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ARTILLERY IN OFFENSIVE OPERATIONS

ARMY WAR COLLEGE
AUGUST, 1917

WASHINGTON
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WAR DEPARTMENT,
WASHINGTON, *August 31, 1917.*

The following pamphlet "Artillery in Offensive Operations" is published for the information of all concerned.

[300.61 A. G. O.]

BY ORDER OF THE SECRETARY OF WAR:

H. L. SCOTT,
Major General, Chief of Staff.

OFFICIAL:

H. P. McCAIN,
The Adjutant General.

WAR DEPARTMENT,
THE ADJUTANT GENERAL'S OFFICE,
Washington, June 19, 1917.

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BY ORDER OF THE SECRETARY OF WAR:

H. P. McCAIN,
The Adjutant General.

OFFICIAL BRITISH NOTES OF FEBRUARY, 1917, ON ARTILLERY IN OFFENSIVE OPERATIONS.

(These notes cancel the notes on the same subject published as Chapter VIII, Field Artillery Notes No. 1, War Department, May 9, 1917.)

CONTENTS.

	Page.
I.—Organization and command	7
II.—Artillery in the general plan of attack	9
1. The rôle of the artillery	9
2. Selection of the front of attack	10
3. Estimate of guns and ammunition required	11
III.—The artillery plan	12
1. Scope of the artillery plan	12
2. Allotment of artillery	13
3. Air observation	15
IV.—The preliminary arrangements	16
1. Reconnaissance	16
2. Distribution of work	16
3. Positions	17
4. Protection of positions	17
5. Observing stations	18
6. Artillery command posts	19
7. Communications	19
8. Control and direction of fire	20
9. Trench bridges	21
10. Ammunition supply	21
11. Antiaircraft guns	22
V.—The preliminary bombardment	23
1. Object of the preliminary bombardment	23
2. Fire to effect physical and moral damage	23
3. Destruction of obstacles—Wire cutting	25
4. Destruction of defenses and their accessories	25
5. Fleeting targets	28
6. Accuracy of fire	28
7. Forward guns	29
8. Advance batteries	29
9. Character of the bombardment	29
10. The bombardment of rearward lines	30
11. Duration of the bombardment	31

	Page.
VI.—The support of the attack	32
1. The general mission of the artillery	32
2. Importance of concealing the hour of the assault	32
3. Barrages	33
4. Object of the barrage	33
5. The field artillery barrage	33
6. Strength of field artillery barrages	35
7. The organization of the barrage	35
8. Pace of the barrage	36
9. Time tables	37
10. Control of the barrage	38
11. Rate of fire and depth of lifts	39
12. Enfilade fire	39
13. Ammunition for the field artillery barrage	40
14. The howitzer bombardment	40
15. Consolidation and counter attacks	41
16. Zone calls	42
17. Information and communication	42
18. The artillery advance	44
Appendix I.—Organization of artillery staffs	46
Appendix II.—Diagrams of barrages	47
Appendix III.—Scheme of work to be undertaken by a battery to obtain cover when it has advanced to a new position beyond our old front-line trenches	48
Appendix IV.—Estimates of ammunition required	50

I. ORGANIZATION AND COMMAND.

1. Artillery has so developed both in power and quantity during the past two years that it has become a much stronger weapon of offense than heretofore. To obtain the full value from this arm, which plays so great a part in battle, it is essential that its action should be so efficiently controlled as to insure that its maximum force is utilized. Every detail regarding the employment of artillery must be thought out beforehand. The efficient execution of its allotted tasks will largely depend on the early issue of clear orders and on the methodical supervision of its subsequent work.

2. A commander directs and supervises the action of his artillery through the medium of his artillery commander, who must be equipped with the authority, information, and technical knowledge essential to his position.

The artillery commander attached to the staff of an army or a corps may, within the discretion of his chief, command the whole of the artillery of the formation, in order that the commander's plan may, as far as the artillery is concerned, be translated into orders and be carried out in the most effective manner and with the least delay. The rapid transmission of orders to batteries is a matter of vital importance.

3. The army deals with the distribution and employment of the artillery allotted to it and with the details of artillery cooperation with armies on either flank. It provides for cooperation between the various corps and decides, within the limitations imposed by the commander-in-chief, the nature and duration of the preliminary bombardment.

The army is also concerned with the general direction of the preparatory arrangements, lays down the general principles to be followed as regards the employment of antiaircraft guns, counter battery work, night fire, enfilade fire, and concentrations of fire, and indicates the most effective methods to employ in the attack.

4. A corps commander disposes of every nature of artillery essential to the preparation and execution of an offensive operation. There can therefore be but one commander for all the

artillery of the corps, both field and heavy, if the energy of the whole is to be systematically and uniformly directed. At the same time the army commander may decide to retain certain units of heavy artillery under army control, and in many cases will at least lay down the special objectives to be engaged by the long-range big guns (6-inch, 9.2-inch, and 12-inch).

5. A table showing the details of organization of artillery commands is given in Appendix I.

This new organization recognizes the great importance of reconnaissance work on the part of the artillery, and each artillery staff is provided with an officer charged with the execution of such work. The study and collation of information derived from air photographs and maps, as far as it affects the artillery, form an important feature of the officer's duties.

The organization of the staff of the corps heavy artillery commander is designed to meet the double task that falls on his shoulders. Broadly speaking, destruction of defenses and of communications, combined with barrage work, comprise the one branch of heavy artillery work; counter battery work the other. It is, however, essential that no hard and fast line shall be drawn between these two main subdivisions of the heavy artillery commander's duties. Organization must be so supple as to insure that at all times it shall be a simple matter to devote any proportion of the heavy artillery to either task, according to the needs of the tactical situation, without delay and without confusion. Arrangements must be made to insure that heavy artillery groups engaged on trench bombardment are in a position to cooperate closely with the divisions interested in the hostile trenches in question.

6. Army field artillery brigades have been formed to provide a means whereby a mass of field artillery may be concentrated for any special purpose. Such brigades can be allotted to armies, corps, and divisions, as circumstances may require.

Despite this new organization, a division in the early stages of an offensive operation will often require for its support more field artillery than is afforded by its own divisional artillery, even though reenforced by such army field artillery brigades as may be allotted to it. In this event, two or even three divisional artilleries may be found supporting the operations of a single division. In such cases all this field artillery will normally be grouped under the C. R. A. of the attacking division.

7. The composition of heavy artillery groups may, as explained in "Artillery Notes, No. 3" (counter battery work), con-

sist of both gun and howitzer batteries, or of either nature separately, so long as the action of all the batteries devoted to any one area is controlled by one authority. One point, however, must always be borne in mind, and that is that the composition of heavy artillery groups must envisage the demands of an early advance. Mixed groups of medium and heavy weapons present the obvious disadvantage that in the event of a rapid advance either the medium batteries (which will be the first to advance) must break loose from their groups or fresh groups must be automatically formed to control the advancing batteries.

8. The relations between the artillery and the royal flying corps must be of the closest if these two arms are to work together effectively to the common good.

This particularly applies to the case of counter battery work, as is impressed in the "Artillery Notes, No. 3," dealing with that subject.

G. O.'s C., R. A., of armies (or corps) deal direct with the commanders of corps and balloon wings (or squadron and balloon companies) in all matters relating to their combined work, and should do all in their power to impress upon their subordinates the value resulting from mutual confidence based upon mutual understanding. The corps and balloon wing commanders are, however, the executive commanders of the corps squadrons and balloon companies, respectively, and as such act as the technical advisers of G. O.'s C., R. A., of corps, with whom they should be in the closest touch.

II. ARTILLERY IN THE GENERAL PLAN OF ATTACK.

1. THE RÔLE OF THE ARTILLERY.

The rupture of the enemy's front, generally strongly defended and organized in depth, is the first phase of an offensive battle.

This entails the destruction of the obstacles to the infantry's advance and of the means of defense that support those obstacles, the moral and physical reduction of the defenders, and lastly a rapid and combined advance of all arms acting in close cooperation.

Thereafter successive phases may comprise a modified form of the first, namely, the attack of improvised lines of defense with but little time for deliberate preparation, leading to a final phase of open warfare.

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Experience has proved that effective artillery preparation is indispensable to success, the extent and nature of the preparation depending on the scope of the intended operation. In each subsequent phase the artillery must aim at maintaining the closest touch with and affording the greatest support to the infantry. The measure of ultimate advantage will largely depend on the momentum of the first blow and the rapid exploitation of early successes before the enemy has time to recover from the shock.

2. SELECTION OF THE FRONT OF ATTACK.

Granted the vital importance of effective artillery action in the offensive, it follows that the general plan of attack must be such as to admit of a full development of artillery fire and of complete cooperation between the artillery and the infantry.

For this it is not enough that the requirements in guns and ammunition should have been carefully estimated and adequately provided. The first and most essential element of success is that the front selected for attack should be of a nature to admit of this full development and cooperation. Conditions are most favorable when the ground allows of artillery commanders—

(i) seeing clearly the enemy's defenses, and also following the movements of the attacking infantry.

(ii) controlling the fire of their guns rapidly and effectively.

For, however carefully thought out the arrangements for the control of both artillery fire and infantry movement may be, they are always liable to be thrown out of gear by some unexpected development.

It is, then, the first duty of the artillery commander to place before the general officer commanding the force full particulars as to the manner in which the ground affects the efficiency of the artillery preparation and support, so that the latter may give due weight to such considerations in selecting the front of attack. "An objective which may appear at first sight easy of access to the infantry may prove in the end costly to attack if it does not lend itself to the judicious application of artillery fire, and vice versa, localities which present difficulties to the infantry alone may, if it is possible to bring the converging fire of artillery to bear on them, be carried with comparatively little loss."

3. ESTIMATE OF GUNS AND AMMUNITION REQUIRED.

The general plan of attack having been settled, it is the next duty of the artillery commander to prepare an estimate of the amount of artillery and of ammunition required for the operation. The first point to remember is that the ammunition required depends upon the work to be done more than on the number of guns available. The latter is, however, the governing factor as regards the time which will be required for the preparation and has therefore an important bearing on the general plan of attack. If surprise forms any part of this plan, it is essential that sufficient fire units should be available to allow the different portions of the enemy's defenses to be bombarded simultaneously. The number of hostile batteries to be dealt with is another consideration directly affecting the amount of artillery that will be necessary.

