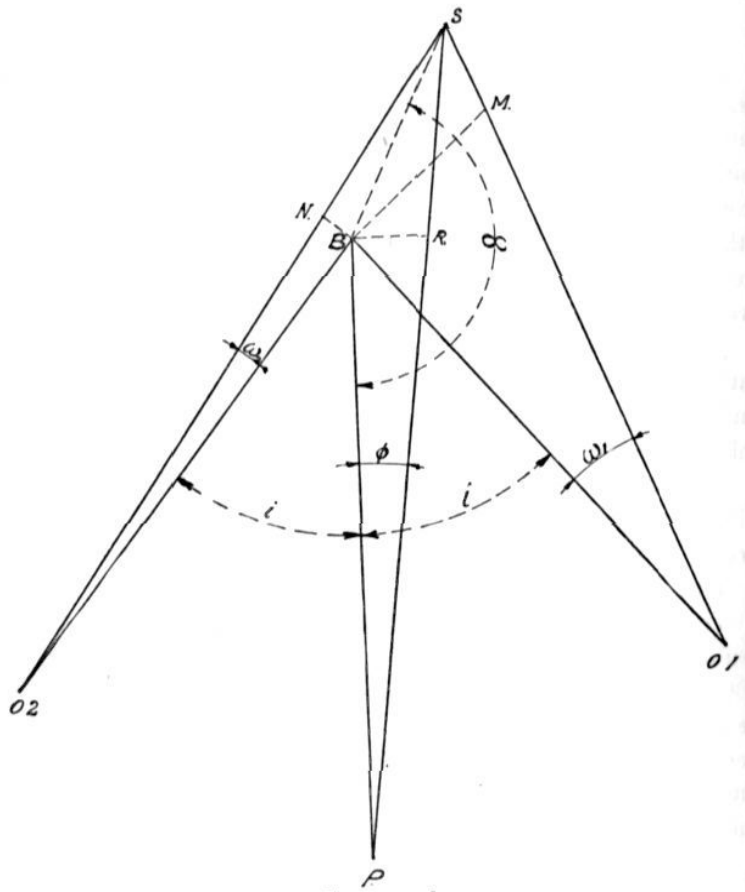


Figure 1

range of the target and the range of the mean point of burst S; in other words, the range change.

$$\text{Now (Fig. 1) } BM = X \cdot \cos \underline{/SBM}$$

$$= X \cdot \sin(\pi/2 - \underline{/SBM}) \qquad (1)$$

$$\underline{/SBM} = \underline{/PBS} - \underline{/PBO_1} - \underline{/MBO_1}$$

$$= \alpha - i - \pi/2$$

Substituting in (1) for /SBM, we have

$$BM = X \cdot \sin(\pi - \alpha + i)$$
$$= X \cdot \sin(\alpha - i) \quad (2)$$

Also, $BN = X \cdot \cos \underline{/SBN} = X \cdot \sin(\pi/2 - \underline{/SBN})$ (3)

$$\underline{/SBN} = 360^\circ - \underline{/PBS} - \underline{/PBO_2} - \underline{/NBO_2}$$
$$= 2\pi - \alpha - i - \pi/2$$
$$= 3/2\pi - (\alpha + i)$$

Substituting in (3) for /SBN, we have

$$BN = X. \sin(\alpha + i - \pi)$$
$$= -X. \sin(\alpha + i) \quad (4)$$

It will be seen (Fig. 1) that

$$\omega_1 = \frac{BM}{R/1000} \text{ and } \omega_2 = \frac{BN}{R/1000} \quad (5)$$

Substituting in (5) for BM and BN, we have

$$\omega_1 + \omega_2 = \frac{BM + BN}{R/1000} = \frac{X}{R/1000} [\sin(\alpha - i) - \sin(\alpha + i)]$$
$$= \frac{2X}{R/1000} (-\cos\alpha \cdot \sin i)$$
$$\therefore -\cos\alpha = \frac{R/1000}{/2X \sin i} (\omega_1 + \omega_2) \quad (6)$$

$$\omega_1 - \omega_2 = \frac{BM - BN}{R/1000} = \frac{X}{R/1000} [\sin(\alpha - i) + \sin(\alpha + i)]$$
$$= \frac{2X}{R/1000} (-\sin\alpha \cdot \cos i)$$
$$\therefore \sin\alpha = \frac{R/1000}{2X \cdot \cos i} (\omega_1 - \omega_2) \quad (7)$$

Now in Fig. 1, $\text{ø} = \frac{BR}{R/1000}$ (8)

Also $BR = X. \cos(\alpha - \pi/2)$
$= X. \sin\alpha$

Substituting for BR in (8) we have

$$\text{ø} = \frac{X \cdot \sin\alpha}{R/1000} \quad (9)$$

Substituting for sin α, its value found in (7), we have

$$\text{ø} = \frac{\omega_1 + \omega_2}{2 \cos \cdot i} = \frac{\omega_1 + \omega_2}{2} \cdot \frac{1}{\cos i} \quad (10)$$

which expresses the relation between the observed deviations ω_1 and ω_2, and the deflection change ø to be made at the piece to bring the next group of shots on the line PB.

With our sights, a shot is moved from right to left as the deflection is increased. A shot to the right (left) of the line PB will therefore call for a positive (negative) correction. ø will be positive if

$\omega_1 > \omega_2$ or if ω_1 is positive and ω_2 is negative. ø will be negative if $\omega_1 < \omega_2$ or if ω_1 is negative and ω_2 positive. An inspection of Fig. 2 will show in what sign the angles should be read; the right observer reports observed deviations to the right (left) of the line O_1B as positive (negative); the left observer reports deviations to the left (right) of the line O_2B as positive

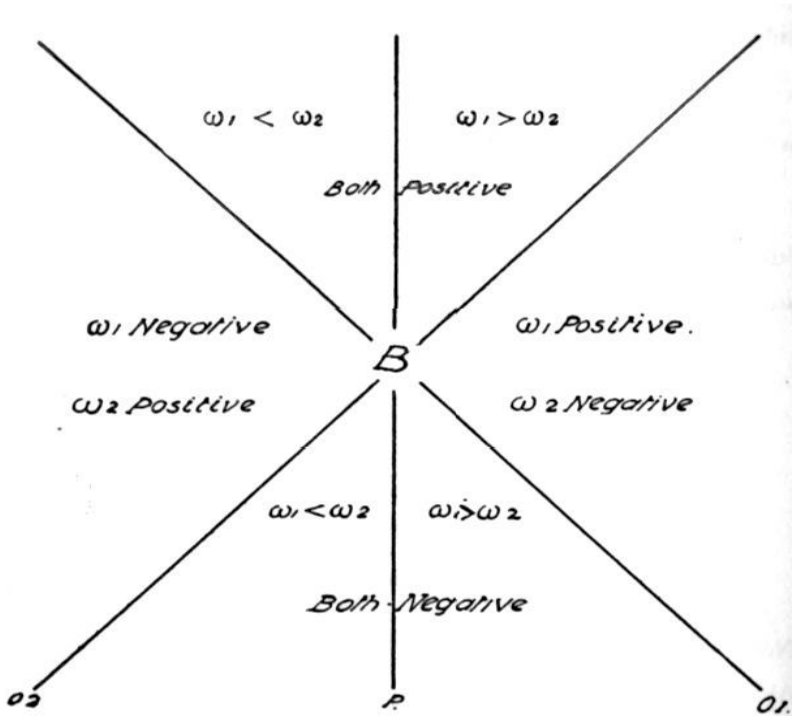


Figure 2

(negative). The rule therefore is: From the deviation reported by the right observer subtract algebraically the deviation reported by the left observer; divide this by 2. cos i. Compare this with the rule given in paragraph 446, *Artillery Firing*.

Considering now the range from Fig. 1, we have

$$RS = F = X \cdot \sin \underline{/RBS}$$
$$\text{But } \underline{/RBS} = \alpha - 90^\circ = \alpha - \pi/2$$
$$\therefore F = X \cdot \sin(\alpha - \pi/2) = -X \cdot \cos\alpha$$

Substituting for $-\cos\alpha$, its value found in (5), we have

$$F = \frac{\text{¦ø} + \text{¦ø}}{2} \quad \frac{R}{\sin i/1000} = \frac{\text{¦ø} + \text{¦ø}}{2} \quad \frac{R}{i} \qquad (11)$$

in which i is expressed in mils and R in yards, metres or quadrant elevation. The corresponding change in range will be in the same unit.

These equations (10) and (11) are the basic equations governing bilateral observation and their practical application will now be discussed.

Considering equation (10), when $\frac{1}{\cos i}$ is approximately unity, *i.e.*, when the observing angle i is small, we have $\text{ø} = \frac{\text{¦Ø}+\text{¦Ø}}{2}$. The value $\frac{i}{\cos i}$ for different angles of observation from o to 1600 mils are:

Angle i in m	Value $\frac{i}{\cos i}$	Difference
0	1.00	.– –
100	1.01	.01
200	1.02	.01
300	1.05	.03
400	1.09	.04
500	1.14	.05
600	1.21	.07
700	1.30	.09
800	1.41	.11
900	1.58	.17
1000	1.80	.22
1100	2.13	.33
1200	2.63	.50
1300	3.45	.82
1400	5.13	1.68
1500	10.20	5.07
1600	∞	∞

It will be seen that the value of $\frac{i}{\cos i}$ is approximately unity for observing angles up to 400 m, and its value is less than 1.4 for angles up to 800 m. No great error will therefore be made in taking $\text{ø} = \frac{\text{¦Ø}+\text{¦Ø}}{2}$ for observing angles up to 800 m. For observing angles between 800 m and 1200 m, the average value of $\frac{i}{\cos i}$ is 2 and equation (10) thus reduces to $\text{ø} = \omega_1 - \omega_2$.

Between 1200 and 1400 m, the average value of $\frac{i}{\cos i}$ is approximately 4 and equation (10) reduces to $\text{ø} = 2\ (\omega_1 - \omega_2)$. Between

1400 and 1600 m, the value of $\frac{i}{\cos i}$ changes so rapidly that its exact value would have to be taken. But angles of observation over 1400 m may well be eliminated because they give very poor intersections and consequently inaccurate observation for deflection. Hence, when the observing distance is R we have the following empirical formulas:

$$\begin{array}{lll} \text{For i between 0 and 800 m,} & \text{ø} = \frac{\text{¦ø}+\text{¦ø}}{2} & \\ \text{" " " 800 " 1200 m,} & \text{ø} = \omega_1 - \omega_2 & (12) \\ \text{" " " 1200 " 1400 m,} & \text{ø} = 2\,(\omega_1 - \omega_2) & \end{array}$$

Artillery Firing, paragraph 446 gives $\text{ø} = \frac{\text{¦ø}+\text{¦ø}}{2}$, for all values of i. This is true only when i is less than 400 m and when both O.P's are symmetrically disposed with respect to the line of fire.

Considering the column of difference, up to 800 m, the value of $\frac{i}{\cos i}$ varies less than 0.1 for every 100 m. No great error will therefore be made if, within this limit, the observing angles are not exactly equal. As a practical proposition, if the observing stations are selected within the following limits, accuracy will not be sacrificed:

If the two observing angles are between	Their difference in magnitude should not exceed
0 to 600 m	400 m
200 to 800 m	300 m
500 to 1000 m	200 m
800 to 1200 m	150 m
1100 to 1400 m	100 m

The slight error due to a difference in the value of i may be compensated by taking the average of the two observing angles or $\frac{i1+i2}{2} = i$.

When the observing angles exceed 1400 m, $\frac{i}{\cos i}$ increases so rapidly and the angle of intersection of the lines of observation becomes so large that the results for deflection become inaccurate unless the observers are close to the target. The observations for range, however, will be excellent. When the observing angles exceed 1400 m it is better to make observations for deflection from another O.P. near the line of fire or preferably to use a combination of axial and unilateral observation.

Considering equation (11), the algebraic sum of the two reported deviations gives the magnitude of the range change, and is called the

index of the shot. A positive index indicates an over; a negative index, a short; a zero index indicates that the range is correct. As before the average of the two observing angles should be taken or $\frac{i1+i2}{2}$ = i, in which case equation (11) will give excellent results as to the amount of the range change.

When the observers' displacement is not known within reasonable limits, or when the difference in the observing angles exceeds the limits previously given, it is better to accept only the sense of the index that the shot is short or over.

In deducing our equations we assumed originally that the two observing angles were equal and that the O.P's were at a distance R from the target or adjusting point. Such limitations on the selection and location of O.P's are of course unacceptable, and bilateral observation could be used only infrequently if these restrictions as to location of O.P's were imposed. But as has been shown, the observing angles need not be exactly equal. Within certain limits a difference of considerable magnitude in the observing angles is permitted without introducing any inaccuracy in the practical results.

As long as these conditions in the observing angles are fulfilled, an even wider latitude is also permitted in the observing distances which need not be equal to the range PB nor be equal to each other. All we need do is to correct the observed deviation ω to correspond to the deviation as it would have been had the O.P. been on the line OB but at a distance equal to R. In other words, multiply the observed deviation ω by the factor r/R in which r is the observing distance and R is the range.

If both O.P's are at the same distance r from the target then equation (11) becomes

$$F = \frac{\frac{r}{R}(\omega_1 + \omega_2)}{2} \cdot \frac{R}{i} = \frac{\omega_1 + \omega_2}{2} \cdot \frac{R}{i} \cdot \frac{r}{R}$$

$$= \frac{\omega_1 + \omega_2}{2} \cdot \frac{r}{i} \qquad (13)$$

If the two observing distances are not equal and the smaller of the two is not less than half the greater, *i.e.*, if $r_1 \not> 2r_2$ or *vice versa*, no appreciable error will be introduced by taking $r = \frac{r1+r2}{2}$, and equations (12) for ø may be written:

$$\text{For i between 0 and 800 m,} \quad \phi = \frac{\omega_1 + \omega_2}{2} \cdot \frac{r}{R}$$

$$\text{" " " 800 " 1200 m,} \quad \phi = (\omega_1 - \omega_2) \cdot \frac{r}{R} \qquad (14)$$

$$\text{" " " 1200 " 1400 m,} \quad \phi = 2(\omega_1 - \omega_2) \cdot \frac{r}{R}$$

In *Artillery Firing* (par. 443) percussion precision adjustment is recommended in case of the graphical method of bilateral observation, and (par. 447) a bracket adjustment in case of the index method. In other words, when the graphical method is used, the fire is improved by starting with a trial elevation which is the mean of two verified elevations differing by one fork, whereas when the index method is used a bracket of two verified elevations differing by two forks is first obtained (or only one fork if the objective has little depth and is clearly visible) to be immediately followed by zone fire for effect.

