

TACTICAL EMPLOYMENT
OF HEAVY ARTILLERY

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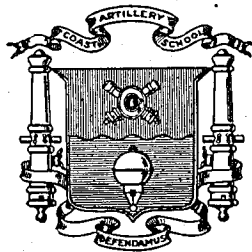
Tactical Employment of Heavy Artillery

(Provisional)

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PREPARED BY
THE COAST ARTILLERY BOARD

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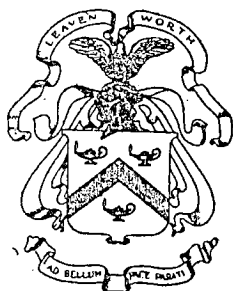
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TACTICAL EMPLOYMENT OF HEAVY ARTILLERY

Chapter I.

INTRODUCTION

From the standpoint of tactics artillery may be divided into five classes, as follows:

(a) Light Artillery—small caliber artillery such as is normally assigned to divisions.

(b) Medium Artillery—medium caliber artillery such as is normally assigned to corps.

(c) Heavy Artillery—large caliber artillery such as is normally used as army artillery, attached to armies for special missions or assigned to the defense of harbors and other strategic points on the coast line.

(d) Anti-Aircraft Artillery—all artillery designed to fire against moving aerial targets.

(e) Trench Artillery—light weight artillery designed to throw heavy bombs.

Inasmuch as the Coast Artillery Corps is charged with only the heavy artillery, anti-aircraft artillery, and trench artillery, the tactics of these types only will be considered.

Heavy artillery has two distinct classes of missions. The first relates to coast defense and the second to land warfare. When used in coast defense operations, the targets of heavy artillery generally will consist of naval vessels which, in most cases, will be moving. In land warfare, on the other hand, targets generally will be stationary. The tactics of heavy artillery is considered, therefore, under corresponding headings.

Chapter II.

EMPLOYMENT OF HEAVY ARTILLERY IN COAST DEFENSE

PRINCIPLES OF COAST DEFENSE

The recent development of matériel and the methods of employing it has made it necessary to revise our scheme of national

defense, and accordingly the present approved Coast Defense Project calls for a positive defense against enemy landings on our seacoast.

The project assumes that a successful invasion of the United States must be directed against certain vital areas, and that defense against invasion would consist of preventing landing operations within such areas.

Our line of defense will consist of the fortified harbor defenses, more or less highly organized beach defenses lying between the harbor defenses, and areas considered impracticable for enemy landings,—which will be kept merely under observation.

Our harbor defenses, now designated Coast Defenses, are *strong points* of the line of defense. They are provided with heavy artillery, anti-aircraft artillery, mines, automobile torpedoes, etc., and with infantry supports for local protection. They are designed to guard our naval bases and our harbors and cities against seizure or bombardment by the naval forces of the enemy.

It is contemplated that when war becomes imminent, the troops allotted to coast defense will be concentrated at selected points and the vital areas will be prepared for defense. Considering the difficulties under which a landing force must operate, and the ineffectiveness of accompanying artillery fire, especially when the firing ships can be held far off-shore, a comparatively small defending force should be able to retard the enemy until the necessary supports and reserves can be brought up. Furthermore our aerial patrol which purposes to cover the sea area 150 miles from shore should be able to keep us in touch with the enemy's movements for a considerable period of time before he launches an attack.

When the defenses have been prepared, all troops except those required to man the defenses, and small patrols for observation of the coast between prepared positions, will be withdrawn to support and reserve positions.

The rôle of our navy must be purely offensive. It is maintained to defeat the enemy naval forces on the high seas and not for the local defenses of our coast in whole or in part. In time of war, however, it does furnish a coastal patrol consisting of land observers, air and naval craft, and auxiliaries such as submarines, patrol boats, etc., to assist in the defense of our harbors.

The system of defense outlined above in its general features is a foundation upon which all our tactical resources must be coordinated, and the resources of the Coast Artillery must be

employed in the furtherance of this system of positive seacoast defense.

MISSIONS OF HEAVY ARTILLERY IN COAST DEFENSE

A study of the policies of national defense shows that heavy artillery (fixed, railway and tractor) has the following missions:

(a) To prevent the occupation of our harbors and the use of their facilities by the enemy.