The nature of guns required depends, like the ammunition, on the character of the work to be performed. Every type of gun or howitzer is particularly adapted for certain tasks, and the proportion of each type demanded should be based on such considerations.

An estimate of the guns and ammunition needed can, therefore, only be made after thorough reconnaissance of the enemy's system of defense, including his trenches, machine-gun emplacements, observing stations, communication trenches, rear lines, strong points, wire, etc. This reconnaissance must include not only the examination of the ground from all possible points of view, but also the reports of air observers and a very careful study of maps, air photographs, and of all information available in the intelligence section. This section should indicate the roads used by the enemy in bringing up reinforcements and supplies of ammunition and food, the places where they can best be blocked by artillery fire, and the forming-up places likely to be used for counter attack. The number and nature of the guns which may be brought into play by the enemy is also an important factor, as it governs the requirements for counter-battery work.[1]

It is important that the artillery commander should make this reconnaissance in company with the general staff of the formation and that the fullest information regarding not only

[1] Counter-battery work has been dealt with in a separate note (No. 3 of this series).

the enemy's defenses but also his habits should be obtained from both the artillery and the infantry holding the front.

III. THE ARTILLERY PLAN.[1]

1. SCOPE OF THE ARTILLERY PLAN.

In all offensive operations it is the duty of the artillery commander of the force engaged to prepare an artillery plan based on and supplementary to the general plan of attack.

To enable him to do this he should be informed as early as possible of the minimum resources of guns and ammunition that will be available.

The plan should consist of a clear and complete statement of the objects to be attained by the artillery and the methods to be employed. It will lay down the allotment, grouping and organization of the artillery (including medium and heavy trench mortars) for the attack, the tasks and zones of the various commands, and the arrangements for observation, communication, and the cooperation of aeroplanes and balloons. It will deal with the establishment of artillery command posts, the expenditure and supply of ammunition, arrangements for liaison with the infantry, the forward movement of batteries, and any other points regarding the action of the artillery which it is necessary to include. The measures to insure cooperation between subordinate formations and the possibility of bringing a heavy concentration of fire on to particular areas, if required, must be thought out and clearly defined. The preparation of this plan will thus involve a comprehensive consideration of all the tasks which the artillery will or may be called upon to perform during the preparation and execution of the attack.

The plan must embrace each phase of the battle, and careful arrangements must be made to insure that one phase shall follow another without any unintended break in the action of the artillery.

The lower the formation concerned, the more detailed will be both its artillery plan and the study and reconnaissance upon which that plan is constructed.

As soon as the broad outline of the artillery plan has been worked out and approved, it is advantageous to issue it to sub-

[1] See Appendix A, paragraph 2, of "Instructions for the Training of Divisions for Offensive Action."

ordinate commanders concerned, or at least to make it known to them at a conference, in order that they may have the earliest opportunity of studying and solving their individual problems. Even if circumstances ultimately entail modifications in the suballotment of artillery and in the apportionment of tasks, the inconvenience arising from minor changes in subordinate plans is far outweighed by the advantage gained by the increased time thus rendered available for consideration of the general tasks demanded and for reconnaissance. To complete the manifold arrangements essential to the successful execution of an artillery plan is necessarily a lengthy process. The early publication of the plan, even if not in all its details, will greatly assist the work of subordinate artillery commanders.

2. ALLOTMENT OF ARTILLERY.

The number and variety of the tasks which the artillery is called upon to perform necessitate very careful arrangement, if the different natures are to be employed to the fullest advantage. These tasks depend upon, and must therefore vary with the nature of the enemy's defenses and the strength of his artillery. The following principles, however, will generally apply:

RÔLES OF VARIOUS NATURES OF ARTILLERY.

Field guns (18-pounder) are primarily employed in barrage fire, repelling attacks in the open, raking communications and wire cutting. They may also be employed for neutralizing fire against batteries within their reach, and to assist in the destruction of such enemy defenses as are vulnerable to the H. E. shell of field guns, e. g., breastworks and barriers. They will also be required for the purpose of preventing the enemy from repairing damage to his defenses, where this work is beyond the power of the infantry.

Medium guns (60-pounders) are employed in counter-battery work, especially for neutralization; for raking communications, and forming barrages beyond the range of field guns.

Heavy guns (6-inch, 9.2-inch, and 12-inch) are used against villages, camps, dumps, railway stations, etc., beyond the range of other artillery. Also against observing stations, such as chimneys and church towers, and occasionally for long-range counter-battery work.

Six-inch guns are also used against balloons and for enfilading distant trenches.

Field howitzers (4.5-inch) are employed for the bombardment of the weaker defenses; enfilading communication trenches and against troops that are badly intrenched; for destructive counter-battery work against ill-protected batteries and for neutralization with gas shells; for barrage work, especially by night; also (when No. 106 fuse is provided) for cutting wire which is beyond the wire-cutting range of field guns (3,200–3,400 yards), wire at short distances from our own trenches, in hollows, on iron standards, and of the "knife-rest" type.

Medium howitzers (6-inch) are used for destruction of defenses and against intrenched troops. They are very effective for neutralizing fire against hostile batteries, though not really powerful enough to destroy well-constructed emplacements. They are of great value for destructive work in an advance, when the enemy's guns are forced back into positions more or less hastily constructed, and can also be used with No. 106 fuse for barrage fire and for wire cutting.

Heavy howitzers (8-inch and 9.2-inch); the principal rôles of these weapons are counter-battery work against batteries provided with good cover and the destruction of strong defenses. They also may be employed for barrage work with No. 106 fuse.

Superheavy howitzers (12-inch and 15-inch) are required for the destruction of specially strong defenses, bridges, etc. The 12-inch howitzer is also used with great effect for counter-battery work.

Light trench mortars[1] may be used to harass the enemy in the final stage of the bombardment, for barrage work and for the close support of the infantry. They are not usually employed during the course of the preliminary bombardment.

Medium trench mortars[1] are employed to assist other artillery in wire cutting and in the preliminary bombardment. Owing to their liability to be destroyed by hostile artillery fire it may often be advisable to defer opening fire with these mortars till the last day of bombardment.

Heavy trench mortars[1] are of value for the destruction of dugouts and strong points within the limits of their range.

In allotting tasks to guns and howitzers for the preparation of an attack on a large scale, simplicity must be the keynote of the scheme. Heavy howitzers' tasks should preferably be arranged in "lanes" in the same way as are those of field guns. Enfilade

[1] The handling of trench mortars as a whole is dealt with in Artillery Notes No. 6.—Trench Mortars.

fire against the enemy's main system of defense, in the case of all heavy artillery,[1] should, as a general rule, only be employed for special reasons (e. g., in the case of a limited offensive or of a marked salient). Guns and howitzers placed for enfilade can usually only play a very limited part in the actual attack, and the greater the success the earlier will they have to change to an entirely new arc of fire. Moreover, signal communications are greatly complicated under conditions of enfilade.

3. AIR OBSERVATION.

A great deal of artillery work, especially counter-battery work, must depend upon the cooperation of the royal flying corps. It is the duty of the artillery commander, in consultation with the royal flying corps commander concerned, to consider the most suitable allotment of the aeroplanes available and to include in his artillery plan the arrangements decided upon. A factor which must always be borne in mind is the jambing of wireless. This limits the number of machines which can work on any particular front at the same time. One machine to every thousand yards may be taken as a maximum.

Pilots and observers allotted to artillery work should, in principle, work with the same units throughout both the preparation and the battle itself and should be changed as seldom as possible. Close personal touch between pilots and observers and the battery commanders for whom they work is of the first importance.

Balloon companies are allotted to corps for artillery work and must work in close touch with the corps squadron. The selection of suitable targets for the aeroplanes and balloons is the duty of the artillery commander, who should make a point of seeing his corps squadron and balloon company commander together every evening to decide the allotment for the ensuing day. An intimate knowledge of the country is the chief essential of successful balloon observation. Balloons should, therefore, be changed from one area to another as seldom as possible.

The principles governing the work of aeroplanes and balloons for the artillery are explained fully in "Cooperation of Aircraft with Artillery" issued by the general staff, December, 1916 (S. S. 131).

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[1] Enfilade fire from field artillery will often offer great advantages (see par. 12, Sec. VI).

IV. THE PRELIMINARY ARRANGEMENTS.

1. RECONNAISSANCE.

Through reconnaissance of the enemy's defenses and dispositions and also of the ground available is the first step in the work of preparation. With this object it is of the greatest importance that the various artillery commanders should get into touch as soon as possible with the commanders of the infantry whose attacks they are to support. Equally must they establish an early understanding with the R. E., signals and R. F. C. officers on whose assistance they rely.

Maps or diagrams require to be prepared showing the artillery tasks in detail, wire to be cut, defenses to be demolished, routes to be employed by artillery in movement, signal communications, allotment of O. P.'s charts of visibility from O. P.'s, and arcs of fire or other means of showing the quantity and nature of fire that can be brought to bear on any given point.

Many of the necessary reconnaissances must be made in conjunction with the infantry or other officers directly concerned with each particular problem; so that time may be saved by all arms and branches working in close cooperation from the first. Infantry officers should examine the ground from artillery observing stations, artillery officers from the trenches and from balloons and aeroplanes, while combined reconnaissances from the ground or from the air must be completed by joint study of aeroplane photographs and maps.

By these means not only should no point for consideration be overlooked but each arm will learn to appreciate the capabilities and limitations of the others.

2. DISTRIBUTION OF WORK.

A thorough understanding of the work to be done and of the time at which it is to be done, is essential to the success of the artillery preparation and subsequent action. The work must first be divided amongst the subordinate artillery commands, e. g., in the case of a corps between the different divisional artilleries and the heavy artillery. Subordinate commanders then allot tasks and zones to their brigades and groups and the commanders of these to their batteries.