The reason for this difference in the method of adjustment is due to the deficiency in the index method as given in (par. 446) *Artillery Firing*. The rule there stated gives $ø = \frac{\omega_1 - \omega_2}{2}$ and $F = \frac{¦ø + ¦ø}{2}$ whereas we have shown above that their values should be as given in equations (13) and (14).

If the values of ø and F as given by the latter equations are taken, the depth of the zone to be covered in fire for effect can be reduced and the methods of percussion precision adjustment applied as in the graphical method.

In this connection it is important to keep two facts in mind: first, observations and sensings based on a single shot are unreliable; therefore always base the corrections on the mean of two or more shots fired with the same elevation and deflection. Second, as the distance between the range centre of a group of shots and the target diminishes, the more unreliable will be the sensings for an exact range; therefore, as the bracket becomes smaller, it is necessary to base its limits upon the observation and sensing of a greater number of shots.

These two facts can be easily shown by a study of probabilities. As an example, let us assume that the range centre is over, in the first case a distance equal to one probable error, and in the second, a distance equal to twice the probable error. What is the probability of firing at an ineffective range if we had based our observations on the sensing of a single round short in each case. The law of single events applies. The probability that the range centre is short, is in the first case .16 + .07 + .02 = .25 or ¼, and in the second case .07 + .02 = .09 or 1/10. We would therefore have been in error in spite of a correct sensing of a single shot, one time out of four in the first case and only one time out of ten in the second.

Now let us take two observed shots. The sensing may be.

(a) Both over;

(b) One over and one short;

(c) Both short.

If the outcome had been (a) or (b), the range would not have been misjudged, because in neither case would the range have been sensed short, but had (c) been the outcome we again would have been in error. Applying the law of compound events to (c), the probability that the range centre is short, is ¼ × ¼ = 1/16 in the first case and 1/10 × 1/10 = 1/100 in the second. If the range centre had been at the target, then the probability of the sensings being correct for range would have been ½ × ½ = ¼. In other words, we would have been in error in spite of correct sensings, one time out of 16 in the first case (range centre one probable error over), only one time out of 100 in the second case (range centre two probable errors over), but one time out of 4 in the third case (range centre at the target).

To summarize:

1. Select an O.P. on each side of the line of fire.

2. Symmetrical disposition of the O.P.'s while desirable is not absolutely necessary as long as the difference in the observing angles and in observing distances does not exceed the following limits:

(a) Observing angles between	Difference not to exceed
0 and 600 m	400 m
200 and 800 m	300 m
500 and 1000 m	200 m
800 and 1200 m	150 m
1100 and 1400 m	100 m

(b) The smaller observing distance should not be less than half the greater.

3. When the observing angles are greater than 1400 m, the results of observation for deflection becomes inaccurate unless the observers are close to the target. In this case observations for deflection should be made from an O.P. near the line of fire.

4. The deflection correction is:

For i between 0 and 800 m $\quad \phi = \frac{\phi_1 + \phi_2}{2} \cdot \frac{r}{R}$

" " " 800 " 1200 m $\quad \phi = (\omega_1 - \omega_2) \cdot \frac{r}{R}$

" " " 1200 " 1400 m $\quad \phi = 2\,(\omega_1 - \omega_2) \cdot \frac{r}{R}$

in which $r = \frac{r1 + r2}{2}$.

5. The range correction is:

$$F = \frac{\phi_1 + \phi_2}{2} \cdot \frac{r}{i}$$

in which $i = \frac{i1 + i2}{2}$ and $r = \frac{r1 + r2}{2}$

6. The algebraic sum of the two deviations ω_1 and ω_2 is called the *index* of the shot. A positive index means that the shot is over, a negative index that it is short.

7. Do not make corrections based on the observation of a single shot but take the mean deviation of a group of shots.

8. The smaller the bracket the greater the number of sensings necessary to verify the limits of the bracket or to get an adjusted elevation.

NOTES ON ARTILLERY FIRE*

BY GENERAL DEDIEU-ANGLADE
CORPS ARTILLERY COMMANDER OF THE 16TH CORPS
Translated from the French by Captain P. C. Harper, 18th F. A.

IN a remarkable work which appeared before the war, Colonel (since made general) Rouquerol showed that French artillerymen had made a great mistake in not making use of mass effects in 1870. He urged an organization of the command of artillery with a view to the realization of these effects in the future. Was his advice followed?

It is sufficient to go to the environs of Metz, and to visit the regions of Morhange and les Etangs and to review the battle of August 18 to 20, 1914, fought forty-four years after by the second French Army, in order to reply "No."

Following this, during four years of conflict, there could be seen in a given sector great numbers of guns firing at the same time. Some executed fire of destruction to open the path of the infantry; others destroyed or neutralized batteries; others executed fire of interdiction, harassing fire, sweeping fire, put down gas concentrations, and so forth. Lots of noise and lots of ammunition expended, but little or no mass effect because all the guns spread their fire in space and even in time.

Mass effects, that is the sudden and adjusted concentration of a mass of trajectories on well-selected objectives, were realized by some groupings. They were always very successful but they were due to individual initiative.

The conditions indispensable for executing these effects of mass are:

(a) A suitable organization of the artillery command;

(b) Matériel adapted to manœuvre by fire;

(c) Proper methods of fire and conduct of fire.

(a) ORGANIZATION OF THE COMMAND

In order not to go beyond the experience of the writer, no higher echelon than the Army Corps will be considered. Has the Corps conducted artillery fire? Is it organized for this duty?

Before the war the rôle of Corps Artillery Commander was gradually being pushed into the background. The latest practice gave him the duties of a technical adviser and especially of a supply officer. It is true that there remained under his orders a regiment of field

* Translation of an article in the Revue D'Artillerie March, 1921.

artillery of four battalions but after the first battles this regiment was cut in two and assigned to the infantry divisions. The colonel and lieutenant-colonel often remained without commands. The general of artillery does not even seem to have been always consulted about this distribution. The decentralization in the interest of the Infantry Division was then complete. It goes without saying that this period did not develop mass effects. It could not produce them.

This evil continued to make trouble during the remainder of the year 1914 and during the entire campaign of 1915. The heavy artillery, already important, although created out of all calibres, would have been able to produce mass effects but, placed exclusively under the orders of the army, its power was dissipated. It remained too distant, notably on the 9th of May in Artois and on the 25th of September in the Champagne. Not until 1917 was a reorganization of the artillery command effected. The infantry divisions then had their divisional artillery staffs organized with sufficient personnel and their matériel reinforced with modern heavy guns. On the contrary, the commander of the corps heavy artillery, a position already created in 1916, remained merely commander of a regiment equipped chiefly with Bange matériel. The artillerymen of the future will avoid this duty because it is of minor importance.

As for the Corps Artillery Commander, always a technical adviser and supply officer, he was assigned, on paper, the duty of coördinating the employment of all the artillery. The fact was, however, that under the pretext of "counter-battery," he was limited to the duties of first colonel of the corps regiment. He had returned to him, then, his peace time regiment armed with larger but less modern guns, as a rule. Not until 1918, in fact, do we find that the Heavy Corps Artillery organizations were given a group of 105's, while many still kept their old long 155's, Model '77. The reorganization was made above all for the advantage of the Infantry Divisions; the decentralization, not to say the dissolution, of the corps artillery was only more accentuated by it.

The result was that up to the armistice the battle was conducted almost entirely by the divisions. It was no more possible to get mass effects than in 1914.

The organization showed other faults. We shall confine ourselves to discussing those illustrated by the following facts:

In March, 1918, four divisions of one of our most celebrated corps held the front from the Mort Homme to the Fort de Vaux (Verdun). Each division had a group of 155 Short Schneiders, that is, 48 guns in all for the corps. From the 11th to the 21st of March the enemy pounded one of these divisions. The only support it had were the guns of the Heavy Corps Artillery while the modern

heavy guns of the neighboring divisions remained silent. Because of the extended front it would have been necessary to withdraw the guns of the other divisions momentarily to install them in the sector that was being attacked. Not having authority to order this removal the corps was obliged to turn to the army for the help it should have been able to do without.

Many times in May, June, September and October, 1918, we have seen the Corps Artillery command order general concentrations of five minutes on nests of batteries or works directly opposed to the infantry, but it was too often found that important units of the divisional artillery had some excellent reason for failing to comply, such as reliefs, interior work and so forth.

In the course of the pursuit of 1918, when the enemy no longer opposed us with anything but machine-guns, we have seen the corps order the heavy guns of its organization to stop, but the divisions did not use these march tactics. This resulted in bottlings which delayed the march of the infantry in a very unfortunate way. In brief, the army corps gave up its organic artillery while the divisions would not part with theirs.

These are the facts and all discussions about the character of individuals will change nothing. If war breaks out tomorrow the same mistakes will recur. As in 1870 and in 1914 the faults of the peace organization will greatly handicap the putting into action of the artillery.

(b) THE MATÉRIEL

Concentrations are impossible without matériels having volume of discharge, endurance, sufficient range, large fields of fire.

As a result of not believing in the tactics of great defilade and having held that one tool could be used for every purpose, the artillerymen of 1914 experienced the great surprise of finding their 75 too short. Even when pushed up to the infantry firing line this gun is incapable of mass effects on the front of an army corps. This became more apparent when, after the first battle, it was found necessary to install it, whether or no, behind covering masses and masques, the depth of which often absorbed the power considered as normal by its designers (maximum efficiency at 2500 metres).

The Bange matériel, which constituted our principal heavy artillery up to 1917, possessed the endurance but did not have the volume of discharge nor the flexibility in battery which is indispensable to manœuvre by fire. At the end of the campaign our long-range artillery was neither sufficiently numerous nor did it have enough endurance.

(c) METHODS OF FIRE AND CONDUCT OF FIRE

The pre-war doctrine, "Neither instruments nor formulas," could not produce effects of mass or surprise. These effects have only become possible since the day that artillerymen, thanks to instruments and formulas, have been able to do away with adjustment. This progress is perhaps the most considerable brought about by the war. Combined with the long ranges which are thus made possible to use, it is destined to revolutionize the tactics of yesterday.

The Long Ranges

The control of the sea is an important triumph; it cannot be called sufficient, however, for if we had been beaten at the Marne it would not have been played. The indispensable control will be that of the air in the future. In this new kind of struggle our groups of squadrons will demand the support of the guns on the ground. It is by effects of mass, by instantaneous and sustained concentrations that the latter will have to operate. Will victory in the air give the decision? It is possible.

Nevertheless, for long years to come we must expect battles on the ground and the artillery will play an even more important rôle in them than in the past. "More range" was the cry of the survivors of 1870 and with those of 1918 it is "still more range." Moreover, to destroy the present guns of the enemy, we are obliged to alter ours to increase their range. The enemy has shown us well enough that he understands the importance of range and that he is seeking still greater range. We shall be forced to surpass him in this particular.

The Big Berthas have shown us that the paradox of yesterday is the actuality of today. Great range does not require a matériel too heavy to be of practical use in war. Did the Germans have pieces easier to supply, better adapted for accompanying the infantry, more mobile in fact than the Berthas. Supplied with ammunition right up to their platforms by the existing roads, they could support attacks as far as Paris without displacement. Without going too far we must admit that the usual ranges of tomorrow will be at least 15 to 20 kilometres. What will become, with such matériel, of divisional and corps organization? Are we going to continue to burden the divisions with eight or ten kilometres of artillery carriages, in order that the corps organization shall have nothing but the left-overs. Prudence demands that we avoid such mistakes.

During the critical hours of 1918, which guns contributed most toward saving the delicate situations. Was not the new skeleton formed with long guns, regrouped in great haste? How much more easily and promptly could these regroupings have been made if the

corps artillery had been more powerfully organized and armed not only with long guns, but also with an adequate air force? There is no room for doubt that these guns will open the firing, will form the "umbrella of fire" advocated by some people before the war, and will permit the infantry divisions to get into action. The latter, being light above all things, and armed with accompanying artillery, should and will then consolidate the success.

Tactics of Fire

Whether the battle takes place in the air or on the ground the dominant idea should be to secure mass effects in the minimum of time.

Attack.—The obstacles to the advance of our infantry are:

The hostile artillery;

The hostile machine-guns.

With artillery really adapted to mass effects, fire should be successively delivered with all the artillery of the corps, including the divisional artillery:

1. On the hostile artillery;
2. For the immediate support of the infantry.

To strike the two objectives at the same time is to practice dispersion.

Defense.—Everything should be done to prevent the hostile infantry from progressing. All the guns in the corps should concentrate against this infantry, necessarily neglecting the other objectives. If the accuracy of our information permits us to turn momentarily from the infantry to attack, for example, the artillery, the mass of all the guns should be employed in this shift of objective. Here again, attempting to do two things at once must be avoided.

Counter-battery

Few people believe in its effectiveness.

We have mentioned above the defects in the organization of the grouping charged with this mission—command subordinated, matériel unsuited for a mission calling for the most modern weapons. It might be said in reply that the counter-battery missions were entrusted to the commander of all the artillery in the corps and that the criticism of the organization of the command is uncalled for.

We have seen corps artillery commanders, closely following the regulations, hold their heavy artillery command close to their P. C., sometimes 20 kilometres from the front. It goes without saying that under these conditions counter-battery work is either slow or untimely, generally ineffectual. The corps artillery commander cannot be a grouping commander, an executive in the true sense of the

word. The commander of the corps heavy artillery should be up with the P. C.'s of the divisional artillery commanders. When it is a question of a mass effect against the hostile artillery he takes charge of the operation, assigning to the divisions their share of the work. In turn he receives from the latter the program for the work in immediate support of the infantry.