(b) To prevent naval bombardment of and raids on coastal cities and military and naval bases.

(c) To furnish strongly fortified bases from which our naval vessels acting on the offensive may operate.

(d) To repel an enemy fleet supporting a landing in force.

(e) To support the field army operating against enemy forces who are attacking our land frontiers or who are attempting to land or have succeeded in landing on our seacoast.

Consideration of the missions given above shows that heavy artillery, in order to perform its missions against enemy vessels, must be able:

(a) To sink, or drive away by its fire, such hostile naval vessels as attempt to enter our harbors; or to prevent the use by the enemy of harbors whose entrance defenses have fallen. In the latter case fire may be against enemy vessels lying in the harbor, or in exceptional cases, against the utilities of the harbor.

(b) To sink, or drive away by its fire, such hostile naval vessels as attempt to bombard our coastal cities and military and naval bases.

(c) To insure unmolested entrance into or exit from our naval bases by our own naval vessels. This would include holding the hostile fleet at such distance that our debouching fleet may take up a battle formation before coming under effective fire of the enemy.

(d) To sink, or drive away by its fire, hostile naval vessels supporting a land force, or attempting to land raiding parties in the vicinity of our coastal cities and military or naval bases.

(e) To sink, or drive away by its fire, hostile transports or supply vessels attempting to land troops or supplies on our coast.

In addition to the above, heavy artillery employed against naval vessels must be able to protect itself by its own fire against naval vessels attempting to destroy it by artillery fire alone or in conjunction with small land and air forces.

HEAVY ARTILLERY AVAILABLE FOR COAST DEFENSE

The following heavy artillery suitable for firing against moving targets is either on hand or in project for early completion and supply:

PRIMARY ARMAMENT

Cal.	Type cannon	Type mount	Angles of Elevation	Max. Range	Range Classification
16"	Gun	Fixed	-3 to 65	44,850	Long
16"	Gun	Fixed	-5 to 30	38,800	Long
14"	Gun	Ry.	0 to 50	41,570	Long
12"	Gun	Ry.	15 to 38	27,500	Long
12"	Gun	Fixed	0 to 35	29,130	Long
16"	How.	Fixed	-5 to 65	24,940	Medium
16"	Gun	Fixed	-5 to 20	23,000	Medium
14"	Gun	Fixed	-5 to 20	22,500	Medium
14"	Gun	Fixed	-5 to 20	19,700	Medium
12"	Gun	Fixed	-5 to 15	18,630	Medium
12"	Mortar	Ry.	20 to 65	15,291	Medium
12"	Mortar	Fixed	45 to 65	19,319	Medium
12"	Mortar	Fixed	45 to 65	15,291	Medium

SECONDARY ARMAMENT

8"	Gun	Ry.	0 to 42	23,950	Medium
7"	Gun	Ry.	-4 to 15	16,900	Medium
155 mm.	Gun	Tractor	0 to 35	17,186	Medium
6"	Gun	Fixed	5 to 15	17,700	Medium
6"	Gun	Fixed	-5 to 12	15,930	Medium
10"	Gun	Fixed	-5 to 12	14,200	Short
8"	Gun	Fixed	-5 to 12	12,900	Short
3"	Gun	Fixed	-5 to 15	8,950	Short
3"	Gun	Fixed	-5 to 12	8,100	Short

All primary armament is to be supplied with its accuracy life of armor piercing shot designed to pierce the heaviest armor carried by modern capital ships. In addition, all pieces that are mobile will be supplied with 25 per cent of this amount of common steel shell for land warfare.

The secondary armament is to be supplied with common steel shell only. This shell will be able to penetrate the plates of lightly armored vessels.

At present there is a great variety of projectiles on hand for both the primary and secondary armament. Old armor piercing shot and shell and common steel shell are on hand for several calibers and it may be some years before some of it, notably that for the 12" mortars, is replaced by more modern projectiles. For secondary armament, all such projectiles will be retained as part of the regular allowance.

FIRE EFFECT ON NAVAL TARGETS

To determine the effect that can be expected from the fire of our heavy artillery on naval targets it is necessary to consider the possibilities of armor penetration, the number of hits required to put the various types of naval vessels out of action and the percentage of hits to be expected at the various ranges.