3. POSITIONS.

Positions will have to be found for the large number of extra guns, howitzers, and trench mortars which will be required for an offensive operation of any size, as well as probably for several of those already in action whose original positions were selected with a view to defense.

The artillery must aim at extending its destructive action over as deep a zone as possible and at being able to engage the enemy's most distant batteries.

These considerations and the importance of reducing movements of guns to a minimum during the earlier stages of a battle demand that a large proportion of the attacking artillery shall be placed well forward.

What this proportion should actually be will depend chiefly on the range to the various objectives, the ground, the facilities for ammunition supply and the characteristics of the matériel. It is a mistake to mass a great number of batteries within too confined an area (particularly a valley), where they may all be neutralized at the same time by a comparatively few hostile guns or by a gas attack.

It may sometimes be necessary for corps and divisions to place their batteries outside their own area. Whenever this is the case the necessary arrangements should be made by the next higher formation; but it is to be remembered that the placing of a battery outside the area of its own formation nearly always entails certain difficulties as regards signal communications, ammunition supply, and subsequent advance. This procedure, therefore, is not to be recommended unless distinct tactical advantage is thereby gained.

4. PROTECTION OF POSITIONS.

The procedure of withdrawing the detachments from a battery which is being shelled is incompatible with the preparation and support of an infantry attack, when the guns must be fought regardless of the enemy's fire. In principle, therefore, every field and medium battery should, as far as possible, be provided with cover strong enough to resist bombardment by the enemy's heavy field howitzers (5.9-inch).

Considerations of labor and matériels may, however, prove to be limiting factors, and in this case a careful system of con-

cealment (camouflage) must be adopted for such batteries as are not otherwise protected. Even so, it is essential that shell-proof cover should be provided for the detachments close to the guns. The battery command post must always be strongly protected. Large reenforcements of artillery will usually arrive within a week or two of the opening of the preliminary bombardment, and their actual positions, telephone communications, approaches, and ammunition dumps must be well on the way toward readiness, as these matters are essential to control, direction, and delivery of fire. In order that on arrival these batteries may waste no time in preparing their positions, large dumps of R. E. matériel should be made at convenient points at an early date. Tables should be prepared showing the average amount of matériel required to dig in a battery of each caliber so that indenting may be simplified and a battery be able to draw its matériels and to begin work without delay. When batteries move forward there will be a great demand for protective matériel, and this fact must be borne in mind when allotting resources.

Apart from the question of the strength of the cover provided, the concealment of emplacements should always be studied during their actual construction. As soon as work starts, either camouflaged screens or rabbit netting threaded with grass, etc., can be erected on short stakes over the area to be excavated, while the personnel work underneath. In this connection it must be remembered that during the preparation for an offensive on a large scale the difficulty of concealing guns and tracks leading to them will be greatly lessened by the fact that the ground within about 3 miles of the trenches will be broken up in every direction by numerous other constructional works.

Guns concealed in the neighborhood of ruined villages, rubble heaps, brick stacks, and so on, are particularly difficult of location from the air.

Field artillery ammunition should always be strongly protected against hostile artillery fire; while the cartridges of heavier natures should be similarly treated, even if it is not possible to do the same for the shells.

5. OBSERVING STATIONS.

The provision of a sufficient number of strongly constructed observing stations and of covered approaches to them is a matter of vital importance. To risk the interruption at critical moments of the whole system of directing artillery fire for

want of energy in this matter is inexcusable. Telephonists' dugouts and exchanges must be made practically impervious to artillery fire. All work of this nature must be treated as a matter for continuous attention, and must never be left to the eve of an offensive. Corps must arrange for considerable assistance by royal engineers in this work which can not be effectively executed by gunners alone. Every part of the hostile lines should be visible from at least one O. P.

The allotment of O. P.'s is a matter calling for the direct intervention of corps artillery commanders. All artillery headquarters, from corps downward, should possess a chart showing what can be seen of the enemy's defenses and territory from each O. P. under their control, and also a photograph of the view from each. Armed with this information it is the duty of the corps artillery commander to allot observing stations to the artillery of the corps so that the best value is obtained from them. O. P.'s will usually be allotted to certain batteries, at least as regards maintenance and control; but it will often occur with large concentrations of artillery that any one O. P. may have to serve two or even more batteries.

The establishment of special artillery observing stations for watching the progress of the infantry and reporting it to corps artillery headquarters has proved to be of great value. The probable future positions of similar stations on the far side of the hostile trenches should be studied and be made known to the infantry before the assault so that they may be available for the transmission of information in general.

6. ARTILLERY COMMAND POSTS.

The selection of artillery command posts (including brigade and group headquarters) is another important matter which must be done by general and R. A. staffs of corps in consultation. These command posts should not be changed until the time to advance arrives, when they should be moved to equally permanent positions. They must be so sited that they are likely to be out of constant shell fire, as once communication between artillery commanders and their batteries becomes impossible or even difficult, organized operations cease.

7. COMMUNICATIONS.

Previous to an offensive operation it will be necessary to provide the requisite communications for a much larger force of artillery than will normally be engaged in holding the line,

and this requires very careful organization. The actual communications to be established in each case must depend upon the organization of the artillery. They will include, in addition to the ordinary framework in the way of command posts and observing stations, the communications required by the higher artillery commanders. These latter will be laid by the signal service, but it is essential that such circuits should be kept quite distinct from the general system.

In order to save labor, and at the same time to obtain real efficiency in telephonic communications, the whole of the artillery communications in the corps should be worked out as one plan by the corps signals, who must take executive control of all artillery lines. Corps signal schemes must be coordinated by army signals. An organized system of trunk lines and exchanges in the forward area, supervised by experts, is best calculated to attain the end in view at minimum expenditure of resources. Large infantry working parties for digging in wires will be required both in the preparatory stages and after an advance. This must be taken into consideration when labor requirements are being calculated. It is impossible to take too many precautions to avoid the interruption of communication.

In addition to protecting the telephone wires, as far as this is possible, preparations must be made for the rapid opening of alternative means of communication. Visual signaling is the most important of these, and stations should be selected and established. Possible points in the enemy's line should also be selected beforehand, so that, after the attack has succeeded, intermediate observers may know where to look for signals. The establishment of central stations from which messages can be sent on by telephone will prove of great assistance. Short-range wireless sets have been successfully used (up to 7,000 yards) where visual signaling is impossible; but in such cases reliance will often have to be placed on orderlies, either on foot or on bicycle. Here, again, arrangements must be made in advance so that everyone may know what to do when the time comes.

8. CONTROL AND DIRECTION OF FIRE.

Accuracy of fire is a matter of the utmost importance. It demands studious attention to calibration of guns, calculations for atmospheric and other errors, and to the selection and thorough registration of a few well-chosen datum points which must be daily used for checking ranges.

Artillery boards, carefully prepared and kept up to date, are an essential to this system which, particularly in the case of heavy howitzers, is more satisfactory, more economical in ammunition, and less likely to disclose the amount of artillery present than was the old system of indiscriminate registration of innumerable points. The latter has proved to be neither necessary nor desirable.

In order, however, to insure that newly arrived batteries shall be able to register their datum points with absolute thoroughness, and that all batteries shall be able to check their ranges two or three times a day on these points (a matter of the utmost importance during the bombardment, and even more so on the day of attack), it is essential that corps artillery commanders shall make detailed arrangements for this work to be carried out, so that confusion of observation shall be avoided.

As already explained, the simpler the artillery fire plan is the greater the hope of its successful execution. If the ground to be bombarded be divided up into lanes and clearly defined areas, both checking ranges on datum points and observation during bombardment will be immensely facilitated. Lanes or areas[1] must be distributed on a time-table issued daily by the corps, so that every hour is fully occupied. Unless every battery commander follows a clear system based on these lines, great confusion will inevitably result and the efficacy of the artillery fire will be correspondingly diminished.

9. TRENCH BRIDGES.

The preparation and transport by artillery of portable trench bridges has not been found to be universally necessary. Trenches are crossed more easily and more quickly by the simple process of filling them in. Good, strong bridges are, however, required in large numbers for constructing ammunition routes across captured trenches in the event of wet weather, as under such conditions the filled-in places over which guns may have crossed will soon become soft and impassable.

10. AMMUNITION SUPPLY.

During the preparatory period the preliminary arrangements in connection with the supply of ammunition are amongst the first matters to be taken in hand, for the commander's power

[1]Areas should be about 500 yards square, each containing a definite target, such as a line of trench, running approximately across the center.

of maneuver is largely dependent on the supply of ammunition. To insure the smooth working of this supply, careful plans must be made from the commencement.

The construction of railways, light railways, and roads for the conveyance of ammunition must be started a long time before operations commence. Roads without railways can ill stand the strain of ammunition traffic. Wherever possible, special roads should be reserved for the use of ammunition lorries and wagons, so that their own movements and the movements of troops may not be blocked. Matériel for the extension of the light railways should be dumped near their termini, in order that they may be carried forward as soon as the advance takes place. It has often been found that the state of the ground after a bombardment makes it impossible to supply ammunition, except by pack transport, to those batteries that have advanced. Arrangements must be made beforehand to deal with these conditions if there is any possibility that they will arise.

In order to meet any possible breakdown in the railway or other unforeseen emergency an army reserve of ammunition should be made in a central position before the commencement of operations. In excess of their echelons, which must be full, corps should dump sufficient ammunition for the preliminary bombardment and for expenditure on the day of attack and the day after the attack. At least 20 per cent of the ammunition so dumped should be held in corps reserve. In addition, each battery should dump at its position sufficient ammunition for its own requirements, plus a small reserve, and not according to a fixed scale. All the ammunition should be close to the guns in order to save labor during the strenuous periods of the preliminary bombardment and the day of attack.

11. ANTIAIRCRAFT GUNS.

Antiaircraft artillery must be disposed during the preparatory period so as to prevent hostile aircraft from reconnoitering and from bombing ammunition dumps, railways, etc.

As a general guide, units forming the front line barrage are best sited at about 4,000 yards apart and at an average distance of 3,000 yards behind the front-line trenches. Units required for the second-line barrage will generally amount to about half the number of those required for the front line and should be placed at a distance of about 5,000 yards from them. Anti-

aircraft gun positions, once definitely located by the enemy, are unlikely to remain tenable for long. Units should, therefore, change their positions frequently, and this entails the selection and preparation of an adequate number of sites, each of which must be linked up to the army antiaircraft telephone system.