An artillery duel is a more delicate matter than the destruction of a trench. Even before the war it was considered uncertain. The authors of the regulations of September 8, 1910, in order not to admit their inability, declared that the hostile batteries would not be more than 200 metres from the crest and so solved the problem by zone fire. Up till 1916 hardly any other form of fire was used. Then came the period of fire of precision. Then batteries were destroyed; slow battles above all mechanical battles; the destroyed guns were soon replaced.

Fire of neutralization followed fire of precision. We pretended to neutralize, with one section of old 120's for instance, one or more enemy batteries, such as batteries of 210 mortars.

The truth is that we have not been willing to pay the price. It is necessary to strengthen the grouping assigned to the corps and not hesitate to reinforce it with all the divisional artillery; in other words, to operate by mass effects. We can prove by experience that the application of these principles has always resulted successfully. It must be added that an artillery battle is indecisive in itself. It is only undertaken with a view to immediate exploitation by the infantry. Counter-battery work is only complete after the capture of the enemy's guns. This point has been too often lost sight of in fixing the objectives of attacks.

Liaison

What has liaison to do with mass effects?

In March of 1908 I was called to Clermont by General Percin to coördinate a battery of artillery with a company of infantry. I can remember the controversies of that period. After six years of efforts on the drill grounds and at manœuvres I did not cease during the entire war to seek a solution of that problem, whether as commander of 75-mm, regiments or as commander of Heavy Artillery.

I have decided that the liaison of accompanying guns cannot win the battle. The infantryman who receives machine-gun bullets would have been glad to see his artillery immediately annihilate the hostile machine-gun, but he was always unable to locate it. Liaison has broken down and will break down again, not so much because of the means employed as because of the impossibility of locating and observing the target.

On the other hand, under the pretext of liaison, there occurs a deplorable breaking up and separation of artillery units. After the war, during manœuvres, there will be no hesitancy about taking a battalion away from a colonel of artillery and giving it to a colonel of infantry or even to a major of infantry. The latter demands the momentary formation of anomalous groups composed of field guns, mortars and long guns putting the artillery battalion commanders out of a job. They thus attempt to oppose not only the machine-guns but also the artillery of the enemy.

Of course close liaison is indispensable. It is very necessary that the infantrymen and artillerymen know each other intimately, but for the purpose of avoiding such errors as the above and to be able to put into practice mass effects.

In support of this theory I shall cite one instance out of a thousand. Toward the end of October, 1918, a division was stopped on the Serre River before a certain bridge. Some elements had crossed the river near the bridge but could not raise their heads without being cut down by machine-guns. As the enemy's artillery was practically out of action at this time, the infantry were in perfect liaison with their accompanying group of artillery. Nevertheless, the corps commander and the general of the division were present during a whole day while fruitless attempts were made to cross the river because it was impossible to locate the machine-guns. Tiring of this, it was decided to concentrate all the divisional artillery on the bridge during the night and then the crossing was made without losses. The machine-gun emplacements had been destroyed and the gunners killed.

CONCLUSION

The doctrine of mass effects was that of Napoleon. Lost sight of by French artillerymen in 1870, it was not used as much as it should have been in the last war. The inevitable adoption of very long range matériels having great volume of discharge and methods of fire eliminating preliminary adjustment, becomes more and more apparent. Whether battles are to be fought on the ground or in the air the artillery will take part in them by means of sudden concentrations of masses of trajectories.

As in the last war, the roar of the guns will be uninterrupted but the objectives will be struck successively in the order most advantageous for infantry action.

Whether in attack or defense, it is necessary to avoid the dispersion of trajectories incident to striking several objectives simultaneously.

But to include this doctrine in the regulations will be in vain as long as the rules of artillery and the organization of its command elsewhere lead fatally to dispersion.

The corps has always easily parted with its basic regiment to the infantry divisions. It has not been able to make use, even in part, of the divisional artillery, preferring to turn to the army, though by so doing it left the divisional batteries silent.

Decentralization, *a priori*, in the interest of the divisions will be more fatal still with the long ranges of the future.

Besides, if the divisions are burdened with eight or ten kilometres of carriages they will not be any more mobile. If they become engaged without a powerful protection of fire they will only be plunder for the enemy.

The "umbrella of fire," indispensable for their deployment, should be required of the corps artillery, which should have basically the greater part of the artillery.

It is the corps which should direct the artillery combat, with the commanders of the heavy artillery and divisional artilleries as subordinates.

In order to be able to furnish immediate protection for the enormous matériel of the corps artillery and to exploit its effect immediately the divisions should be light above all things and should therefore be composed largely of infantry. It will be sufficient if the divisional artillery be composed organically of accompanying units and a staff capable of acting as under-director of the corps groupings that is, to be able to absorb for the moment the reinforcements of heavy artillery.

The doctrine which seeks mass effects does not exclude liaison between the arms. On the contrary, it makes liaison possible by only demanding of it what it can give. This doctrine guards against the breaking up of the artillery resulting from a "close liaison" too literally carried out, a breaking up which occurred only too often in the last war.

THE TRAINING OF ARTILLERY RADIO OPERATORS

BY MAJOR C. N. SAWYER, SIGNAL CORPS

UNLIKE the infantry, the artillery in combat divisions was alone concerned with the installation and operation of its communication system during the World War. The artillery also maintained its own signal school in France, so as a corps it has considerable experience in signal training. Previous to the war, however, radio was but little used by the artillery, and its proper place in the scheme of artillery communication was probably not thoroughly understood, even after the war had been in progress for some time. In the first place, the radio equipment furnished to artillery regiments was defective in that there was no transmitting equipment authorized, and for that matter the battalions were in the same predicament; and, in the second place, there was a lack in all the corps of well-trained message centre systems for coding and decoding messages. Through the energy of some officers, transmitting equipment was obtained for some regiments before the war was over, but that was not sufficient, for if messages were sent to the battalions by radio there was no way for the latter to answer. This equipment limitation left very little for the regimental and battalion radio sections except the work with aeroplanes and the receiving of meteorological data. That proper radio equipment with well-trained operators could have been of considerable service to the artillery is scarcely to be doubted. In several known cases two regiments were on one circuit from the brigade and the service was poor. Had there been proper radio equipment, communication might have been much better. Especially was this true when circuits were cut or when organizations had just moved into new positions and before wire communication was established. Any arm can be expected to use communication in such a manner as to get the most out of it, once they have it. This paper, therefore, is concerned with how to get good radio communication. Since efficient radio equipment has been or will be issued to artillery units, the remaining factor is the training of competent radio operators.[1]

DISTRIBUTION OF RADIO EQUIPMENT

It is proposed to furnish artillery regiments and battalions with a set for transmission and reception. It is also proposed to furnish infantry battalions with the same or a similar set. This at once

[1] See "Radio Communication for the Field Artillery" May-June, 1921. FIELD ARTILLERY JOURNAL.—Editor.

introduces a problem the artillery has not had before, that of training transmitting as well as receiving operators in their battalions. If the artillery operators only had to work among themselves it would not be difficult, but they must work with the infantry operators, so that their training must be coördinated.

The regiments will have another type of set eventually, which will work with brigades and be capable of communication with infantry regiments and brigades, if, in fact, it is not the same set.

It would seem from the experience of the past war that if infantry battalions are equipped with good radio sets, which can work with artillery battalions, that this fact may have some bearing on the question of the accompanying gun, for in the normal case either the infantry battalions or the guns if served by a radio set could move as often as they pleased and where they pleased, and not have to depend on wire communication. To be of the best service to the infantry in this particular case, and in any event, the artillery radio operators should be well trained.

DETAILS OF OPERATOR'S TRAINING

The basic ideas involved in this training should be: (*a*) To train the operator to send and receive messages at the rate of twenty words per minute. (*b*) Along with this operating training, to give the operator sufficient practical elementary electricity to enable him to connect up the batteries to his sets properly; the different types of cells and their uses and method of measuring current and voltage in radio circuits. (*c*) How to set up, tune and operate the sets issued by the Signal Corps to artillery radio sections. (*d*) To be able to handle message forms. (*e*) To work in the different types of nets. (*f*) To handle military traffic on a net composed of a particular type of set. (*g*) For selected men, the methods involved in this training.

CODE PRACTICE

Equipment for code practice has not heretofore received proper attention. If operators are trained on field service buzzers or with the little training buzzers, the former has a poor key and the latter is apt to get out of order. If two or three hours are daily devoted to code practice, and ten minutes or more is lost per hour daily because of defective equipment, the total time lost soon mounts up to a formidable figure. There are a number of small A.C. generators on the market which put out 500 to 800 cycles, and one of these can be used to generate a constant frequency which can be applied to all circuits. For beginners there should be sending and receiving practice daily in about equal amounts. Previously most army training

has developed men who can receive, but the sending training has been neglected. Good sending is just as necessary as good receiving.

Since artillery operators will work in two types of nets, two types of table nets equipment should be provided, one type having the "break-in" feature of an ordinary telegraph loop, where if any operator opens the key it opens the circuit which will provide training for the SCR-77[2] sets, and the other type of net should be so arranged that the operator has to throw a switch to go from receive to transmit, and cannot hear himself send. This is the condition which exists in the operation of the SCR-79-A or SCR-127 or 130 sets. In the latter case, if two operators on the net transmit at the same time, neither know it until it is all over. These nets laid out on tables should contain from three to six stations so arranged that operators in the same net do not sit alongside each other. Operation of sets in nets require net regulations, and tentative regulations have been adopted at the Signal Corps School pending the issuance of official regulations. Efficient radio operation is the result of painstaking attention to a number of very small details. For instance, messages for radio stations in battle are in code, hence radio operators must be trained to send and receive coded messages; this means both numerals and letters. Message centres code and decode such messages. They should go to the radio station printed legibly in capital letters, and from the receiving radio station likewise printed in legible capital letters. This requires that operators learn how to print capital letters legibly at the rate of about sixty per minute. When operators can handle about fifteen words per minute they should be given the above net regulations to study, and should begin the practice of message transmission on the table nets. The nets containing the "break-in" feature are the easier to learn, because the receiving operator can break the operator who is transmitting when the former does not get a group. Moreover, the operator can hear himself send, which is a decided advantage. In the other type of net where a switch is used, and the operator can not hear himself send, it is very necessary that the net regulations be strictly observed. One reason why preliminary training is given this way is that it is easier to supervise the operators, and they learn one thing at a time: then when they go on sets they are capable of handling traffic, and have only the set operation to master, the rest being already second nature.

Artillery brigades will find it advisable to adopt a standard word message for training and tests. Since the field codes have been of three letters in a twenty-word coded message, each group of three letters offers a suitable standard. They will also find it advisable

[2] Wherever the letters SCR-77 appear they should now be read SCR–77–A.

to specify just how the address and signature shall be coded. For instance, one method is to assign numbers to the officers at a headquarters: 1—The commanding officer; 4—the supply officer, etc. Then combine this with the call letter of the station as follows: The operations officer at 1st Brigade Headquarters, whose call letter is ZD, sends a message to the Commanding Officer 1st Artillery Regiment, whose call letter is BH, it would be coded as follows:

BH1	No. 1	14:30	FC1
BGH	NCR	LTV	ZOD
			ZD_3

and the message is sent to the ZD operator in that form, showing that the operations officer at ZD wrote message No. 1 at 14:30 addressed to the commanding officer at the station whose call letter is BH. It is also well to require all operators to copy everything they hear, enter it on their log sheets, in capital letters. Received messages for that station are entered directly on the page of the Field Message Book in capital letters and double spaced, four code groups on each alternate line.

It is possible with such a system where the equipment and methods of training are carefully laid out, and men take operating three hours a day, to produce a twenty-word operator in five months who can handle traffic on nets as follows:

SCR-77 net of two stations, 14–16 standard messages per hour.

SCR-77 net of six stations, 20–24 standard messages per hour.

SCR-79-A and 127 nets of two stations, 9–12 messages per hour.

SCR-79-A and 127 nets of six stations, 6–8 messages per hour.

In order to do this in the time specified, however, it will be necessary to hold weekly tests and post the ratings of students, and also keep accurate records of the net work. For the net work messages are prepared in advance as shown above, and distributed to each station, and at the close of the period the log sheets and all messages are collected and the errors checked up and the records posted where students can see them (see charts following). It would also seem advisable to train all radio operators in a brigade in one place at definite hours. This will insure competition, uniformity of instruction, and team-work in actual operations. Better instructors should be available there, and the whole training could be of a more efficient nature.

COMBINED MESSAGE CENTRE AND RADIO TRAINING

When a net is capable of handling six or more standard messages per hour on sets, combined message centre and radio training problems should be conducted. A tactical situation is assumed, messages,

and data tables prepared, and messages are given to the message centre for each radio station.

The message centre codes the message given it, records the time, sends it by orderly to its radio station, which transmits it, and when received it is returned to the receiving station message centre, which decodes it. The purposes involved are as follows: (*a*) It gives the net a more real traffic load; (*b*) it is a real problem, and the operators enter into the spirit of it; (*c*) they know they are being timed, which brings in a little of the excitement of the battlefield; (*d*) it checks up the legibility of both message centres and operators in writing coded messages; (*e*) practice for message centres in coding and decoding; (*f*) the assessment of errors in coding, decoding, and to the operators in transmitting and receiving; (*g*) it gives the message centre an idea of the amount of traffic a net will bear; (*h*) an idea of the time involved from the time a message is filed until it is issued to the courier service by the receiving message centre officer; (*i*) the same problem is given by the message centre to different sections of operators in different stages of training; (*j*) it gives a clear idea when used on different types of nets of the amount of traffic each kind of net should be able to handle with fairly well-trained operators; (*k*) it sets standards of training which future operating sections must come up to, at least they should come up to the average of such records (see chart on page following).

TYPES OF NETS

It will make considerable difference in the results obtained if the types of nets as well as the reasons for the methods used are explained to your operators. Technically, nets are separated on a basis of having but one type set, as a rule, in a given net, and also on the peculiarities of the sets. Tacitally, nets are divided on a basis of their operation with the various battle command posts. Since artillery and infantry operate their own communications under G.O. No. 29 W.D., May 18, 1920, this will result in purely signal corps nets, mixed signal corps and infantry and artillery nets, and nets of infantry and artillery personnel only. The division net is operated by signal corps troops at Division Headquarters, and by infantry at Infantry Brigade Headquarters, and by artillery at Artillery Brigade Headquarters. This is a combined arm net, and will usually consist of three or four stations.