CHARACTERISTICS OF NAVAL TARGETS

Naval vessels may be divided into *capital* and *non-capital* ships and *submarines*.

Capital ships are those provided with heavy armament and heavy armor. They vary in length from 350 to 850 feet, and in beam from 70 to 100 feet. Their maximum speeds vary from 18 to 35 knots per hour i.e., from 600 to 1200 yards per minute. Their armor is from 9 to 12 inches, and in a few cases as much as 14 inches on the vertical surface protecting the vital parts of the ship. Their deck protection consists of from 2 to 7 inches of armor arranged in three or more decks, and in future ships this may be materially increased.

The primary armament of the latest capital ships consists of from 8 to 12 guns of calibers varying from 12 to 18 inches, and the secondary armament of from 16 to 24 guns of calibers varying from 5.5 inches to 7 inches. The armament of the earlier ships of this class consists of 4 guns of approximately 12-inch caliber, from 12 to 16 guns of 5-inch to 10-inch caliber, and of a number of 3-inch guns. All capital ships have torpedo tubes and most of them now have anti-aircraft guns as well.

The ranges of the primary armament now mounted on most existing capital ships are limited by the angles of elevation permitted by their mounts. No guns are now mounted so as to fire at ranges much in excess of 30,000 yards. In fact few guns are now mounted so as to fire at ranges in excess of 25,000 yards, and many of the earlier capital ships mount guns that have a maximum range materially less than this. Future capital ships probably will have their guns mounted so as to fire at ranges of 35,000 yards or more.

The secondary armament as mounted on the later ships has a maximum range, of approximately 15,000 yards, and on many of the earlier capital ships these guns are mounted so as to be limited to ranges materially less than this.

Non-capital ships are of the very greatest variety. The greater number of such ships have little or no armor, and speed of less

The armored non-capital ships may have armament that includes 10-inch guns and a relatively large number of smaller guns. Destroyers are usually unarmored and carry from one to four guns of approximately 6-inch caliber. Other unarmored ships may carry several 6-inch or smaller guns.

Submarines of the earlier types were limited in speed and cruising radius. Guns, where mounted at all, were few and of small caliber. The latest submarines have maximum speed of 20 knots or more per hour on the surface and of 12 knots or more per hour submerged. They are of large size and have a cruising radius of from 3000 to 5000 miles or more. They mount one or two guns as large as 6 inches in caliber, in some cases. A submarine mounting a 12-inch gun recently has been constructed. Greater size and speed, larger guns, and probably some armor protection are to be expected in future designs.

The following table gives approximate values for the thickness of armor that the various calibers of primary armament may be expected to penetrate at the various ranges when the impact is normal to the surface:

(Normal Impact)

Ranges, yds...	5000	10,000	15,000	20,000	25,000	30,000	35,000	40,000	45,000
Calibers	Thickness of side armor that will be penetrated.								
12" Mortar...									
12" Gun.....	15"	12"	9"	7"					
14" Gun.....	22"	17"	13"	11"	10"				
16" Howitzer.	12"	10"							
16" Gun.....	27"	23"	20"	17"	15"	13"			
Calibers	Thickness of deck armor that will be penetrated.								
12" Mortar...	5"	6"	7"						
12" Gun.....					7"				
14" Gun.....					10"	10"	10"	10"	
16" Howitzer.			12"	12"	12"				
16" Gun.....							13"	13"	13"

It may be assumed that when angles of fall are 30° or less, projectiles will bite on vertical armor, and that angles of fall little greater than 30° often may give deck penetration when suitable projectiles are used.

The common steel shell, now on hand and to be furnished in the future for the secondary armament, will be effective against one inch structural steel plates but not against armor of any appreciable thickness. The old A. P. shot and A. P. shell now supplied the fixed batteries of the secondary armament probably will be effective against the armor carried by non-capital ships.