V. THE PRELIMINARY BOMBARDMENT.[1]

1. OBJECT OF THE PRELIMINARY BOMBARDMENT.

The task of the artillery in an offensive battle is to prepare the way for the infantry and to support and protect the infantry throughout its progress. The preparation of the way is achieved by the preliminary bombardment, which aims at—

(*a*) The overpowering of the hostile artillery.
(*b*) The physical and moral reduction of the enemy's infantry.
(*c*) The destruction of matériel obstacles to the advance of the attacking infantry and of other defenses.

Action against the hostile artillery, a matter of the greatest importance in all operations, is dealt with in detail in G.H.Q. Artillery Notes No. 3.—Counter battery Work, and will only be referred to in this paper in general terms.

2. FIRE TO EFFECT PHYSICAL AND MORAL DAMAGE.

The enemy will suffer a certain degree of physical and moral loss both from action against his artillery and from the destructive fire directed against his defenses. But his power of resistance must be reduced by further special measures. Fire must be directed with the object of denying to the enemy the arrival of reliefs, reinforcements, ammunition, and supplies of all kinds. Communications, places of assembly, bivouacs, billets, dumps, railway stations, headquarters, etc., must all be attacked by artillery on a considered and clearly ordered scheme. The share of field artillery in this work consists by day chiefly in searching communication trenches (especially trench junctions) between the points bombarded by heavier natures and other approaches that are hidden from view, while by night it will fire on communication trenches, tracks, roads, cooking places, and so on in the forward zone. The heavy artillery should fire

[1] See Section III, paragraph 3, of "Instructions for the Training of Divisions for Offensive Action."

by day and by night on roads, railways, billets, and other targets beyond the reach of field artillery. The damage to roads effected by the general bombardment has proved to be a serious obstacle to the subsequent advance. This point must be borne in mind when ordering the fire of heavy howitzers on or in the neighborhood of main roads. The use of instantaneous fuses in these circumstances may minimize the damage done.

In selecting batteries for these tasks due regard should be paid to the obvious advantage of enfilade fire against communications of all kinds.

Gas shell, if used in sufficient quantity, may give good results against such objectives as ravines and woods; especially at night, when fear of them will compel the enemy to wear gas helmets.

The guiding principle of all artillery fire against communications, etc., is to employ short, sharp bursts of fire at irregular intervals of time. By day these tasks will not call for the special employment of a large number of pieces. On the contrary, batteries of suitable caliber and selected with regard to their position should be detailed to carry out this work in addition to other duties. By night, however, fire of this nature must be much more vigorously conducted in order that the enemy's efforts to relieve or supply his forward troops may only be possible at the cost of heavy casualties and that the morale of his garrisons may derive no benefit from a comparative lull in the artillery fire; indeed, a searching shrapnel fire on approaches must be almost continuous. To achieve this without imposing on the artillery too great a burden it is necessary to reserve a certain number of field batteries (gun and howitzer) and of sections of heavy artillery, especially for night-fire tasks, or else to organize a system of reliefs of personnel within batteries. Otherwise the artillery will either be tired out before the assault, or the night fire will not be conducted with the vigor and care that are so essential. Infantry can cooperate with the artillery against near objectives by means of direct and indirect machine-gun fire.

A sound fire scheme of this nature can only be prepared after a detailed study of maps and air photographs, assisted by information gleaned from prisoners. During the bombardment itself, if of any considerable duration, the plan should be constantly reconsidered and modifications introduced, so as to keep the enemy in a state of uncertainty as to our intentions and therefore exposed to loss. This phase of the artillery action is highly

important and must never be allowed to become a mere matter of routine. Every round expended on a definite plan, right back to extreme range, is well spent.

3. DESTRUCTION OF OBSTACLES—WIRE CUTTING.

The principal obstacle that has usually to be destroyed is the enemy's wire.

Wire cutting has been in the past chiefly the "task of the 18-pounders and medium trench mortars, and is carried out in each divisional zone by the field artillery allotted to that zone, any assistance required from neighboring field artillery units being arranged by the G. O. C. R. A. Corps." The provision of instantaneous and nondelay fuses for howitzers introduces an entirely new factor into the wire-cutting problem, which it may become possible to solve far more easily and in much less time than has hitherto been the case.

"Wire cutting demands the closest cooperation between the artillery and infantry. Commanders of assaulting battalions should visit the O. P.'s of the batteries cutting the wire on their front to watch the progress of the work, and should inform the battery commanders when they consider that the wire has been properly cut. In addition, patrols should be sent out nightly during wire cutting to examine and report on the progress made during the day."

"Once gaps have been made it is the duty of divisional commanders to employ all means at their disposal to keep these gaps open during the hours of darkness throughout the period of the preparatory bombardment. These means include the use of rifle and machine-gun fire, rifle grenades, etc. Much artillery ammunition can thus be saved, and so can be used for strengthening the fire on communication trenches and other approaches." [1] The amount of artillery fire that is generally available in any offensive battle is now so great that wire as a factor of defense tends to lose much of its old importance.

4. DESTRUCTION OF DEFENSES AND THEIR ACCESSORIES.

The objectives that are to be destroyed during the preliminary bombardment are stated in the corps' artillery plan, after the ground, maps, air photographs, and all other sources of informa-

[1] See Section III, paragraph 3, of "Instructions for the Training of Divisions for Offensive Action."

tion have been thoroughly studied. To attempt complete destruction of the enemy's trenches is impracticable, except in the case of enfilade fire, and it is unnecessary. The artillery's task being to open the way for the infantry, its fire must be directed toward breaking down, firstly, the enemy's material powers of resistance, and, secondly, his means of directing his defense, incidentally thus increasing his demoralization by causing casualties and inducing confusion. The enemy's matériel powers of resistance include such targets as machine-gun emplacements, strong points, important trench junctions, selected dugouts, and other shelters. His signal communications, command posts, observing stations, water-pipe systems, etc., must be shelled with the object of disorganizing his defense. As a general principle, it is best, particularly in the case of a long bombardment, to destroy first those objectives which are most dangerous or will give the enemy the most trouble to repair.

The extent of the ground to be bombarded will naturally depend upon the objective assigned to the attack. In all cases the enemy's defenses for several hundred yards to either flank, the distance depending upon the lie of the ground and the trace of the works, must be dealt with as severely as the front of attack itself; while all salients within 1,200 yards of the front attacked, from which flanking fire could be brought to bear, must receive drastic treatment.

The enemy's system of communication (telephone and telegraph) should be broken down at the outset; fire being directed with this object in accordance with the information gleaned from prisoners and air photographs. The object will naturally be best obtained by shelling battle headquarters and telephone exchanges where many wires meet.

Important trench junctions must be destroyed so that reliefs and ration parties, etc., may be compelled to expose themselves to shrapnel fire.

Deep dugouts present an almost invulnerable target, even to the heaviest artillery; the best result that can be expected is the blowing in of some of the entrances. But such dugouts, though they afford good protection, should not prove an ultimate salvation to the enemy's infantry, who will be unable to emerge from them in time to meet the assault, if the barrage and the infantry's advance are properly coordinated and exactly executed.

Machine guns still remain a formidable asset to the defense. A certain number are housed in concrete emplacements, and these

must be destroyed before the assault takes place. The best method of dealing with machine guns which are maintained in deep dugouts and brought up to the parapet to repel an assault is considered in the paragraphs dealing with the field artillery barrage. Another method frequently employed by the enemy has been to place machine guns in shell holes and other ill-defined positions outside the actual trenches. These, though more commonly met with in the later stages of the battle, may be successfully countered by searching all the ground in front of and behind the immediate objective with shrapnel every day, a procedure calculated to make any shallow position untenable. The "creeping barrage" should finally account for any machine gunners that survive.

The destruction of observing stations is dealt with in "Counter-Battery Notes;" they must not be everlooked.

The destruction of trenches and strong points is primarily the task of trench mortars and howitzers of all descriptions, other than the field howitzer which, in future, will have nothing but instantaneous fuses and so be chiefly a man-killing weapon. "Guns can, however, be employed with advantage against breastworks, trenches taken in enfilade, barricades, houses, and other vertical targets."

"The extent to which the enemy's trenches and works should be destroyed has become a matter for serious consideration."[1] If they are more or less completely demolished, little or no cover will be left for our infantry. This, though of no moment in the preliminary bombardment of the enemy's front-line system of defense before the launching of an attack on a large scale, has been found to prove a grave disadvantage when the trenches gained have to be held; a case that will arise in a limited offensive or in the later stages of a battle aimed at gradually wearing out the enemy's power of resistance.

The bombardment of woods and villages should not consist of an indiscriminate shelling of the whole area. The portions that require bombardment, whether because they are to be captured or because they flank the advance, must be definitely determined.

In all cases it is necessary to arrange to prevent by fire the repair of destroyed or damaged defenses. In this, as with cut wire, infantry can assist to a considerable degree.

[1] See Section III, paragraph 3, of "Instructions for the Training of Divisions for Offensive Action."

5. FLEETING TARGETS.

During the course of the preliminary bombardment, opportunities will occasionally be presented of causing loss to fleeting targets (reinforcements, reliefs, working parties, or troops driven from shelter by artillery fire). Certain batteries should, therefore, be held available on the "zone-call" system to engage any such targets located from the air. Arrangements should also be made to extend this system to ground-observing stations, so that any observer, seeing a favorable target, can pass information quickly to a selected and suitable battery. There is no reason to retain such batteries solely for this purpose; they can carry out other tasks as well.

6. ACCURACY OF FIRE.

The necessity for destroying definite points in the enemy's organized system of defense demands the greatest accuracy of artillery fire, particularly when the opposing lines are but a short distance apart. The importance of accuracy can not be overestimated, and must be constantly insured by means of definite orders, rigorous fire control, and constant supervision. To this end it is essential to arrange for periodical pauses in the bombardment of each section of the bombarded area; in order that fire may be checked on datum points, the detachments rested, the equipment carefully inspected, and minor repairs effected. During these pauses every endeavor should be made to take air photographs of the hostile area, for these will disclose beyond argument the accuracy of the fire brought to bear and will enable commanders to repeat or to modify their bombardment program accordingly.