The brigade net in the artillery will consist of the Brigade Headquarters set and the one at each of its two regiments, resulting in a three-station net.

The infantry brigade net will have the brigade and two regimental sets, and may either be a three-or six-station, depending on whether

MESSAGE CENTRE AND RADIO TRAFFIC STUDY CHART

BD
ORGANIZATIONS PROBLEM NO. _____ . DATE _____

						This message centres serial No.	1
						Message identification marks	2
						Time filed at message centre	3
						Time filed at radio station	4
						Encoding time at message centres	5
						Time sending started	6
						Delay time at radio station	7
						Time receipt acknowledged by receiving radio station	8
						Actual transmission time	9
						Time delivered to receiving message centre	10
						Actual time into sending radio station and out at receiving radio station	11
						Time issued from message centre to courier service	12
						Decoding time	13
						Total time filed at sending message centre to issued at receiving message centre	14

OFFICERS PREPARING THIS STUDY:

_____

_____

_____

Names
Date completed _____

NOTES:
Columns 1-5 to be filled out by this station message centre. Columns 6-9 to be obtained from log sheets of radio station by instructors. Columns 10, 12, 13 to be filled out by receiving station. Columns 11 and 14 by instructors.

the units are in a small area and must operate in a six-station net to prevent interference, or operate on a wide front, so that each brigade has its own separate net.

The regimental net in the artillery equipped with SCR-77 sets, for instance, might be composed (1) of individual nets of three stations each, or of a six-station net, depending on the distance between the regiments.

```
.....Front Line
    X          X     X    Battalions
Artillery  X
    X              X       Regiments
```

If now we add the infantry battalions we will have a distinctly artillery net.

```
.....Front Line
Infantry  O      O   O     O   Battalions
          X          X     X
Artillery      X
          X          X
```

as shown, and the four infantry stations which at times, especially for barrage calls, may enter the artillery net temporarily. If poorly trained operators are used in either net it is bound to cause confusion, which demands that all the operators be well trained. It would be well in all net problems on sets either in the training building or in the field to issue to each station at the opening of the traffic problem a statement of the assumed conditions. For instance:

Problem No. 1

Date.....

A Regimental SCR-77 Net

1. To-day the traffic problem will consist of coded messages in a regimental net composed of the regimental station and both battalion stations.

2. Call letters.

```
XA          XB
X           X
(1st Bn.)        (2nd Bn.)
      XC
      X (Regiment)
```

Operators

XA .....

XB .....

XC .....

and the following more difficult problem:

Problem No. —

Date.....

A regimental SCR-77 net, communicating with infantry battalion stations.

1. Call letters.

.....Front Line

YB O	ZH O	
(1st Bn. 1st Inf.)	(3rd Bn. 2nd Inf.)	Operators
KC X	RJ X	
(1st Bn. 1st F. A.)	(2nd Bn. 1st F. A.)	

YB .....
ZH .....
KC .....
RT .....
WF .....

WF
X
1st F. A.

2. The infantry battalion P.C.'s have moved forward, and the artillery P.C.'s have also moved forward, and have not yet established wire communication. The message traffic between the infantry and artillery battalions will be heavy. The Regimental Station will direct the operation of the net.

Another problem would be to add the other regiment and then its infantry battalions. If messages are prepared in advance, such problems cannot help but be of interest to the operators. If they are worked in conjunction with the message centres which code real messages and keep track of the time involved, it will be of interest not only to the operators, but of value to the officers, for the amount of traffic that can be handled by the operating teams determines in a large measure the uses to which it can be put. Twenty-word operators on the SCR-77 set, with one month's training in net regulations, should easily be able to handle twenty messages of twenty code words each in a four-station net, provided no relaying was required. This is at the rate of one message every six minutes.

SUMMARY

1. Code practice equipment should be of the best in order to eliminate lost time.

2. Two types of table nets should be provided, one with the "break-in" feature, where the operator hears his own key, and

one where there is a switch to be thrown when the operator goes from transmit to receive, or *vice versa,* and where the operator does not hear his own signals.

3. A definite speed should be required of radio operators, and twenty words is recommended.

4. Weekly ratings of code practice speed should be kept in all units.

5. Preferably all operators in a brigade should be trained in one school.

6. A standard message should be adopted for training and tests.

7. Brigade records should be kept of the progress in net operation, and the relative proficiency on standard messages of the several brigades determined.

8. Message centres should be trained to code addresses and signatures in a uniform manner.

9. Combined message centre and radio operating problems should be conducted.

10. The test for proficiency of the radio operators in a brigade should be the transmission of a fixed number of standard messages per hour in a three- or six-station net so far as the regiments and battalions are concerned, and of a fixed number for the brigade net composed of the brigade and regimental stations.

FIRST ARTILLERY BRIGADE

CONTINENTAL OPERATORS' SPEED RECORD. FOR WEEK ENDING _____

(SHOWING NAMES, ORGANIZATIONS AND SPEED OF THE OPERATORS.)

	Brigade	1st Reg.	1st Bn.	2d Bn.	2d Reg.	1st Bn.	2d Bn.	
25-word operators								
20-word operators								
15-word operators								
10-word operators								
5-word operators								

1ST ARTILLERY BRIGADE
CONSOLIDATED CONTINENTAL OPERATOR RECORD. FOR WEEK ENDING _____
(DATE)

Words per minute	*B	5	10	15	20	25	Total
Brigade							
1st Reg.							
1st Bn.							
2d Bn.							
2d Reg.							
1st Bn.							
2d Bn.							
Total							

*Beginners.

If all operators are tested every week with a five-minute test for sending and receiving, and the above record is compiled and posted weekly, it will mean not only competition, but it offers a method of comparison of what other Brigades are doing with their operators.

1ST ARTILLERY BRIGADE
TRAINING TABLE NET RECORD
3-STATION NET
NET NO. 1

Date																						
Hours Work'd																						
Operators		S	E	R	E	P	S	E	R	E	P	S	E	R	E	P	S	E	R	E	P	
1																						
2																						
3																						
Total																						

S—Messages Transmitted
E—Errors in Transmission
R—Messages Received
E—Errors in Messages Received
P—Errors in Procedure

1ST ARTILLERY BRIGADE
NET RECORD PROGRESS REPORT
3-STATION NET
NUMBER OF MESSAGES TRANSMITTED PER HOUR DAYS

	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	11th	12th	13th	14th	
Net No. 1														
Net No. 2														
Net No. 3														

DISCUSSIONS

Organization of the Artillery in the Army Corps[1]

BY GENERAL FARSAC, COMMANDING ARTILLERY, 18TH CORPS, FRENCH ARM.

[EDITOR'S NOTE.—*In presenting to our readers a study of this kind it must be borne in mind that while the organization of a French Army Corps may differ considerably from ours, due to local conditions, nevertheless such a study should be of interest to all field artillerymen.*]

The preponderating rôle of fire during the war of 1914-1918 has led to the conception of *manœuvre by fire* and by this term is to be understood fire, both aerial and terrestrial, of guns of all calibres and of automatic weapons.

The idea of movement is, above all else, implied by the word manœuvre.

This doctrine developed in successive instructions from G. H. Q., during the progress of the campaign and emphasized in *The Instructions on the Service of Artillery in the Field,* of June, 1919. dominates all the official precepts.

It may be stated as follows: *Employ fire by powerful and successive concentrations*.

In the field of strategy the accord between doctrine and organization is complete. The General Artillery Reserve is its fruit; its birth has been difficult, its development very slow; but carefully managed by expert hands which were guided by a tenacious will, it is now in full maturity and the solicitude with which it is surrounded proves that the hopes that were founded upon its creation have been fully realized.

The General Artillery Reserve really constitutes, in the hands of the Commanding General, a mass of fire powerful because of the number and kind of guns and endowed at the same time with a high degree of mobility, which permits him to organize and develop on the vast chess-board of the struggle operations successive

[1] It is unnecessary to observe that the ideas set forth in this paper are opposed to the precepts of the regulations on conduct of large units and on combat. But as is stated in the preface to the article appearing in the January 1920, number, the publication of an article in the *Revue d'Artillerie* does not confer on it, *ipso facto*, an official character, and the author assumes sole responsibility for his views.

The Editor proposes also in order to defend the precepts actually in force to publish promptly a reply to the article by General Farsac.

[2] Translation from the *Revue d'Artillerie,* October, 1920, by Lieutenant Colonel Edward T. Donnelly, General Staff, U. S. A.

both in time and place, but all supported by means of powerful concentrations.

In the tactical field the accord does not appear so clearly, and the application of the doctrine is more difficult principally because of a defective organization of the artillery in the corps.

The object of this article is, in the first place, to show the faults in the present organization and afterwards to suggest an organization more in harmony with the principles announced in the instructions or recent regulations.

The organic composition of the artillery in the corps is as follows:

For a division: 1 staff of divisional artillery with:

1 regiment of 75's of 4 battalions,

1 regiment of 155 howitzers of 2 battalions.

For the corps: 1 regiment of heavy guns of 4 battalions:

The proportion between the artillery of the corps proper and the divisional artillery is, therefore,

1 to 6 for a corps of 4 divisions,

1 to 4.5 for a corps of 3 divisions.

After reinforcements by units from the G. A. R. the proportion always remains on the average of one to four.

Thus, the corps, not to consider it as a simple organ of command possessing with vitality and intelligence a great capacity for absorption, but as a veritable "unit of battle," organizing and directing the manœuvre by fire, divides a minimum of three-fourths of the artillery assigned to it between the divisions and retains a maximum of one-fourth under its direct orders.

There is in this condition an anomaly which is shocking at first sight, and one is justified in asking if this distribution, *a priori,* of very powerful means of fire ought not inevitably carry with it a reversal of the rôle of command in favor of the divisions.

And first, why wish to associate organically in the unit of combat—that is, the division:

Infantry,
Light Artillery,
Heavy Howitzers?

The association of the infantry and the 75-mm. gun is a vital necessity. The infantryman and the artilleryman of the 75 have equal mobility and almost the same degree of wastage; they participate in the same incidents of the struggle, in the same emotions, if not in the same dangers, and their *liaison* will never be sufficiently close or intimate. One cannot act without the other

and they complement each other harmoniously; and for my part I consider that the question of the single arm should be subjected to a brief delay.

But if the 75-mm. gun, called, pursuant to a very happy expression, the *artillery of direct support*, ought to be an integral part of the unit of combat to the same extent as the infantry it is not the same thing with respect to the heavy howitzers.

(The question does not affect the light howitzer—105-mm., for example—which does not differ greatly from the 75 except in having a more curved trajectory.)

The mobility of the 155-mm. howitzers is very different from that of the 75 and the wastage of the personnel of a battery of heavy howitzers is less rapid than that in the *artillery of direct support*, primarily because of the difference in their missions. Furthermore, the heavy howitzer is rarely in direct and permanent *liaison* with the infantry units, and remains, in principle, grouped under the orders of the divisional artillery commander.

The more or less frequent relief of divisions which succeed one another in the same sector of the battle, involving at the same time the relief of divisional artillery commanders, and often of groups of 75's of *direct support,* does not affect it (the heavy howitzer) for a considerable time, because of its ability to remain in position longer. The organic assignment of the heavy howitzers to a division does not correspond to any necessity of command. On the contrary, it is illogical as well as opposed to the confidential instructions from G. H. Q., to attach to a unit a matériel whose radius of action extends over the front of several units of the same formation. The result in this case is always much less satisfactory than if the matériel had been assigned to the higher unit.

THE CORPS IN BATTLE

LET US NOW CONSIDER THE CORPS IN BATTLE

First—Offensive Operations.

According to present methods all the organic heavy howiters and those of reinforcement are distributed among the first line divisions in the same way as the *artillery of direct support*. Only the heavy guns remain at the disposal of the commander of the corps artillery.

The first have a mission of destruction in the zone of action assigned to each division; the second have counter-battery and distant interdiction missions over the entire front of the corps.

The operation order of the corps commander has fixed the length

and method of preparation and the successive objectives to be reached at specified times. There will probably be in this order a paragraph entitled, "Plan of Manœuvre" and condensed substantially into these terms: "The principal effort on the right" or "on the left," etc. This plan has served to determine the initial distribution of the means put at the disposal of the front line divisions; but since the "Plan of Manœuvre" is set forth on a sketch one cannot see more than a series of lines generally parallel extending themselves over the front of the corps and prolonged from one part to another on the entire extent of the zone of action of the Army.

The manœuvre resolves itself definitely into a simultaneous progression on a vast front and the necessity for alignment reigns supreme. Besides, it could not be otherwise, for with some rare exceptions the units are joined and the barrage which precedes them in their march would quickly become dangerous if they advanced by echelon.

What are the consequences? First heavy concentrations are the exception.

In principle the artillery operates by sections but with unequal density of fire. During the preparation, some unusual concentrations will be frequently foreseen, either in the zone of the divisions (assembly points in particular) or in the normal zone of the heavy artillery of the corps, but these concentrations will be effected with limited means and hardly ever outside the respective normal zones of the divisional artillery and the heavy guns.

At the moment of attack the curtain of fire envelopes the entire front of the corps and advances according to schedule. Its density will be just what is necessary, that is, rather light if the distribution of fire is manifestly regular; and in a case where the distribution would become very irregular, some serious miscalculations might be feared.

The lack of density of fire has been the cause of many failures, whether it may have been drawing out a preparation of too long duration (in the first part of the campaign) or whether through too short preparation the destruction has been too scattered and therefore ineffective. Only quite exceptionally can the effect of mass be simultaneous.

Second—The Manœuvre by Fire is Not Directed by the Corps

(*a*) The attack is launched. At the beginning the advance is effected evenly across the entire front, but presently it brings about a dislocation in the march of the units, slight waverings followed by halts.

Exact adjustment of the barrage to the requirements of the sinuous form of the curvings of the first line is impossible to realize during the progression and one encounters considerable difficulty at the moment of halt.

What would be the rôle of the corps in the face of a situation provoked by a threatening pocket, for instance, in front of a division?

It is possible to allow events to follow their own course in anticipation that the advance of the divisions on either side of the pocket will be able to break this up by the menace of encirclement. If the pocket is small and represents nothing but a little clot of isolated resistance, its presence must not, indeed, influence the harmony of the manœuvre. But in the situation which we are now considering this cannot be done. The uncovered flank of a division not halted in its progress forms a dangerous menace for which it is necessary to provide, first, because it had not been foreseen, and next, because the troops feel, in spite of everything, dependence on alignment.

It then becomes the duty of the corps commander to increase the means of fire placed at the disposal of either of the division halted before the pocket to enable it to take up its march in better condition, or of the division whose advance has been normal to provide against the flank attack which is feared and also to facilitate the continuation of the manœuvre should the general situation make it possible and necessary.

But the transfer of fire, from one division to another, in the same corps cannot be accomplished without disagreements due to the jealousy of each commander of a division of his authority over all that has been assigned to him as his own, or, in any case, cannot be made without great loss of time.

The decentralization of command in the artillery is anything but favorable to the flexibility of fire of this arm.

(*b*) Let us admit that the progress of the first line divisions is normal and is accomplished without special incidents.

An objectve is reached; before beginning again the advance a delay, longer or shorter, has been provided for to permit the units to be gotten in hand (with or without passage of lines) and sometimes also for a rough sketch of organization.

There is here a critical moment which concerns the line over its entire extent because all its elements find themselves in the same situation, that is to say, a condition of instability more or less precarious.

Over a distance of 6 to 8 kilometres—one can say with even

greater exactness over the entire front of the army—there is no unit really firm and capable of an efficacious resistance. A counter-attack supported by a violent concentration of fire and directed against a part of this unsettled line, of which no part is yet firm, could force the recoil of the whole.

This critical period repeats itself at each halt following the capture of an assigned objective. It exists also before the launching of an attack, when the troops are massed in the advance trenches. A powerful counter-preparation directed against certain points of the front are able to frustrate the attack.

(*c*) Finally, in a case where it seems necessary by reason of the vigor of hostile artillery reaction to concentrate on this artillery all means of fire at one's disposal, particularly that of heavy guns or howitzers of the corps and divisions, one always finds oneself in the presence of the same difficulties due to the initial decentralization.

It is to be noted, besides, that the staff of the heavy artillery of the corps, whose composition is analogous to that of a regiment of 75's, is not constituted so as to take over even momentarily a small amount of artillery.

In short, the initial distribution of the artillery assigned to the corps into two groups of which the most important is attached to the divisions and each of which has a well-defined mission, leads necessarily to the linear manœuvre proceeding by successive lines.

The corps is itself forbidden the manœuvre by fire and therefore the conduct of the battle.

The failure of heavy concentrations in the employment of artillery is the result of the discord which exists between theory and organization.

In order that the corps may fulfill its function as a battle unit, that is to say, may be able to regulate and direct the manœuvre by fire, we must give to it the necessary means, and with that in view we must, above everything, place under its direct command the mass of fire capable of operating over the entire front of the corps—actually all the heavy guns and howitzers.

Then and then only, its manœuvre instead of being linear can develop itself by echelon from one point of support to another and proceed by these successive concentrations, the gaining of each objective thus echeloned in time and space being supported by nearly all the corps artillery.

Prior to 1914 this progression from one supporting point to

another was sanctioned by our regulations but the methods of fire failed. To-day methods exist and are successful, and in order to secure from them the result that one can by right expect, it is sufficient to organize in accordance with these principles.

PROPOSED ORGANIZATION

The organization proposed is as follows:

To the divisions: The *accompanying* artillery, and the *artillery of direct support*.

To the corps: All the heavy artillery—guns and howitzers—under the orders of a brigadier general.

The proportion between the corps and divisional artillery will thus be:

1 to 1.3 for a corps of 4 divisions;
1 to 1 for a corps of 3 divisions.

And, after reinforcement, the proportion should always be kept at about 1 to 1.

EMPLOYMENT OF FIRE WITH THE PROPOSED ORGANIZATION

Let us consider what should be the rôle of fire with this new distribution in the different phases of the battle.

The uniting of all the heavy artillery capable of being used on the front of the corps under the same command permits, with the greatest facility, the concentration of fire over the entire extent of the zone assigned to the corps, imparting vigor and endurance to these concentrations according to the importance of the objectives and the urgency of their destruction, such as hostile batteries, defensive organizations, rallying points, etc.

Action by successive concentrations produces considerable destruction against material objects as well as against personnel, thanks to the variety of trajectories which result in searching the ground in all directions: it accomplishes, besides, local surprise and leaves the enemy in ignorance of the point of future employment of this mass of fire and, in particular, the part of the front from which the attack will be launched.

The manœuvre of the corps, admits then, of a series of echeloned attacks. Let us assume, to fix the idea, that the anticipated progression is effected by echelon of division.

All the artillery of the corps, including a part, more or less considerable, of the divisional *artillery of direct support*, as yet inactive, with the exception, well understood, of groups charged with the neutralization of hostile batteries or to execute interdiction, is able

to support the division engaged during its progress and also to place in front of it a curtain of fire truly dense and deep, the efficacy of which will be increased by fire from the flanks and even in enfilade.

Machine guns, without counting fire from airplanes, obviously will participate in this action.

As soon as this assigned objective has been gained and after a period of time to be determined in each case, the mass of fire is available to support the advance of the division behind which will progress in its turn under the protection of a curtain of fire of great density as before.

One will be obliged, it is true, to assign some groups to the security of the front division (a portion of his *artillery of direct support* with some batteries of heavy howitzers, if necessary), but it should be observed that the moving forward of this mass of fire on another part of the front will free to some extent the advance elements from the fire of the hostile artillery and will thus give them greater ease in organizing the captured position and at the same time in adjusting the fire of the *artillery of direct support*.

The division forming the first echelon will find itself, therefore, in a sound condition at the critical moment when the neighboring division will reach in its turn the objective which has been assigned to it and will be ready to support it to some extent by machine-gun fire.

The danger of counter-attack will not be so serious as in the case of progression in line because by the very fact of the attack by echelon there exists at any moment of the development of the battle a firm element capable of resistance and able to assist in the resumption of the advance after a partial check.

The number of echelons and the length of the bounds will be necessarily governed by the terrain and by the respective situations of the forces facing each other. The more broken the ground, the more the units will be divided in number and space.

An echelon can include, according to the circumstances, either all or part of a division, or elements of two adjoining divisions, or even the entire front of the corps. But what we wish to bring out is that the centralization of the very powerful means of fire in the hands of a single authority under the direct orders of the corps commander makes it practicable to direct the battle during its entire development and to cause the employment of fire to conform to the principles now accepted.

The manœuvre by echelons is adapted to all combinations. It does away with dependence on close alignment, teaches the troops to protect their flanks and allows openings, more or less considerable,

to be left between the lines protected solely by elements behind; spaces which will facilitate artillery fire—particularly oblique fire.

It permits avoidance of certain portions of the terrain difficult of approach (woods, ravines, etc., very favorable to a fire from gas shell and finally, the capture by outflanking and encircling of supporting points, unyielding to frontal attack.

Finally, it economizes the infantry by reason of the density of fire which surrounds it during its progress and increases its ability to remain in action.

One objection presents itself, nevertheless. Does not the manœuvre by echelon facilitate equally the concentration of the hostile artillery on the echelon which advances?

If the enemy remained true to the present organization the concentration will be very difficult to accomplish in the desired time. If the organization of his artillery has for its basis the centralization of means, he who is the best instructed, the most skillful, in a word the best tactician will gain by it.

An advance by echelons, besides, is more difficult to follow by the hostile artillery fire than an advance in line. He who holds the initiative knows where he is going and in what formation, but the uncertainty of the hostile artilleryman will increase precisely as he sees the attack instead of showing as a continuous line present itself in sinuous form which is broken constantly and of which the rapidly shifting parts surrounded by dust and smoke are the more dangerous to him.

Finally, if the reaction of the hostile artillery is too energetic the commander of the corps artillery will always be in readiness, both during the preparation and during the advance, to direct heavy concentrations on the batteries which will be discovered.

Third—Defensive Operations

It is now admitted that the greater portion of the heavy artillery—guns or howitzers—should participate in the counter-preparation, the neutralization of the hostile artillery passing to the second phase.

The mission of the corps artillery, with the exception of a small number of batteries, is then unique; to strike hard on the assault troops massed in the first line; centralization of means is consequently fully indicated.

The corps possessing very full information and a complete view of the situation is better placed than the divisions to obtain good information concerning concentrations of fire on the most dangerous parts of the front.

Especially in the face of an enemy advancing in extended lines, heavy concentrations on certain portions of the lines will be able to dislocate the attack formation and to break in places its best arrangement. The desired result will be more easily attained than if the counter-preparation covered the entire front with a density too weak to break the élan of the assaulting troops.

Finally, in case the progress of the assailant cannot be checked and where retreat becomes necessary it appertains solely to the corps to organize the methodical withdrawal of the heavy artillery, to establish somehow with it the framework of a barrage position.

To leave the heavy howitzers with the divisions at this critical period is to expose them to capture by the enemy without any advantage to the defense.

The *artillery of direct support* is sufficient for a division manœuvring in retreat.

CONCLUSIONS

To sum up, the assignment to the corps of all the heavy artillery is necessary both in offensive and in defensive operations.

Thanks to the centralization of very powerful means of fire, the corps is ready to manœuvre by fire according to the present teaching and to direct the battle during its entire development.

The concentrations can be proportioned with great facility and the volume of artillery fire should be exploited to the fullest extent, on condition, be it understood, that this arm gains the necessary flexibility.

Centralization lends itself, besides, to the regard for the hierarchy of command and the reunion on the terrain of parts of the same regiment.

Oblique fire, and enfilade fire especially, can be easily effected by units whose position lends itself to this kind of fire, whatever may be the units to which they are attached, without which it would be necessary, as has often happened, to tell off one or more batteries to fulfill this mission in a position entirely out of touch with respect to the rest of the regiment.

Finally, it allows movement by echelons which brings into play the most brilliant qualities of leadership, and lends itself to all combinations.

Centralization requires, however, safety and rapidity of communications. Until the present, telephonic transmission of orders has been employed almost exclusively. But the progress made in radio leads us to expect it to be a common means of communication

between ground stations in the future, at least as far as the regimental command posts. Safety and rapidity will thus be realized.

There are, however, some situations in which decentralization becomes necessary; advance over open ground or rapid retreat after a break of the front.

In these two opposite situations it behooves the corps commander to give temporarily to the divisions the heavy artillery which will be necessary for them (principally batteries of 105's) according to their respective situations and at the same time to regulate the pressure forward or the falling back of the mass of artillery in such a way as to put it, as soon as possible, in readiness to participate in the general action. He will then resume again the conduct of the battle.[3]

PLAN OF ORGANIZATION OF THE ARTILLERY IN THE CORPS ON A WAR FOOTING

Headquarters of the Corps

General commanding the artillery, assistant to the corps commander. Permanently assigned to the corps commander to regulate, according to his instructions, the employment of fire of the heavy artillery and to coördinate the employment of the divisional artilleries.

Director of ammunition supply in the corps. Has under his orders the artillery brigade of the corps and the artillery park.

Brigade of Heavy Artillery of the Corps

Under the orders of a brigadier general having at his disposal one staff, strongly organized and comprising; two regiments of 155-mm. howitzers of three battalions; one regiment of guns of four battalions.

Corps Artillery Park

Present organization, but with a staff increased by two officers.

Divisional Artillery

One divisional artillery staff; one regiment of *direct support*—75's, and 105 howitzers; accompanying artillery as needed; divisional artillery park.

NOTE: All the units, as far as the regimental command posts included, possess sending and receiving wireless sets for ground communications.

[3] The provisional attachment to the divisions of the heavy howitzers and the resumption of control of these same units by the corps is a simple operation with the proposed organization. It is not the same thing when the heavy howitzers are assigned organically to the divisions.

Supply and Distribution of Artillery in an Army Corps

THE question of the amount and distribution of artillery for the large units continues to be a live question in France. Colonel O. B., the artillery writer of the *France Militaire,* published in two recent numbers his contribution to the discussion which is translated herewith:

At the end of the late war each Army Corps was assigned: (*a*) A heavy artillery regiment, not belonging to a division, comprising in principle two groups of three batteries of 155-mm. guns and two groups of three batteries of 105-mm. guns (heavy artillery regiment). (*b*) A divisional artillery composed of a regiment of 75's organized in four groups of three batteries (field artillery regiment) and a regiment of 155 howitzer organized in two groups of three batteries (heavy artillery regiment, howitzers).

On the active parts of the front this artillery was in addition more or less reinforced by units of the General Artillery Reserve. It does not seem that for the moment any new factors could cause a modification of this assignment of artillery. Let us recall, however, that the mission of the divisional artillery is the direct support of the infantry, the heavy guns being in principle designed to be used for counter-battery fire against the hostile artillery along the entire front of the Army Corps and even beyond that within the limits of its range.

The justification of this distribution of missions seems to-day too well known to be discussed. We desire only to examine whether or not a more advantageous distribution of the artillery in an Army Corps consisting of three divisions might not be recommended. Undoubtedly the organic distribution noted above is a result of the war and it might seem rash to dare to discuss it. But what progress would be hoped for if it did not seem possible to do better after reflection in the calm of peace time than during the agitation of fighting when it was necessary to act quickly.

General Farsac considered it possible from the tactical point of view in his discussion in the *Revue d'Artillerie* of last October.[1] Having noted that eighteen of the twenty-two groups constituting the total of the Corps Artillery, each corps having three divisions are distributed, *a priori* and uniformly, among the divisions, the General purposes to take away from the three divisional artilleries of each corps their groups of howitzers. There would be then out of a total of twenty-two groups of Corps Artillery, twelve groups at the disposal of the divisions and ten groups at the direct disposal of the commanding officer of the corps artillery. There is no doubt that this distribution would make it possible for the Army Corps

[1] See preceding article. Editor.

to improve the conduct of a modern combat which depends essentially on the power of artillery fire.

But let us examine the question from other points of view than that of pure tactics and study the facilities of organization, instruction, and manœuvre of the subordinate units which the new proposed distribution would give.