Cases will occur where effect on the enemy's front trenches can only be insured at the cost of an occasional round into our own trenches. This is a matter of pure ballistics, beyond human influence, and must be recognized as such by infantry commanders. The advisability of withdrawing infantry from their trenches during a bombardment must depend on the local conditions. If the trenches are good and the men keep down, they may be safer in the front trenches than they would be if crowded in support trenches, which may be heavily shelled at times by the hostile artillery. If the distance between the opposing trenches is such that some rounds are likely to fall in or short of our trenches, then the trenches must be cleared

for the requisite time. The only alternative is to place the "mean point of impact" of the artillery fire beyond the target. This is unsound, as it entails a much reduced chance of achieving the destruction required at a greatly increased cost of ammunition. In view of the consideration that a few of our own heavy shells dropped in a crowded trench, especially just prior to the assault, may prove disastrous to the morale of the attacking troops, it will almost always be advisable to clear our trenches for the sake of an effective fire. The enemy is not likely to rush them in any strength at such a time. It is the duty of the artillery commander to make these points clear to the general officer commanding; it is the latter's duty to decide. If trenches are to be cleared, it is important that ample notice should be given to the infantry, in order that they may have time to make the necessary arrangements for temporary evacuation and for denying to the enemy any opportunity of coming forward out of his trenches to avoid the effects of artillery fire.

7. FORWARD GUNS.

In some cases guns dug in, actually in or close to the front-line trenches, may prove of great value for special purposes, such as for making a breach in the hostile parapets or for knocking out machine guns. Provided time is available, experience shows that field guns can be got into almost any position, and that their fire at such short ranges produces a very marked effect. The secret of success lies in the most careful attention to detail. Unless every possible precaution is taken, the gun and detachment may both be put out of action before they have effected their purpose. Although there is no doubt that their presence has a great moral effect, their use must not be overdone, and they should not open fire just before the assault.

8. ADVANCED BATTERIES.

Batteries placed right forward to open fire at or after the time of assault are considered in paragraph 18, Section VI.

9. CHARACTER OF THE BOMBARDMENT.

The program of bombardment must be so arranged as to keep the enemy in a state of uncertainty as to the time when the infantry attack will be launched. The approximate hour

of assault should be settled early and not changed. It will then be possible to insure that, as far as the artillery is concerned, the actual assault shall come as a surprise. The German is peculiarly accustomed to order and regularity, and so it is advantageous to accustom him daily at the proposed hour of assault to a regular routine to which he must conform under pain of suffering casualties. Then, when the real hour comes, there will be a very good chance of letting the infantry into the enemy's trenches by making some slight alteration in that routine.

False ("Chinese") attacks are generally carried out during the bombardment with the object of inducing the enemy to man his parapets and then subjecting him to an intense man-killing fire. The infantry, trench mortars, etc., should participate in these feints so as to give the greatest impression of reality.

The lifts for the attack should be practiced during the bombardment. Officers must be detailed to watch all such shoots so that thin places in the barrage or inaccurate shooting may be rectified in time. For the former purpose balloon observations may also be employed with great advantage. Further, the results can be corroborated by means of air photographs, and arrangements should be made to photograph each practice barrage. Besides watching our own barrages, steps should be taken to observe and record those put down by the enemy, as much valuable information may be gleaned from this source.

10. THE BOMBARDMENT OF REARWARD LINES.

As already stated, a vigorous and systematic artillery fire must be maintained over the enemy's back areas up to the limits of gun range, with the immediate objects of inflicting casualties, arresting movement, and generally disorganizing his supply and other services. This will entail the deliberate destruction of many selected points in the enemy's rearward lines of defense, but does not constitute a regular bombardment.

The extent to which rearward lines must be bombarded depends on several factors. The ultimate object of the first day's attack, the range to the rearward lines, the number of guns available and the duration of the bombardment all directly affect this question. It will rarely be possible to effect any extensive damage to the enemy's third line, where such exists, owing to the factor of range which limits the number of guns that can reach the objective.

If the attack is to go through to as great a depth as possible, and if time allows, then certain points in the enemy's second line should be selected for destruction on the same principles as govern the artillery attack of the front system of defense. If, on the other hand, the attack has a limited objective, or if the attack of successive objectives, spread over several days, is contemplated, then there can be but little value in any extensive bombardment of the second line. It is not unusual to find that before the assault considerable anxiety is expressed as to the destruction done to the wire and trenches of the second line. The fighting subsequent to the assault, particularly the various barrages, will do much toward opening a way through the second line of defense. It is easy to exaggerate the resisting power of rearward defenses and to press for its reduction. But the first essential is to insure the infantry's passage over the enemy's front-line system of defense, and to take any chances in this respect in favor of more distant systems is manifestly indefensible.

11. DURATION OF THE BOMBARDMENT.

No definite guide can be laid down as to the ideal length of an artillery bombardment. The underlying factors are numerous and the daily results achieved carry great weight. Hitherto the moral effect of the enemy's wire has involved organized wire cutting, which in reality means a prolonged bombardment. It is possible, as explained in paragraph 3, Section V, that wire cutting in the future will be carried out much more rapidly. The time theoretically required to destroy definite objectives depends on their nature and extent, upon the number of fire units available, and on the facilities for observation. If fire is to be conducted deliberately and with careful observation, this period can be calculated with considerable accuracy. Shortening the period may increase the chances of surprise and may so give the enemy no opportunity of bringing up additional artillery. A long bombardment is calculated to reduce the enemy's morale by its insistence, a short one by its intensity. In all cases it is the duty of the artillery commander to watch closely the progress of the artillery preparation, making such modifications in the allotment of guns and ammunition as he may consider necessary.

The evidence of photographs, corroborated by the reports of patrols and special observers, is the surest guide to the extent

of matériel damage effected. The effect of the fire should be continuously observed by selected artillery officers and aeroplane observers. "Photographs showing the progress of the work of demolition are taken daily when conditions are favorable, and issued to all divisional commanders concerned, as well as to the corps commander. Divisional commanders must satisfy themselves that all danger points in their zones are adequately dealt with, and they should bring to the notice of the corps commander any points which, in their opinion, require further treatment. In considering the state of the enemy's defenses, as disclosed by photographs, it must be remembered that considerable further effect will be achieved by the bombardment which remains to be carried out between the time that the last photograph is taken and zero hour on the day of attack, and also by the howitzer bombardment which lifts forward from trench to trench from zero hour onward." [1]

VI.—THE SUPPORT OF THE ATTACK.

1. THE GENERAL MISSION OF THE ARTILLERY.

Adequate artillery preparation will not alone insure the success of an attack. The support of the infantry during the attack is at least as important, and in this phase the general mission of the artillery consists of—

(*a*) Beating down all resistance to the advance from either front or flanks.

(*b*) Preventing the assembly and approach of counter attacks of all sizes.

In a word, the artillery must aim at overcoming the enemy's batteries, riflemen, and machine guns that have not been destroyed during the preliminary bombardment.

2. IMPORTANCE OF CONCEALING THE HOUR OF THE ASSAULT.

Every precaution must be taken to insure that the actual assault should come as a surprise. It will probably be impossible to conceal from the enemy the intention of an attack on a large scale. If any indication of the actual hour of assault is afforded (as by an obvious change in the intensity or nature of artillery fire, bayonets showing over the trenches, advancing "tanks," etc.), the enemy's infantry will be in instant

[1] See Section III, paragraph 3, of "Instructions for Training of Divisions for Offensive Action."

readiness to man the parapets, the hostile artillery barrage may come down, and the assault may possibly never start.[1]

If, on the other hand, no notice is given to the enemy, he will not know until too late exactly where his barrage is required.

3. BARRAGES.

The barrage system has been lately developed. It must be remembered that, while the following notes deal with the procedure that has recently been the most successful, it is only to be expected that the enemy will devise new methods to defeat our barrage fire. New methods on his part will call for immediate modifications in our artillery tactics.

4. OBJECT OF THE BARRAGE.

The object of the artillery barrage is to prevent the enemy from manning his parapets and installing his machine guns in time to arrest the advance of our infantry. It has already been explained that permanent concrete emplacements for machine guns must be destroyed during the preliminary bombardment and that a daily searching of the ground with shrapnel fire is a helpful method of dealing with machine guns sited in shell holes and shallow positions in front of or behind the immediate objective. Machine guns kept in deep dugouts, or even in deep shell holes if undercut, can not be destroyed by these means, but, on the other hand, a certain period of time is required to bring up and mount such guns. Though this period is not long, it is quite sufficient to enable the attacking infantry to deal with the situation if they are close up under the barrage. The barrage must, therefore, be sufficiently heavy to keep the enemy in his dugouts and shelters as long as possible, and sufficiently accurate to allow the infantry to get so close to the trench attacked that when the barrage lifts they can cover the remaining distance before the enemy can prepare to receive them.

5. THE FIELD ARTILLERY BARRAGE.

To deal with the enemy's infantry and his variously sited machine guns the field artillery barrage may consist of "creeping," "back," and "standing" barrages applied separately or simultaneously.

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[1] See Section V cf "Instructions for the Training of Divisions for Offensive Action."

The "standing" barrage opens on each objective when it is to be assaulted, with the object of forcing the enemy to take cover and of preventing him manning his defenses before the infantry reach the position.

The "back" barrage meanwhile searches and sweeps all the ground in rear of the objective whence rifle or machine-gun fire might be directed against the advancing infantry.

Whether in addition to these two barrages a "creeping" barrage will also be required depends on the distance to be traversed by the infantry from their "jumping off" place to their objective. If this distance is such that the infantry is not sufficiently protected by the fire of the "standing" barrage against any machine guns or riflemen that may still lurk in shell holes, then a "creeping" barrage should precede the advancing infantry, with its mean point of impact at a distance of 200 yards or so in front of them, and move forward till it joins the "standing" barrage, when both barrages lift off together. It must, however, be remembered that the simultaneous employment of three barrages is to be avoided on principle, as it entails a maximum dispersion of effort on the part of the artillery available.