In the actual organization of the Army Corps with three divisions, seven regiments of artillery are required. With all the howitzers grouped together it would be possible to have only six regiments. *i.e.*, for the Corps Artillery proper, a regiment of heavy guns organized in four groups and two regiments of howitzers (155) organized in three groups, and finally, for each divisional artillery a regiment of 75's organized in four groups. This would result in economizing the cadres. But it is specially from the point of view of instruction in time of peace and for carrying out manœuvres which this instruction requires that the advantages of the proposed organization would be appreciable.

The probable reduction of the length of military service in the future, and the restrictions to be anticipated in the number of subaltern officers in the active army must lead to specialization in order to assure good instruction of personnel.

The proposed organization would also facilitate the carrying out of manœuvres of units with proper effectives which the present organization of our Field Artillery regiments does not permit, as a matter of fact, during peace time, inasmuch as the personnel of a regiment can not be considered as interchangeable among its various units. The personnel can not be instructed equally well on both types of matériel which, moreover, have not at all the same degree of mobility; nor do they require the same degree of mobility.

It is necessary to consider not only the advantages but also the possible disadvantages of such an organization.

The advantages would be:

1. The economy of a regiment of artillery for each Army Corps (six regimental instead of seven).

2. Ease of instruction of the subordinate units in specializing their personnel, which changes frequently on account of the short term of service.

3. Uniting all the resources, relatively limited, which are available in time of peace for the instruction of this personnel.

4. Finally uniting organizations which have the same degree of mobility.

We now propose to discuss the disadvantages that could be opposed to these advantages and to draw conclusions:

A first disadvantage resulting from taking away the 155-mm. howitzers from the divisional artillery might be to deprive the command of the division of a means of knowing the processes and the effects of heavy artillery. Undoubtedly; but are there no other ways at least as effective of assuring this required knowledge even in a domain much more extensive? In our opinion the affirmative is the unquestioned answer; for such instruction would be easy to acquire simply by reading the appropriate documents and by showing some demonstration firings.

A second disadvantage of the proposed new distribution might consist in the delay which may result in the case of the direct support of the infantry assumed to be stopped in the advance by an obstacle which the 75 would be unable to destroy. But would this disadvantage be more apparent than real?

Practically the groups of 155 howitzers are not put at the direct disposal of the infantry, and the infantry would, in case of need, inform the divisional artillery of their requirements. It is then the duty of the divisional artillery to estimate whether or not it is really necessary to have recourse to the heavy artillery and, in the affirmative, to act with all the desired power.

With the new organization, the divisional artillery will only have to address themselves to the Command of the Corps Artillery, which would not at all delay the intervention and might even gain in effectiveness. The objection might be raised, it is true, that this point of view, admissible for fire against an obstacle too great for the 75, could not be applied to the case of firing on terrain covered with hostile troops and out of reach of the direct fire of the 75's. But this objection brings up another idea, *i.e.*, whether or not the divisional artillery should include a light howitzer.

This question has been treated many times in the columns of the *France Militaire* and we are convinced of the necessity of creating this kind of matériel.

Each divisional artillery might then include, for instance, three groups of 75's and a group of light howitzers of the same mobility, of the same ease in handling, and designed to resemble as much as possible the 75 in order to facilitate the instruction in time of peace of the personnel of the Divisional Artillery.

The objection therefore does not apply to the new proposed distribution of the artillery in the Army Corps between the Corps and the Divisions. We stated above that the direct support of the Infantry by the heavy howitzers would not be delayed as a result of the proposed organization. This idea is easily justified. In the case considered no difficulty of communication is to be feared, and on the other hand, the heavy howitzer which, with the heavy

guns, enters finally into the artillery duel, will quickly be in position and ready to intervene along all the front of the Corps.

It will be the duty of the Commander of the Heavy Artillery, who is aware that it may be called to support the infantry directly, to adjust the engagement of his groups in such a way as to be able to act immediately with at least two howitzer groups on especial targets other than the artillery.

Conclusion: The proposed distribution presents real advantages and only apparent disadvantages. We do not hesitate to recommend it.

CURRENT FIELD ARTILLERY NOTES

Motor Carriages for Divisional Artillery

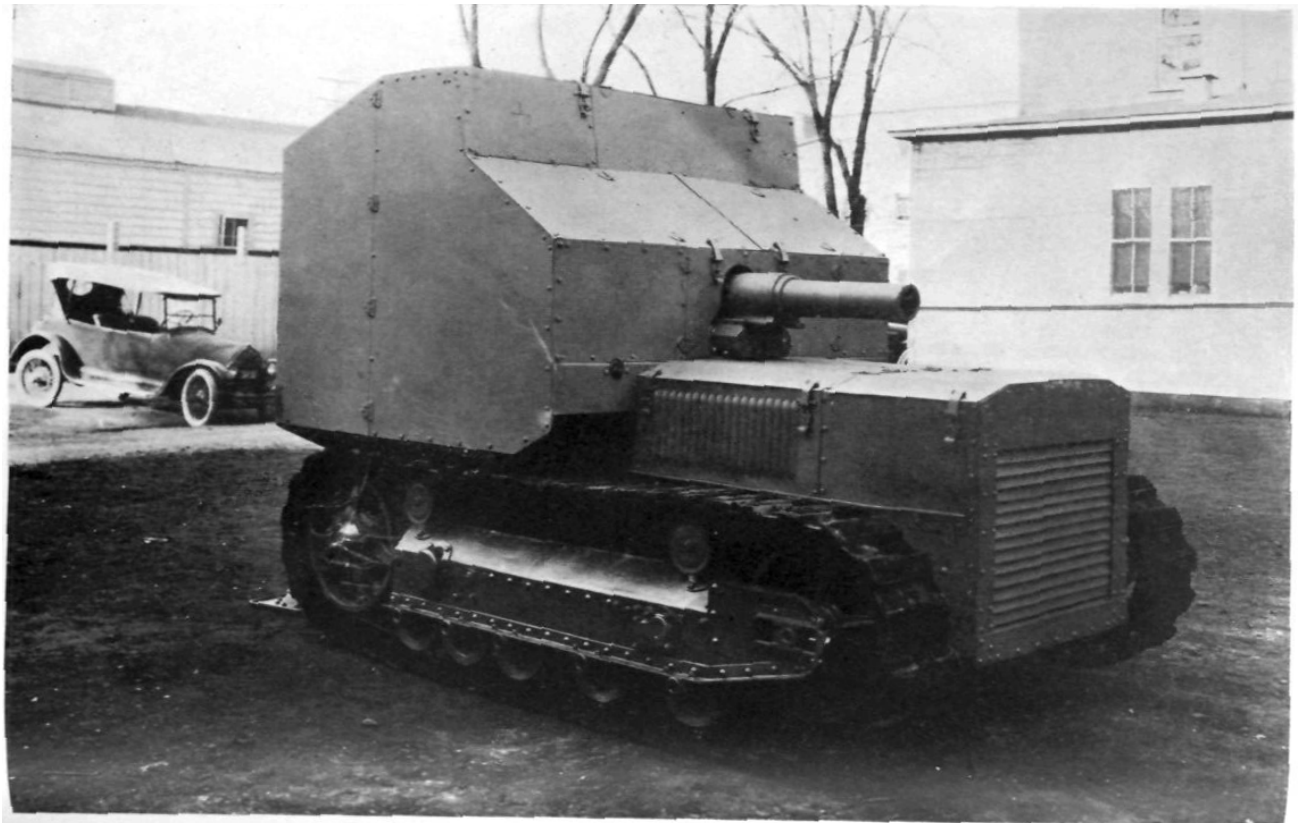
1. Two motor carriages for the new 75-mm. gun or 105-mm. howitzer have been designed and built by the Front Drive Motor Company (Christie), of Hoboken, N. J., and are undergoing test at Aberdeen Proving Ground. These carriages are designed to run on wheels when road conditions are favorable, and on caterpillar tracks when road conditions are unfavorable or when going across country. The change from wheels to caterpillar tracks can be made very easily and quickly. When not in use, the caterpillar tracks are carried on shelves provided for them on each side of the carriage. The carriage can be run with either end in front, at any one of the four engine speeds. Seats have been provided for the chauffeur and three cannoneers. Protection against front and flanking fire is given by a demountable shield which can be carried on the carriage when demounted.

2. During the preliminary tests before shipment to Aberdeen Proving Ground, one of the carriages made the trip from Hoboken, N. J., to Washington, D. C., a distance of 251 miles, in one day, April 10, 1921, in seventeen and a half hours actual running time. One hundred and five gallons of gasoline and twenty-seven gallons of oil were used during the trip, which was made without mishap. All the travel was on wheels. The return trip to Hoboken was made in two days, and also without difficulty. Speeds as high as thirty miles per hour have been attained without reaching the maximum speed of which the vehicle is capable.

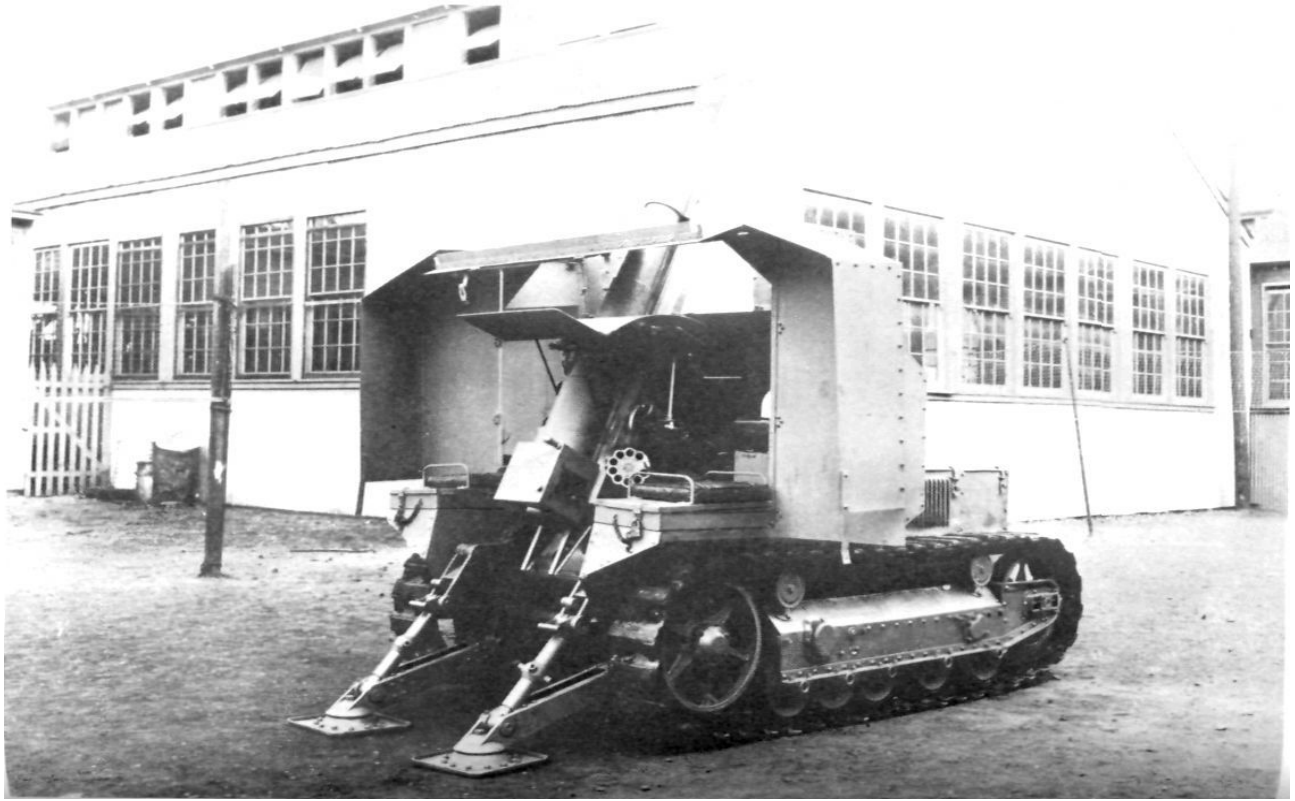
3. One of the contract specifications requires that the carriages climb slopes up to 100 per cent. In order to be sure that the carriages could climb such slopes, the contractor had a mound about twelve feet high constructed near his shops, one side of the mound having a thirty-degree slope and the other a forty-five-degree slope. He then put the new carriages over this mound. To further demonstrate their capacity, they were stopped when part way up the slope, then started and went up and over without difficulty.[1]

4. The carriages have been subjected to firing stresses by firing both the gun and howitzer on them at elevations varying from 0º

[1] For photographs of this test see FIELD ARTILLERY JOURNAL for January-February, 1921, page 24.—Editor.

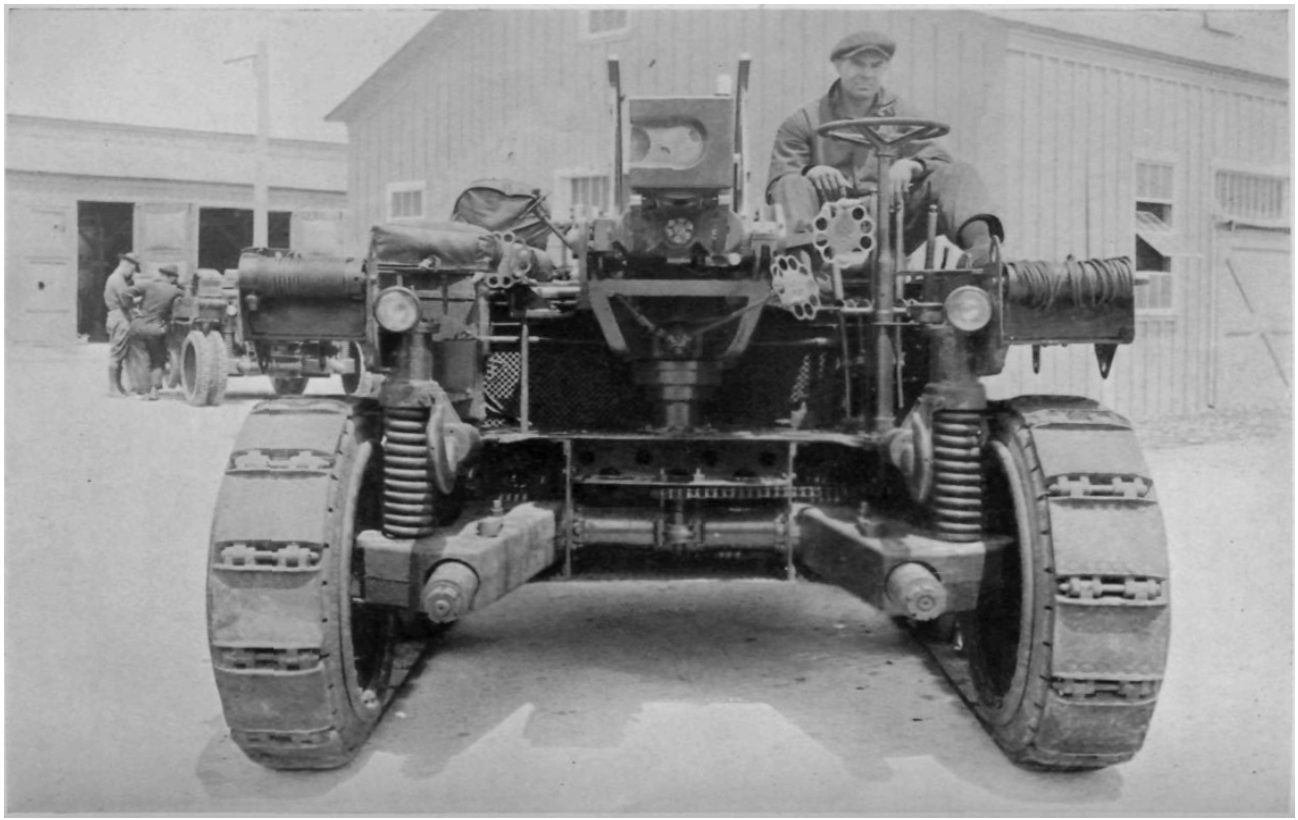


105-HOWITZER MOTOR CARRIAGE (HOLT TYPE) WITH DEMOUNTABLE SHIELD



105-MM. HOWITZER MOTOR CARRIAGE (HOLT TYPE) WITH OUTRIGGERS IN POSITION FOR FIRING

75-MM. MOTOR CARRIAGE (CHRISTIE TYPE). GUN ELEVATED 45º



75-MM. MOTOR CARRIAGE (CHRISTIE TYPE). TRAVELING POSITION ON CATERPILLAR TRACK

to 80º elevation, and have been found to be very stable. No special preparation is necessary before beginning to fire either on the wheels or on the caterpillar tracks.

5. Two motor carriages for the new 75-mm. gun or 105-mm. howitzer have been designed and built by the Holt Manufacturing Company, of Stockton, California, and are now undergoing test at the Aberdeen Proving Ground. These carriages are designed to run on caterpillar tracks at all times. In order to reduce the noise of the metal track, and to prolong the life of the carriage, rubber pads have been attached to the track shoes, and rubber has been used on the track rollers, idlers and sprockets. Seats have been provided for the chauffeur and three cannoneers. Protection against front and flanking fire is given by a demountable shield which can be carried on the carriage when demounted.

6. During a preliminary test before shipment to Aberdeen Proving Ground, these carriages made the trip from Stockton to San Francisco, California, a distance of 120 miles, in two days, fifteen and a half hours actual running time. No effort was made to make speed, and no difficulties in the operation of the carriages were encountered. Speeds as high as twenty-seven miles per hour have been attained. The carriages manoeuvre very nicely at speeds from twelve to fifteen miles per hour. One of these carriages was run about 1000 miles during the preliminary tests, and the other about 300 miles.

7. The engines in these motor carriages have been water-proofed and the carriages have been run in water to a depth that completely covered them, the only part of the vehicle remaining visible being the breather which admits air to the carburetor and engine.

8. These carriages have also been subjected to firing stresses and have been found to be remarkably stable. Two out-riggers are required to be placed in position before firing is begun, but they are very easily and quickly placed.

9. These motor carriages are not entirely satisfactory. They simply represent a step in the process of development of this type of gun mount. The most obvious defect is the excessive weight in both types of carriage, it being over 13,000 pounds. This and other defects can be overcome in future design. The cannon, recuperator and top carriage used on these carriages are the same as those used on the split-trail carriages, Model 1920, and are not entirely suitable for the purpose. In any redesign of the motor carriages, it would be most advisable to include a top carriage that would permit of the maximum capabilities of the cannon and carriage.

10. Test of these vehicles will be continued at Aberdeen Proving Ground and later by the Field Artillery.

Artillery and Infantry

THE translation which follows from the *France Militaire* of July 24, 1921, is a discussion by "Commandant S" of the problem of accompanying artillery. The arguments against such artillery support being first considered, this officer expresses the generally accepted views of French field artillerymen concerning this feature of the work of the artillery. The time that elapses between the moment need is felt by the infantry for support against some particular obstruction and the moment projectiles begin to fall on this obstruction must be reduced. Accompanying artillery does not solve this problem, but it is "one of the elements necessary for its solution."

The translation follows:

It is very true that dividing up battalions of divisional artillery into "batteries" or "infantry sections" results in decreasing the effectiveness of the direct support of the infantry by the artillery. The direct support of the infantry is, however, the most useful and the most indispensable assistance required by the infantry, especially if this support is in the shape of well-conceived concentration of fire and if deceiving barrages are not used. It is very true that dividing up the artillery in this way results in making all system of command impossible, all manœuvres by fire impossible, and all mass effect impossible.

The first reproach brought against the "artillery of the infantry" of 1918 by the adversaries of accompanying guns, seems frequently justified. They are no less right, it seems, when they condemn the miserable results obtained by this detached artillery. If they are to be believed, this artillery brought only insignificant assistance to the infantry, or even none at all, although the artillery suffered severe losses in personnel and in matériel in consequence. In vain did these artillerymen drag their guns into the forward zone of the battle. They saw on their arrival that it is not easier to be better informed there concerning the contact than at the rear, and they saw, moreover, that they were much less able to fulfill the technical requirements which all matériel necessitates in spite of everything (observations, moves, ammunition supplies, services of piece, interior communication, etc.); consequently, the unjustified weakening in the direct support of the infantry and of the general system of the artillery without any corresponding benefit to the infantry. This is said to be the results of the accompanying guns as indicated by the experiments in 1918.

Certain corrections can be made to this deep pessimism. Certainly the work of the infantry batteries did not give the results that had been looked for, but how could it have been otherwise with

the extraordinary difficulties encountered by them. They were forced to move around on the battle field with their horses. Destined to work in the ranks of the infantry and to fire at close range at the nearest hostile elements, these batteries were armed with a direct-fire gun which ordinarily should fire on every occasion as rapidly as possible. They came up against difficulties sometimes absolutely insurmountable in cases of ammunition supply.

In spite of all this, some sure results were obtained, and this in spite of so many obstacles. The artillerymen solved the problem the best way they could after their experience. In each divisional artillery the "artillerymen of the infantry" were specially instructed and specialized. Some became excellent in their difficult mission. Even if they were forced to deplore the frequent inaccuracy in their knowledge of the situation, even in the first line, they were more quickly and better informed than would have been the case had they been four or five kilometres in rear, and they were in position to act quickly and at the right moment often even before the infantry asked for the support.

This infantry did not forget such devotion. In being accompanied in such a way the infantry found solace in the intimate and immediate coöperation of the artillery. Being a witness of the efforts and of the sacrifices of its artillerymen, seeing and appreciating the difficulties overcome, this infantry felt its own forces increased tenfold. *Had only this result been obtained accompanying artillery would be entirely justified.* This is a point of view which its opponents too easly neglect.

But there were other results which can be recalled. If it had been otherwise, how is it that all the belligerents, without exception, organized a system of accompanying artillery? It is undoubtedly easy to raise the objection that this could not be put into practice, even more or less effectively, before the end of the war, during a period when the enemy weakened and less in a fighting mood, was no longer in a state to make it impossible. Those who maintained contact with this enemy until November 11th, do not remember that he had become so inoffensive, and that his machine guns and his guns could be taken at will. It is not without losses that the artillerymen with the infantry were able to carry out their difficult functions. Living the battle of the infantry, they knew, accepted, and shared the same sacrifices. Let them not be reproached with having had the best rôle. Let it not be said that the accompanying artillery caused the weakening of direct support and compromised manœuvre by fire. The reproach may be justified, but in every case it is not the system of accompanying which is at fault, but only the way in which it was carried out, and it is this method which

the "Provisional Field Service Regulations for the Artillery" is obliged to sanction.

As a matter of fact, as long as we have no accompanying artillery supplied with an appropriate and specially designed matériel, it will be necessary to require direct support from the 75. Will the same difficulties and the same errors be reproduced? Most certainly, no matter what is said or done, but, especially, if *nothing* is said and if *nothing* is done.

Together with the light howitzer, the accompanying gun is the artillery matériel which it is most necessary to create. The future offered by the development of caterpillar matériel make possible the assurance that the problem of mobility is capable of solution, either by carrying or by traction. The problem of ammunition supply can be solved in the same way.

Inasmuch as it cannot be admitted that a gun can fire without danger from a caterpillar mount which remains fixed, it must be admitted that this gun can be put in battery on the ground, which will not prevent it from firing from its caterpillar mount if circumstances are specially favorable. This accompanying gun will consequently be light and easily handled. This result will be possible since it will only have to fire a relatively light projectile (about three kgs.) at short ranges and with comparatively low pressures.

The ballistic problem of firing at such short distances from our own troops will be undoubtedly the most difficult to solve, at least with a view to filling the requirements of simplicity that the service of such a gun in the forward zone of the battle necessitates. Let the ballisticians turn pale over questions of multiple charges and variable powder chamber.

The results already obtained by the accompanying matériel actually in service prove that one or even several solutions are possible. With such a gun, infantry batteries could be organized which would be considered as part of the direct supporting artillery and which would not weaken this artillery, at least on the field of battle. Organizing this new artillery by taking men from the infantry should be avoided. It seems that the best thing to do would be to transform one of the groups of field artillery belonging to the divisional artillery into the accompanying artillery.

Ordnance Notes*

Relation between Weights of Cannon and Their Carriages.—One of the primary limitations upon all designs of mobile artillery is that of weight, as in general, mobility can be best improved by reduction in the weight moved. A cannon of the required ballistics having

* Reprint from Army Ordnance July-August, 1921.

been determined upon, the designer must first produce the most efficient cannon possible under limitations which may exist in the art of steel manufacture, and then must place beneath this cannon a carriage of minimum weight.

The choice of steel which can be used in cannon construction is quite limited, and for a given muzzle energy and type the weight will depend principally upon the kind of steel used and, of course, also upon the factor of safety desired. Since this factor of safety and the design procedure has been fairly well standardized, there will be little variation in weight, provided the same standards are adhered to in each case. As a matter of fact, as will be noted later, the same standards have not been adhered to throughout all cannon design, nor have the kinds of steel used been always the same, and considerable variation will be found to exist in weights of cannon which should properly be nearly the same.

One way of measuring the efficiency of a cannon is to determine the ratio of the muzzle energy to its weight. Column 5 of the tabulation herewith shows this ratio which has been worked out for various types of service matériel as well as some of the new experimental matériel. It will be noted that this ratio increases with the calibre and power of the cannon. The increase in this ratio follows from the summation of various elements of the theory of design and manufacturing practice, and is somewhat analogous to the efficiency of trucks, for, it will be recalled, the ratio of live load to dead load increases with size.

If we have designed our cannon properly, the designer may, other things being equal, measure his success by the ratio of its weight to weight of the carriage; and the larger this ratio, the more acceptable to the design of carriage, other things again being equal.

Column 15 of the tabulation gives the actual ratios existing between cannon and the total unit weights for the types of matériel indicated. It will be noted that the average ratio is about 33 per cent.; in other words, the cannon on our present service and experimental matériel weighs about one-half as much as the carriage itself in firing position. It should be added here that this entire discussion pertains to mobile types of artillery carried on wheels, and does not apply to Caterpillar, Seacoast or Railway types except in its general aspects.

The ratios given in column 15 do not give a fair indication of the merits of some of the designs of carriages because in some cases the cannon themselves are not as efficient as might be.

In order to show the true merit of the carriage design, the cannon have been reduced to a more nearly uniform efficiency, the efficiency

weights being given in column 7. Column 16 gives the ratios, using the weights in column 7. The weights given in column 7 are calculated only, and not to a high degree of accuracy, and may in some cases be slightly too high or too low, but they are sufficiently accurate for the purpose of general comparison.

The asterisks in column 16 indicate certain experimental types, and it may be interesting to note how good or bad the ratios are in comparison with existing types.

The Pack Howitzer Matériel must be considered as a type by itself, and cannot be compared logically with larger or more powerful calibres. The ratio .262 is lower than larger calibres, although slightly better than that of the existing 2.95-inch Mountain Gun. This low ratio is due principally to features which it is necessary to incorporate in order to enable quick disassembly and packing on mules. The 75-mm. field matériel, Model of 1920, has a ratio of .335, which approximates the average. This matériel is, however, of the split-trail type, having wide traverse and elevation up to 80 degrees. These characteristics have greatly increased its weight; on the other hand, the gun itself is somewhat heavier than it would be if made of higher grade steel; so, on the whole, the ratio returns, to its average.

The 75-mm. field matériel, Model of 1921, is a good illustration of what results from simplicity of construction and limitations place upon elevation and traverse. This carriage mounts the same gun as the Model of 1920, but permits an elevation of 45 degrees only and has axle traverse. Its ratio, .44, is very good. It may be noted that the actual ratio for these two matériels, given in column 15, shows the Model of 1921 slightly inferior. This, however, is due to the fact that the gun, although of the same ballistics, was built to weigh 945 pounds instead of 1242 pounds, higher grade steel being used. Had the 1242-pound gun been used the ratio in column 15 would have been .40. The remaining matériels, marked with asterisk, show average ratios of about .33 with exception of the 105 mm. Howitzer, Model of 1921, which has a high ratio. This design is similar to the 75 mm., Model of 1921, and the same remarks as above apply.

It would be slightly more accurate to use the momentum of the projectile and powder gases as a basis of determining the efficiency ratios, but muzzle energy is more commonly considered in connection with cannon and the results obtained by using this muzzle energy are proportional to the result which would be obtained by using momentum.