In the first assault, a "creeping" barrage will usually be unnecessary, as the distance between the opposing trenches will, as a rule, be such that the "standing" barrage will be all that is possible or necessary.

In later stages, when the enemy has been forced back into hastily dug trenches, the "standing" barrage may sometimes be dispensed with in favor of the "creeping" barrage which can fill the dual rôle by dwelling for a certain time on each objective to be assaulted. In this case the object of the barrage is to allow the infantry to "follow close up to the barrage from the instant it commences, and then taking advantage of this 'dwell,' work up as close as possible to the objective, ready to rush it at the moment that the barrage lifts." In either case the one essential is that the infantry shall be able to move as close up to the barrage as is possible, so that "the time which elapses between the barrage lifting and the infantry entering the trench may be less than that required by the enemy to man their parapets" and install their machine guns. Success or failure is a matter of a few seconds.[1]

[1] See Section III, paragraph 4, of "Instructions for the Training of Divisions for Offensive Action."

The barrage will meanwhile approach the next objective, picking up the back barrage en route and being organized on a similar system to that arranged for the first objective.

6. STRENGTH OF FIELD ARTILLERY BARRAGES.

The following figures may be taken as a general guide to the relative strengths of field artillery barrages.

One 18-pounder gun per 15 yards should provide adequate barrages of all natures.

An 18-pounder "back" barrage does not require a large number of guns; about one-eighth of the total available should suffice.[1]

7. THE ORGANIZATION OF THE BARRAGE.

The barrage lines throughout the corps must be arranged by the G. O. C. R. A. corps, in accordance with the corps commander's directions, after consultation with divisional commanders, and are best communicated to subordinate commanders in the form of a map showing all the lifts. No changes should be permitted once the barrages have been worked out and issued, except on a change of the general plan of attack.

It is laid down ("Instructions for the Training of Divisions for Offensive Action")—issued by the general staff, December, 1916—section 135, p. 62, par. 3 (i), that the front or jumping-off trench must be as nearly parallel as possible to the enemy's front line so that the leading waves may jump off square to their objective. This is of great importance to the placing of the barrage, as the first objective (the enemy's front trench) can thus be subjected to a barrage from the heavy artillery along its whole length, and then to an 18-pounder barrage followed by a simultaneous assult by the infantry. Against subsequent objectives, however, it will often follow that the infantry can not jump off from a parallel line, and in this case the barrage should swing so that it is parallel to the objective along its whole length before it finally lifts on to the objective. Occasionally it may be difficult to execute this "swing" of the barrage; in such cases the alternative method is to arrange for each small sec-

[1] Where both "creeping" and "standing" barrages have been employed it has been found that the latter has usually consisted of about one-third of the available guns, the "creeping" barrage of the rest, but the proportion must depend on the ground and on the dispositions of the enemy.

tion of the barrage, as it reaches the trench line, to stop there until gradually the whole length of the barrage has been built up. In both cases the barrage ultimately lifts off simultaneously; the fact that certain portions of the assaulting lines are kept waiting while the barrage either swings or is built up does not matter. A barrage that remains parallel to the jumping off the line does not keep the troops waiting in the open; but the infantry's arrival on the objective is not simultaneous and, wherever the trench bends, there is an open space between the barrage and the part of the trench occupied by our troops. This may contain the entrance to a dug-out and it is quite possible that the enemy's machine gunners may receive warning and get their guns mounted in time (see Appendix II).

8. PACE OF THE BARRAGE.[1]

"(i) The secret of a successful assault rests upon the assumption that the infantry conform their movements exactly to the timing of the barrage. The importance of this timing, therefore, can not be overestimated. If the lifts are too quick, the pace will be too fast and the infantry will fail to keep up with the barrage. Once this happens the whole advantage of the barrage will be lost, as the enemy will have time to man his parapet before the infantry reach it. The advance will then be brought to a standstill under close-range enemy rifle and machine-gun fire, while the barrage moves farther and farther away in accordance with the time table.

"If there is too long a pause between each lift, the pace will be too slow, and the rear waves will push on too fast and become mixed up with the leading waves, thereby forming a thicker line and increasing casualties, besides losing the driving power which a series of waves gives to the attack.

"(ii) It is impossible to lay down any definite ruling as to the best pace; it must be regulated entirely by local conditions." The great thing is not to go too fast. The pace must be such that the slowest man can easily keep close up under the barrage. One hundred yards in 3 minutes is a good average pace over dry ground pitted with shell holes.

"The state of the weather, the extent to which the ground is cut up by shell fire, the length of the advance, the number of

[1] See Section III, paragraphs 5, 6, and 7, of "Instructions for the Training of Divisions for Offensive Action."

enemy trenches to be crossed, all affect the pace at which the infantry, and consequently the barrage, can move. In actual practice, the pace has varied from 75 yards a minute, when conditions were very favorable, to 15 yards a minute when they were very unfavorable.

"(iii) A uniform pace throughout the advance is unsound; at the commencement the pace of the barrage should be quicker, gradually slowing down toward the finish as the men become exhausted, in order to give them time to get close up to the barrage and to pull themselves together for the final rush.

"In the case of a long advance, it is advisable to keep the barrage on the objective for a double period, in order to make quite certain that the men are closed up and ready to rush the trench.

"Above all, it is essential that in the attack of a more or less intact system of defense the infantry should cross 'No man's land' as quickly as possible. To achieve this, it is of vital importance that the infantry should start off at zero time with absolute punctuality, for any delay at this moment may be disastrous."

9. TIME TABLES.

"The timing of the barrage is fixed, as part of the corps artillery plan, by the corps commander after consultation with divisional commanders, particular attention being paid to the points of junction between divisions to insure that the barrages on each divisional front overlap properly.

"The timings worked out are then embodied in a program or time table and issued to all concerned.

"The duration of the barrage depends on the number of objectives to be gained.

"Where there is only one objective, the barrage, after lifting off the objective, will continue to creep forward till it reaches a line about 300 yards beyond the objective. This distance is necessary to give room for outposts to be pushed out to cover the consolidation.

"The barrage then becomes stationary and gradually dies down, ceasing altogether as soon as the infantry report that they have secured the objective.

"When there is another objective there will be a certain pause, previously arranged and laid down, to enable the troops detailed for the assault of the next objective to get into position;

the barrage will then commence moving forward again in accordance with the time table."

10. CONTROL OF THE BARRAGE.[1]

"(i) The control of the barrage remains in the hands of the corps commander throughout the assault, but, in order that divisional commanders may be able to deal promptly with any situation which may arise on their front, they will be given a call on a certain number of batteries (18-pounder, 4.5-inch and 6-inch howitzer) from the commencement of the assault.

"All batteries thus detailed will have tasks allotted to them in accordance with corps orders and will carry them out, unless and until their assistance is demanded by the divisional commander concerned.

"The divisional commander will demand the assistance of these batteries through the commander of all the field artillery supporting his division. The latter officer will have his headquarters at divisional headquarters, if possible, and will be in drect communication with all the field artillery groups under him and also with the G. O. C., R. A. corps.

"(ii) To enable commanders of assaulting brigades to take immediate action in any situation which may arise, the divisonal commander may delegate to the brigadiers concerned the power to call direct on some of the batteries placed at his disposal.

"The brigadier will call on these batteries through the commander of the field artillery directly supporting his brigade. This latter officer will, whenever possible, establish his headquarters in the immediate vicinity of the infantry brigade headquarters, but where this is not possible he will maintain the closest touch with the infantry brigadier by means of a senior artillery liaison officer.

"The governing factor as to which of these two methods should be followed is to a great extent a question of communications. Unforeseen situations will always arise necessitating the passage of orders and information between a divisional C. R. A. and his group commanders. If the headquarters of an infantry brigade is so placed that communication between an

[1] See Section III, paragraphs 5, 6, and 7, of "Instructions for the Training of Divisions for Offensive Action."

artillery group commander at or near those headquarters and his divisional C. R. A. has a reasonable prospect of remaining continuously open, such is the best solution. If not, then the artillery group commander is better represented by a responsible liaison officer.

"(iii) Except when minor operations by single battalions are being carried out, it will usually be unnecessary to give officers commanding assaulting battalions the power to call on batteries, and consequently these officers will not require artillery liaison officers."

11. RATE OF FIRE AND DEPTH OF LIFTS.

The rate of fire of 18-pounders should never exceed 4 rounds per gun per minute and this rate should only be maintained for short periods. The equipment will not stand more.

Field artillery lifts should be approximately 100 yards at a time. Intermediate lifts must be arranged so that any trenches or works in front of the objective are included in one of the lifts, and so that the final lift brings the fire right on to the objective. Except in these cases lifts of less than 100 yards are disadvantageous, as time is lost in adjusting the sights, and experience both in the field and on the range shows that at average ranges a 100-yard lift every three minutes completely searches the whole ground.

12. ENFILADE FIRE.

Enfilade fire is of value in the support of an infantry assault not only on account of its great effect, but also because of the accuracy with which it can be used. If the guns placed in position for this purpose are anchored and carefully registered for line on the enemy's front trench when at extreme traverse, the fire can be moved forward slowly as the infantry assault; but their utility comes to an end as soon as the other limit of traverse is reached. Guns so placed can also be used to form a "cross-barrage," i. e., one formed by guns firing at right angles to one another, which will insure some fire from a flank on any route which is attempted through the barrage. Care must be taken in using enfilade fire in support of an attack that there shall be no risk of hitting any bodies of our own infantry on the flank of or beyond those which the guns are immediately supporting.

13. AMMUNITION FOR THE FIELD ARTILLERY BARRAGE.

The barrage has two main properties:

(*a*) It is a man-killing agent.

(*b*) It acts as a screen to cover the movements of the infantry from view.

Therefore shrapnel (with long corrector) presents distinct advantages for use in a "creeping" barrage under which the infantry has to advance, owing to the high proportion of possible man-killing missiles released by the burst of the shell and to the smoke cloud given off. If a large proportion of H. E. shell is employed, the covering screen will be too thin and the enemy will be able to bring aimed machine-gun fire to bear through the barrage from positions in rear. H. E. shell may, however, prove very valuable to cover attacks on woods and villages.

It is possible that the future may bring about considerable modifications in the method of carrying out barrages in view of the introduction of smoke shell. The use of H. E. shell for the "creeping" barrage may be capable of increase if preceded by a smoke barrage to form the necessary screen; or a mixed shrapnel and smoke barrage may conceivably be found useful, either of these methods releasing 18-pounders for the back barrage. H. E. and smoke shell, again, may prove of great use in this latter form of barrage. The employment of smoke shell is, however, still in its infancy, and the above possibilities are only to be regarded as indications of the direction in which artillery thought may ultimately turn.

14. THE HOWITZER BOMBARDMENT.[1]

At the moment of assault the enemy's artillery is a target of vital importance, and an adequate number of batteries must be employed to reduce the enemy's guns to comparative impotence. All howitzers not engaged in counter battery work should begin an intense bombardment of the enemy's trenches, working up lanes in the same manner as the field artillery barrage. It depends upon the ground whether this bombardment moves forward just in front of the field artillery barrage or whether it dwells on commanding points in rear within machine-gun range, thus increasing the strength of the back barrage.

[1] See Section III, paragraph 4 (ii) of "Instructions for the Training of Divisions for Offensive Action."

The moral effect of the former procedure is very great.[1] In either case this bombardment ultimately "works forward well beyond the objective and then remains stationary on trenches, hollow roads, woods, villages, etc., where the enemy might assemble for a counter attack. The effect of this bombardment can be increased if indirect machine-gun fire is brought to bear simultaneously on the areas which are being bombarded, with a view to dealing with any of the enemy who attempt to escape the bombardment by leaving their trenches, etc."

15. CONSOLIDATION AND COUNTER ATTACKS.

The artillery plan must include arrangements necessary to insure the protection of the infantry after their ultimate objectives have been gained.

At every pause of any considerable length care must be taken that trenches, works, and approaches on the immediate flanks of the general infantry line, as well as areas suitable for the assembly of counter attacking troops, are kept under fire. The extreme flanks, where they bend back to the original line of departure, present an opportunity to the enemy unless they are rendered unapproachable by fire.

A final or "protective" barrage must be maintained beyond the ultimate objective as long as it is required by the infantry (see par. 9).

The rate of fire can gradually slacken, and medium and heavy howitzers need not ordinarily be used after the first hour unless called for; but any attempt to economize ammunition at this period may lead to the undoing of the whole attack. The principles of crushing hostile counter attacks must be thoroughly understood. It is a critical period for the infantry when they first become exposed to the hostile artillery fire in preparation of the main counter attack, which will not, of course, ordinarily develop for some hours. The artillery, however good the counter-battery work, can not prevent the infantry being shelled at this period when distant or even new hostile batteries will probably have come into action and when every hostile gun that can fire will do so, regardless of losses. But the artillery, working in conjunction with the air service, should be able to prevent the

[1] A mixed barrage—that is, a barrage of field and heavy artillery combined—has been found very efficacious as covering fire in the attack of a wood.

enemy from assembling for a counter attack. That must be the chief aim of the artillery. If, however, the enemy does manage to launch a counter attack, then the guns must bring it to a stop.

Directly the enemy's artillery preparation begins our artillery must fire in counter preparation. The enemy's batteries must be engaged; a destructive fire directed on his foremost trenches, works, and likely places of assembly; and all approaches and roads, as well as billets, dumps, etc., must be shelled.

Fire in counter preparation must be conducted with an energy and intensity superior to that of the enemy and last for as long a time. At the first sign of an infantry attack a strong protective barrage must be at once placed close in front of the infantry throughout the length of the line attacked.

16. ZONE CALLS.

(See "Cooperation of Aircraft with Artillery," 1916, pars. 22–25.)

The zone-call system has proved its value in battle. Batteries should be specially detailed to answer zone calls and deliver an overwhelming fire on every target notified by this means. The material results are often great, but the moral effect is greater still. The hostile infantry feel that if they are seen moving even in a trench by an airman, a heavy fire is quickly brought to bear on them and their morale suffers accordingly.

Zone calls from the air have proved particularly useful while the infantry are consolidating under cover of the protective barrage. Targets presented by bombing parties preparing to attack our "stops," local reserves leaving their dugouts and larger bodies farther to the rear, forming up for counter attack can be quickly and effectively engaged by this means. It is for these reasons that, when arranging barrages, some batteries should always be earmarked to receive and act upon these calls, most particularly at that period when the final objective has been gained.

17. INFORMATION AND COMMUNICATION.[1]

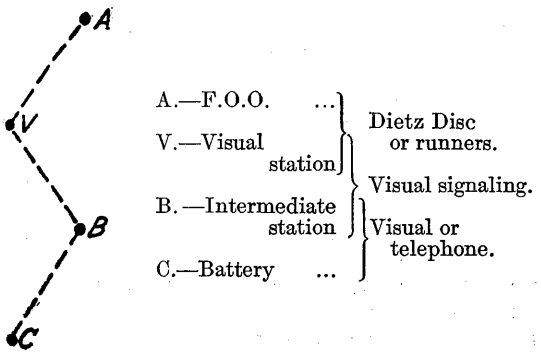
The chief trouble of the artillery is lack of information during the first hours of the battle, for infantry find it extremely difficult to report their exact positions in a shelled country whence all landmarks have disappeared.

[1] See Section III, paragraph 8, of "Instructions for the Training of Divisions for Offensive Action."

Reliable communications and constant touch between artillery and infantry commanders are essential to successful cooperation; but difficult to achieve in the actual course of a battle. Every possible means must be considered and utilized where suitable; telephone, signaling apparatus, wireless sets, rockets, flares, light pistols, carrier pigeons, messenger dogs, and, above all, runners. For the first hour or so after the assault, until communications can be well established, the difficulty of maintaining communication between the two arms is felt, and this difficulty increases when the artillery make their first advance.

Lights.—During these periods communication will generally be restricted by force of circumstances to calls for barrage fire by means of light signal rockets or light pistols. All such signals from the front line must be repeated back by intermediate stations, if necessary as far as the batteries themselves.

Visual signaling often proves a valuable adjunct for maintaining communication in difficult positions and can be used in combination with telephones and runners. The following system has been found useful:



"*Colored flags*, carried by one or two men in each platoon, can be used to indicate to the artillery the line gained by the leading infantry. These flags must not be stuck in the ground and will mean nothing unless they are waved; the poles should be short and blunted at the end. A combination of black and yellow on a flag about 18 inches square is the easiest to observe."

"*Flares.*—The position of the leading infantry has been successfully indicated to aeroplane observers (and so transmitted to

the artillery) by the lighting of flares at certain prearranged times or at an agreed signal from the aeroplane." [1]

Special artillery observing stations have already been mentioned as a means of great value for watching the progress of the infantry (see par. 5, Sec. IV).

Artillery command posts have also been discussed so far as regards their position (see par. 6, Sec. IV). The work of the heavy artillery is so intimately connected with that of the field artillery that direct communication should always be established between divisional artillery commanders and commanders of either corps heavy artillery or of heavy artillery groups, according to the artillery plan; so that in the stages subsequent to the assault no time may be lost in rapid intercommunication and consequent action when required.

Battery commanders must be where they can best see the general situation. Once the attack has been launched this changes so rapidly that there is often no time to receive orders from higher commanders, and battery commanders must be prepared to act instantaneously on their own initiative, of course informing their brigade or group commander of the action taken.

18. THE ARTILLERY ADVANCE.

Artillery on the move is for the time being useless and the advance, particularly that of heavy artillery, is a lengthy process unless it has been worked out in every detail.

Continuity of artillery in action can only be obtained if its advance is made by echelons and practically without interruption.

The next positions must be decided, at least approximately, for each brigade or group and the time when it will probably have to move must be considered.

In order to assist the necessary continuity of artillery fire it will often be advantageous to place certain batteries in action close to the front trenches, with the proviso that they do not open fire before the attack takes place. Such positions must be carefully concealed.

Additional positions in this area may be earmarked, or even prepared, for other artillery and should be capable of early occupation. Even if the emplacements can not be dug, it should be

[1] See Section III, paragraph 8, of "Instructions for the Training of Divisions for Offensive Action."

possible to do much toward preparing the artillery boards, communications, and approaches. Here again camouflage must be freely employed.

The provisional selection of positions between the trenches or beyond the enemy's front line must be based upon study of the map and air photographs, assisted by personal reconnaissance from observing stations.

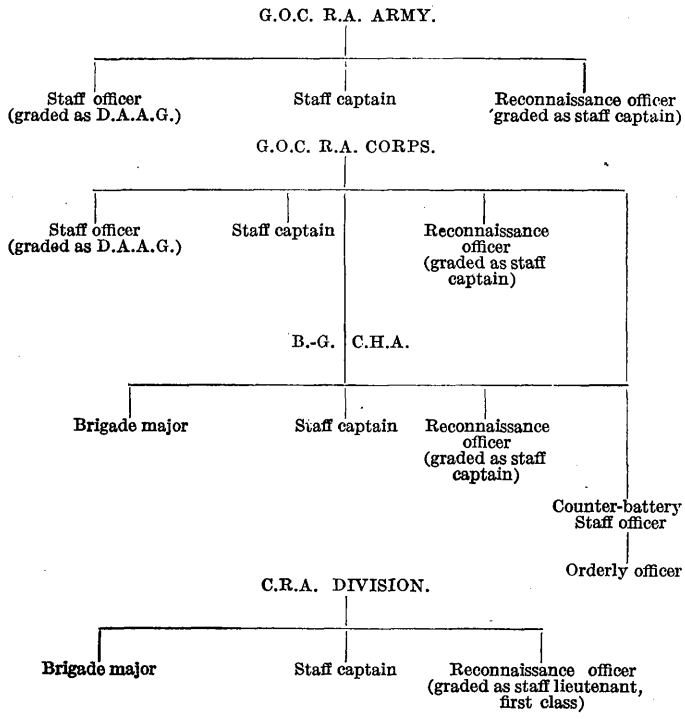
For all positions that are not constructed before the attack (see Appendix III), the artillery commander and the general staff concerned must consider the provision of labor. The mass of artillery will have been at work almost unceasingly since the opening of the bombardment and, if their fire is to be reopened after movement with minimum delay, every endeavor should be made to assist the batteries with personnel for labor.