In conclusion it may be stated that in the case of split-trail carriages having wide traverse and high elevation we are fairly successful if the weight of cannon and carriage combined is three times the weight of the cannon; that is, the efficiency ratio is .33. In the case of single or box trail carriages with moderate traverse and elevation up to 45 degrees, the ratio should be about .4. (See tabulation.)

One Hundred and Fifty-five-mm. Gun and Eight-inch Howitzer Motor Matériel.—The new motor carriage for the 155-mm. gun (1920) and 8-inch howitzer (1920) is now undergoing its preliminary road test at the plant of the Holt Manufacturing Company, Stockton, Cal. Two of these vehicles will soon be completed. This carriage carries either the 155-mm. gun or its companion piece—the 8-inch howitzer.

The design of this vehicle incorporates all of the improvements suggested by tests on the Self-Propelled Caterpillar mounts Mark I, II and III for the 8-inch howitzer (Vickers), the 155-mm. (G. P. F.) gun and the 240-mm. (Schneider) howitzer, respectively. The overall height has been made as low as possible, reducing the overturning effect during firing and while the vehicle is of a rugged construction, it has been made as light as possible.

The engine used is a 6-cylinder G-R-V-T Sterling, dual-valve engine, manufactured by the Sterling Engine Company, Buffalo, N. Y. All six of its cylinders are inclined 45 degrees from the vertical to one side, to reduce the overall height to a minimum. Two carburetors, double battery ignition and two exhaust manifold outlets are used. A maximum of 260 H. P. is delivered by this engine at 1800 R. P. M.

Two types of transmissions are undergoing test for use in this mount to determine which is the most satisfactory. In one type, steering is accomplished by the use of double clutches for each track, while in the other a clutch and planetary gear set is used.

Rubber is used in various parts of the track mechanism to reduce the noise and shock. The motor carriage being large and heavy, the application of rubber is more difficult than when applied to the smaller motor carriage for the 75-mm. gun and 105-mm. howitzer.

The maximum speed expected is 14.5 miles per hour with the engine running at 1800 revolutions per minute. This high speed is desirable in that whenever it becomes necessary for the motor carriage to travel in a truck train, it will be possible for it to do so without interfering with the speed of the rest of the train.

COMPARISON OF GUNS WITH CARRIAGES

Feb. 25, 1921

COLUMN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
NAME OF CARRIAGE	Wt. Proj. Lb.	Muzzle Velocity Ft. Sec.	Energy Projectile Ft. Lb.	Wt. Gun Lb.	Energy Proj. Per Lb. Gun	Energy Proj. Per Lb. Eff. Gun	Wt. Efficient Gun Lb.	Wt. Gun and Carriage Firing Position	Energy Proj. Per Lb. Gun and Carr.	Wt. Pwd. Chg.	Momentum Pwd. Gases	Momentum Projectile	Total Momentum	Momentum Per Lb. Gun and Carriage	Wt. Gun ÷ Wt. Gun and Carriage	Wt. Eff. Gun ÷ Wt. Gun and Carr.
2.95 V. M. Mtn. Gun	12.5	920	166,000	236	700	850	196	830	200	.5	2.350	360	2,710	3.27	.285	.236
75 Pack How. M.-1920	15.	900	190,000	224	850	.....	223	850	223	.46	2,170	422	2,592	3.05	.262	*.262
3. Field M-1902	15.	1,700	680,000	788	865	900	756	2,520	270	1.5	7,050	800	7,850	3.12	.313	.300
75 Field M.-1916	12.2	1,742	578,000	765	760	.....	643	3,045	190	1.5	7,050	664	7,714	2.54	.252	.214
75 French M.-1897	12.2	1,805	622,000	1,015	615	.....	692	2,657	235	1.5	7,050	690	7,740	2.9	.382	.260
75 British M.-1917	12.4	1,742	590,000	995	600	.....	657	2,887	204	1.5	7,050	676	7,726	2.68	.345	.227
75 Field M.-1920	15.	2,175	1,110,000	1,242	900	.....	1,230	3,660	303	3.	14,100	1,020	15,120	4.1	.340	*.335
75 Field M.-1921	15.	2,175	1,110,000	945	1,180	.....	1,230	2,800	396	3.	14,100	1,020	15,120	5.4	.337	*.440
3.8 How. M.-1917	30.	1,200	675,000	681	1,000	1,000	675	2,961	228	1.67	7,860	1,128	8,988	3.03	.230	.228
105 How. M.-1920	33.	1,500	1,160,000	1,260	920	.....	1,160	3,678	314	3.25	15,200	1,550	16,750	4.55	.343	*.315
105 How. M.-1921	33.	1,500	1,160,000	1,020	1,140	.....	1,160	3,000	386	3.25	15,200	1,550	16,750	5.6	.340	*.385
5-60 Pdr. British Mk. II	60.	2,150	4,340,000	4,858	900	1,130	3,830	12,096	358	9.44	44,400	4,040	48,440	4.	.402	.317
4-7 Field M.-1906	45.	2,050	2,950,000	2,688	1,100	1,100	2,680	8,068	367	7.	33,000	2,880	35,880	4.45	.334	.333
4-7 Field M.-1920	50.	2,450	4,700,000	4,200	1,120	.....	4,260	13,000	362	13.4	63,000	3,840	66,840	5.13	.323	.328
155 How. M.-1918	95.	1,420	2,980,000	2,745	1,090	1,190	2,510	7,600	392	8.	37,500	4,200	41,700	5.5	.362	.330
6 How. M.-1908 M. I	120.	900	1,510,000	1,925	790	.....	1,270	7,582	200	3.	14,100	3,360	17,460	2.3	.254	.170
155 How. M.-1920	95.	1,850	5,080,000	4,265	1,190	.....	4,270	13,000	390	14.25	67,000	5,500	72,500	5.57	.327	*.328
155 Gun M.-1918	95.	2,380	8,400,000	8,795	960	1,260	6,660	25,960	323	25.25	118,000	7,060	125,060	4.83	.338	.257
155 Gun M.-1920	95.	2,800	11,600,000	9,200	1,260	.....	9,200	27,000	430	30.1	140,000	8,300	148,300	5.5	.340	*.340
6 British Mk. VIII A	100.	2,350	8,650,000	10,192	850	.....	6,800	22,512	385	23.	108,000	7,360	115,360	5.13	.452	.303
8 How. Mk. V.I	200.	1,300	5,280,000	6,552	810	1,340	3,950	19,100	277	10.75	50,500	8,120	58,620	3.07	.342	.207
8 How. Mk. VII	200.	1,525	7,260,000	7,730	930	.....	5,420	20,050	362	17.5	82,200	9,540	91,740	4.6	.386	.270
8 How. M.-1920	200.	1,950	11,900,000	9,000	1,320	.....	8,880	27,000	440	29.5	138,000	12,200	150,200	5.55	.333	*.328
194 Gun M.-1919	184.	2,300	15,200,000	19,250	800	1,440	10,550	36,500	416	51.	239,000	13,200	252,200	6.9	.530	.289
9.2 How. Mk. I	290.	1,187	6,420,000	6,810	940	1,400	4,000	29,100	221	13.	61,000	10,800	71,800	2.47	.234	.160
9.2 How. Mk. II	290.	1,506	10,250,000	9,576	1,070	.....	7,330	35,500	316	26.	122,000	13,640	135,640	3.83	.270	.206
240 How. M.-1918	356.	1,700	16,100,000	10,831	1,500	1,470	11,000	41,296	390	35.	164,000	18,900	182,900	4.45	.265	.272

Principal Characteristics

Total weight, fully equipped	pounds	45,000
Maximum gun range	yards	26,000
Maximum Howitzer range	yards	18,000
Maximum traverse, each side	degrees	10
Maximum elevation	degrees	65
Distance from ground to gun axis	inches	62.25
Maximum overall length of vehicle	inches	217
Maximum overall height of vehicle	inches	81
Maximum overall width of vehicle	inches	110
Centre to centre distance of tracks	inches	92
Width of track	inches	18
Length of track in contact with ground—		
(a) Minimum contact on hard ground	inches	120
(b) Contact with 5″ depression	inches	166
Ground pressure at 5″ depression	pounds/sq. in	7.5

Road speeds at normal engine speed (1200 R.P.M.)

	Secondary	Primary
Low speed	1.37 M.P.H.	2.32 M.P.H.
Reverse speed	1.92 M.P.H.	3.25 M.P.H.
Intermediate speed	3.7 M.P.H.	6.28 M.P.H.
High speed	5.68 M.P.H.	9.7 M.P.H.
Maximum road speed at 1800 R.P.M. of engine	8.5 M.P.H.	14.5 M.P.H.

Experimental Matériel.—The Rock Island Arsenal now has in process of assembly several of the experimental types of gun carriages which were placed in manufacture some months ago. The most advanced of these is the 75-mm. Gun Carriage, Model of 1921. Assembly of this carriage has proceeded without difficulty, and its submission to proof test is awaited with great interest.

IN MEMORIAM

BRIGADIER GENERAL ELI D. HOYLE (retired), one of the charter members of the Field Artillery Association, died at his residence in Washington, D. C., on *July 27, 1921*.

General Hoyle was one of the most widely known officers of our service, especially among artillerymen, and one of the best beloved. His death comes as a shock to his many friends and as an irreparable loss to his family.

The particularly distinctive quality of his character was his high sense of duty and his idealism. He carried with him throughout his long service in these prosaic times, the idealism and the faith of the crusader and knight of the Middle Ages. His article of faith was service to his Government—the best service that in him lay, and the best service that could be commanded from his subordinates. The spirit of service was his religion. With him there could never arise any question of personal comfort, ease, remuneration or reward, if these conflicted in ever so slight a way with the interests of the Government—the latter absolutely controlled.

But his disposition was not stern and unyielding—on the contrary, his nature was warm and affectionate.

He was a man who delighted in the society of friends; he was always ready to converse with them; always ready to be of any assistance to them. In his family relations he left nothing to be desired.

General Hoyle's entire service until his appointment as a General Officer was in the artillery arm—except such details as he served with Staff Corps and Departments. In his arm, he was one of the leaders, always progressive and serving with distinction.

In his death the country lost one of its finest citizens—a man of whom it may be said he was truly noble in his character.

W. J. SNOW,
Major General, U. S. Army,
Chief of Field Artillery.

BOOK REVIEW

OUTLINE OF HISTORY (2 vols.), By H. G. Wells. The Macmillan Co., 1920, New York, N. Y.

Mr. Wells has at least written a very interesting book—whether the reader agrees with the author in his treatment of the subject and in his deductions, is another matter entirely. But, possessing as he does, imagination, and the flowing style of the fiction writer, Mr. Wells has written a very readable book on what is generally a dry subject—history.

His history "deals with ages and races and nations, where the ordinary history deals with reigns and pedigrees and campaigns." He treats of peoples (Hindus, Chinese, Persians, Egyptians, Frenchmen, Germans, Americans); or religions (Buddhism, Mohammedanism, Judaism, Christianity); of science (geology, biology, archaeology, ethnology, socialogy, economics); in short, the field covered is too great to be more than briefly touched on in this review.

The work, published in two volumes, is divided into nine books.

Book I treats of the origin of the physical world. It also covers the first appearance of life, the origin of species and the Age of Mammals.

Book II treats of the origin and development of the human race from the ape-ancestor down to the present man.

Book III treats of the Dawn of History, and then follows down through the first civilizations.

Book IV treats of Judea, Greese and India. History proper begins in this book. Incidentally, it may be stated that the author is no admirer of David and Solomon. Mr. Wells has a very low opinion of Alexander—but this remark applies to all military men.

Book V treats of the Roman Empire. As was to be expected from Mr. Wells, Julius Cæsar was only a rich, corrupt and dissolute politician.

Book VI treats of Christianity, Islam, and the Middle Ages. Mr. Wells is hostile to Christianity.

Book VII treats of the Mongols, the Renaissance and the Protestant Revolution.

Book VIII treats of the period from the Seventeenth Century to 1920. The book is mostly taken up with the development of the "Great Power" idea, and the evils flowing from it. Incidentally, Mr. Wells pays his respects to Napoleon in true Wells anti-military style. Talleyrand was an abler statesman than Napoleon; Moreau and Hoche abler generals; even Napoleon III was a much more

"supple and intelligent man" than his uncle. In fact Napoleon "was, as few men are or dare to be, a scoundrel, bright and complete."

Book IX is a prophecy. Mr. Wells sees a world with a common religion, no armies or navies, no unemployed, but possessing all the accompaniments of Utopia.

Taken all together, the work shows an immense amount of preliminary reading and investigation in its preparation, considerable originality in its treatment, and a strong bias in its deductions. It is intersting from cover to cover. It is a monumental work—but few readers will accept it as authoritative.

Index to Current Field Artillery Literature

Compiled from monthly list of military information carded from books, periodicals, and other sources furnished by the War College Division, General Staff.

The General Staff College has made the following announcement:

"The publication of the Monthly List of Military Information carded from Books, Periodicals, and Other Sources in the General Staff College Library, will be discontinued with the May, 1921, issue. This decision has been reached partly in the interest of economy, and partly due to the fact that the National Service, published at 9 E. Fortieth Street, New York, N. Y., and the Readers' Guide to Periodical Literature, published by the H. W. Wilson Company, 958 University Avenue, New York, N. Y., cover practically the same field."

ARMIES.—United States. Tables of organization. History of their compilation and explanation of composition. By Major A. W. Lane, General Staff. (*Infantry Journal*, May, 1921, p 486.)

ARMY SERVICE SCHOOLS, FT. LEAVENWORTH, KANSAS.—Field Artillery course for provisional second lieutenants. (Ft. Leavenworth, Kansas, *Army Service Schools Press*, 1917, p. 246.)

ARTILLERY.—Germany. Organization of the German artillery. The German present army (Reichsheer) and the artillery component. By the Second Bureau French Etat-Major. (*La Revue D'Artillerie*, April, 1921, p. 333.)

ARTILLERY FIRE.—Manœuvres by fire. Artillery firing, the projectile, its trajectory, dispersion, etc. By E. Cambuzzat. (*La Revue D'Artillerie*, March, 1921, p. 167.)

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