The amount of artillery that is called upon to advance early will of course vary directly as the measure of success is attained; but, whatever the number of batteries involved, support of the infantry remains the foremost consideration. As the infantry push well ahead, the first step in their distant support is assured by means of those batteries which have been placed right forward. The first batteries to move will be certain field batteries and a proportion of the more mobile heavy artillery units (60-pounders and 6-inch howitzers) which must have been earmarked for this duty. If it is possible to relieve these batteries of any participation in the first phases of the battle, their subsequent movement can be made at short notice. Their routes must have been ordered in advance and improved where necessary. Beyond this again it will naturally follow as a principle that the most retired batteries must be moved forward early, before the battle line progresses beyond the limits of their range and while the more advanced batteries have sufficient range left to cover their movement without unduly weakening the artillery support.

While field artillery is in motion, an increased responsibility will be thrown on the heavy artillery as regards the direct support of the infantry and this also must be arranged for.

Careful organization is necessary for the proper command of guns pushed forward battery by battery, particularly in the case of heavy batteries. These latter must either be attached to divisions or, if it is desired to retain them under Corps control, may be organized to form a special heavy artillery group under a selected commander.

APPENDIX I.


G.O.C. R.A. ARMY.
Staff officer (graded as D.A.A.G.)
Staff captain
Reconnaissance officer (graded as staff captain)
G.O.C. R.A. CORPS.
Staff officer (graded as D.A.A.G.)
Staff captain
Reconnaissance officer (graded as staff captain)
B.-G.
C.H.A.
Brigade major
Staff captain
Reconnaissance officer (graded as staff captain)
Counter-battery Staff officer
Orderly officer
C.R.A. DIVISION.
Brigade major
Staff captain
Reconnaissance officer (graded as staff lieutenant, first class)

APPENDIX II.

DIAGRAMS OF BARRAGES.

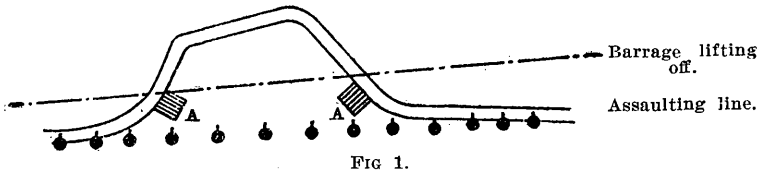


FIG 1.

A.—Dugout from which machine gun can be produced before men in front can get in to bayonet the gunners.

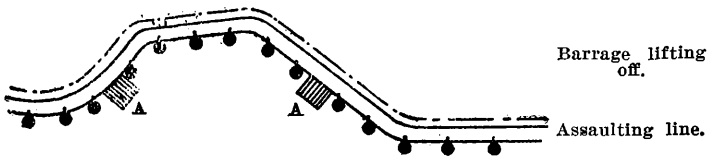


FIG. 2.

Infantry rushing the trench at all points simultaneously.

APPENDIX III.

SCHEME OF WORK TO BE UNDERTAKEN BY A BATTERY TO OBTAIN COVER WHEN IT HAS ADVANCED TO A NEW POSITION BEYOND OUR OLD FRONT-LINE TRENCHES.

1. Dig a pit for each gun deep enough for the gun to fire at the lowest angle of depression when just clearing the ground level.

The pit should be as small as possible consistent with the quick working of the gun and the maximum switch which may be required. The exact measurements should be worked out beforehand for varying angles of maximum switch. The excavated earth must be thrown to the sides and back of the pit, making a parapet not more than 1 or 2 feet above ground level around the pit, except at the front.

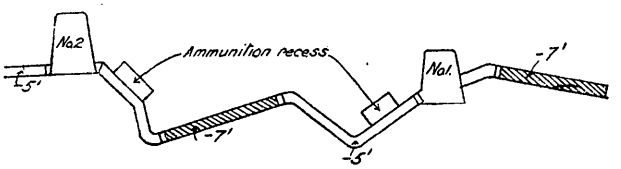
2. Camouflage the pit as far as possible; a tarpaulin over the gun, stretched across the pit, is a good method for use when the guns are not in action and wire netting stuffed with grass or other means of camouflage are not available.

3. Connect up the gun pits by digging a zigzag trench 3 feet wide at the bottom and 5 feet deep; when matériel is available the trench should be camouflaged by roofing; a deep covering of earth should not be allowed on the roof.

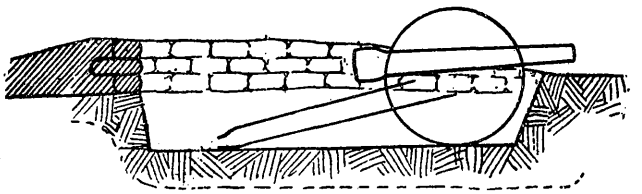
4. If matériel for cross strutting the top of the trench is available, this trench should then be deepened in places to 7 feet, but if strutting matériel is not available the shallower trench is the safer.

(A well-strutted trench, 7 feet deep, affords better cover than hastily constructed dugouts.)

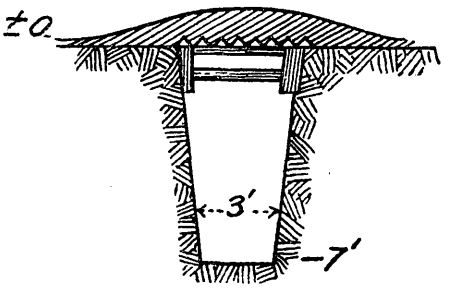
5. Construct ammunition recesses near the gun pits. In the case of the heavier natures of artillery these can only be used for cartridges.



PLAN.



Sectional elevation through center of pit.



Sectional elevation of deep part of trench.

APPENDIX IV. (1).

ESTIMATE OF THE AVERAGE AMOUNT OF AMMUNITION REQUIRED PER GUN OR HOWITZER, UNDER NORMAL CONDITIONS, FOR SEVEN DAYS' "ALL OUT" FIGHTING—TO BE PLACED AT THE GUNS OR WITHIN EASY REACH.

Estimate for an army.

Nature.	Rate per day.	Total for 7 days.
18-pounder	200	1,400
4.5-inch howitzer	150	1,050
60-pounder	150	1,050
6-inch gun	100	700
6-inch howitzer	150	1,050
8-inch howitzer	110	770
9.2-inch howitzer	110	770
12-inch howitzer	70	490
15-inch howitzer	25	175

N. B.—Individual batteries may require more ammunition according to their positions and tasks.

APPENDIX IV. (2).

AMMUNITION IN RELATION TO TASKS.

The following figures may be taken as a rough guide to the amount of ammunition required for the tasks specified under normal conditions and for medium ranges:

Task.	Weapon.	No. of rounds.
1. Wire-cutting.....	18-pdr.....	7½ rounds (shrapnel) + 5 % H.E. per yard of front, for a depth of wire not exceeding the 50% zone of the gun at the range.
	2″ T.M.....	(Fuse percussion No. 107—Instantaneous) 1 round per 10 square yards of barbed wire. 1 round per 6 square yards of loose wire.
2. Trenches — frontal fire—		
(*a*) Destruction of selected points, averaging 30 yards apart.	2″ T.M.....	100 rounds per point, *i. e.*, 3⅓ rounds per yard run.
	6″ or 8″ How....	80 rounds per point, *i. e.*, 2⅔ rounds per yard run.
	9.2″ How.....	60 rounds per point, *i. e.*, 2 rounds per yard run.
		This expenditure should entail a general measure of destruction of the trench between selected points.
(*b*) Total destruction	2″ T.M	5 rounds per yard.
	6″ or 8″ How....	4 rounds per yard.
	9.2″ How.....	3 rounds per yard.
3. Trenches — enfilade fire.	2″ T.M.....	Allow one-half of the above rates.
	6″, 8″ and 9.2″ Hows.	
	18-pdr.....	20 rounds (H.E.) per yard—for total destruction.
4. Machine gun emplacement (roof of 3 rows of pit-props); if stronger use 9.2″ Hows. or 9.45″ T.M. only.	2″ T.M.....	80 rounds (assuming top cover does not exceed 3′ earth).
	6″ or 8″ How...	65 rounds (assuming top cover does not exceed 3′ earth).
	9.2″ How.....	50 rounds (assuming top cover does not exceed 3′ earth).
	9.45″ T.M.....	50 rounds (assuming top cover does not exceed 3′ earth).

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Task.	Weapon.	No. of Rounds.
5. Very strong points (concrete roofs or deep dugouts).	8″ How.	130 rounds per point.
	9.2″ How.	100 rounds per point.
	12″ How.	75 rounds up to 9,500 yards. 100 rounds over 9,500 yards.
6. Cellars	9.2″ How.	8 rounds } per 100 square yards of actual cellar area.
	12″ How.	4 rounds } per 100 square yards of actual cellar area.
	15″ How.	4 rounds } per 100 square yards of actual cellar area.
7. Houses	6″ How.	12 rounds } per 100 square yards of actual built-over area.
	8″ How.	10 rounds } per 100 square yards of actual built-over area.
	9.2″ How.	8 rounds } per 100 square yards of actual built-over area.
8. To prevent repair of damaged defences.	18-pdr.	250 rounds per 12 hours per 300 yards length of target.
9. Night firing on communications.	18-pdr.	50 rounds per point per hour.
	4.5″ or 6″ How. or 60-pdr.	35 rounds per point per hour.
10. Smoke barrages	18-pdr.	2 rounds per 10 yards per minute.
	4.5″ How.	Groups of 8 shell at 200 yards interval per 2 minutes.
11. Gas shell	4.5″ How.	See "Instructions on the Use of Lethal and Lachrymatory Shell"—O. B. 816.
	60-pdr.	