HITS REQUIRED TO PUT A CAPITAL SHIP OUT OF ACTION

The naval engagements of the Russo-Japanese War indicated that it was not necessary to explode shells in a vital part of a capital ship to put the ship out of action. The racking effect of large shells when a sufficient number of hits is secured will derange the machinery used in handling the guns, open her seams, etc. On the other hand the engagements of the World War showed that very few hits are needed to damage badly or even to sink the most heavily armored ship if projectiles can be exploded within the ships. It may be assumed that on the average at least five hits from primary armament will be required with the projectiles of latest design to put a capital ship out of action or to sink it. This is based on a consideration of the vulnerable parts of a capital ship, the angles of incidence that will be obtained, the armor that will be encountered, etc.

HITS REQUIRED TO PUT A NON-CAPITAL SHIP OUT OF ACTION

Non-capital ships vary so greatly in size and protection that no rules can be laid down. However, it is reasonable to assume as a basis that one or two hits from any cannon of the primary armament will put any non-capital ship out of action and in the majority of cases sink it, and that a considerable number of hits from guns of approximately 6-inch caliber will be required to put a destroyer out of action or sink it.

PROBABILITY OF HITTING

It may be assumed that for the primary armament the probability of hitting a capital ship is as follows: from point blank range to 15,000 yards, from 100 per cent to 10 per cent, decreasing as the range increases; from 15,000 yards to 25,000 yards, from 10 per cent to 5 per cent, and from 25,000 yards to 50,000 yards, from 5 per cent to 1 per cent. These percentages are derived by

considering the most dependable data available as to the probable errors of our primary armament and assuming that the fire of these cannon can be adjusted so as to include the target in the 50 per cent zone for range one-half of the time, and that when the target is in this zone no misses are made in deflection. It is believed probable that future development in ballistics, gunnery and projectile design will decrease the probable errors so as to increase materially the probabilities of hitting at medium and long ranges.

Assuming for all cannon of the secondary armament the probable errors of the 155 mm. G. P. F. gun as published in range tables, and assuming the same conditions of adjustment as above, it may be concluded that the probabilities of hitting a destroyer would be as follows: from point blank range to 5000 yards, from 100 per cent to 35 per cent; from 5000 to 10,000 yards, from 35 per cent to 10 per cent; and from 10,000 to 15,000 yards, from 10 per cent to 3 per cent.

Against larger targets the above percentages of course will be increased and this increase will be in a general way proportional to the increase in the size of the target.

CLASSIFICATION OF RANGES

From the foregoing discussion of naval targets, naval armament, and the characteristics of our own armament, it would seem most reasonable to classify ranges from 0 to 15,000 yards as short ranges, from 15,000 to 25,000 yards as medium ranges, and above 25,000 yards as long ranges. Accordingly, in the preceding tabulation, cannon have been classified as short range, medium range or long range cannon, depending upon their maximum ranges.

CHARACTERISTICS OF NAVAL ATTACKS

Naval attacks on the strong points of the defensive line along our seacoast—i.e., on our harbor defenses—may be of any one of the following distinct forms; or two or more of these forms of attack may occur simultaneously.

- (a) Blockade.
- (b) Bombardment.
- (c) Direct naval attack.
- (d) Combined land and naval attack.
- (e) Attack of barriers, docks, utilities, etc.
- (f) Attack of naval craft, utilities, etc., inside harbors.
- (g) Attack by landing raiding parties.

Without doubt, all of these forms of attack will be accompanied, in the future, by aerial operations on a considerable scale.

A *blockade* corresponds somewhat to an investment or siege in land operations. A harbor or other point on the coast or an entire part of the coast line is covered by a naval force which prevents or attempts to prevent the egress and ingress of both naval and commercial vessels. Naval forces engaged on purely blockading duty ordinarily do not engage land artillery; when such vessels do engage land artillery however, the blockade assumes one of the other forms of attack.

The use of submarines has had a pronounced influence on blockading operations. A close blockade such as was maintained at Santiago, Cuba, by the American fleet in 1898 is no longer likely. In the World War the blockade of German ports was accomplished in a large measure by the patrol off the Shetland Islands.

A *bombardment* may be directed against the defenses of shore cities, utilities, bases, etc.; against the shore cities, utilities and bases themselves, or against both at the same time. When bombarding land defenses the ships firing probably will close to the shortest range possible without suffering undue loss from the fire of the land artillery. When bombarding cities, bases, utilities, etc., such ships probably will fire from positions just within their limits of range from the target in order to remain at the greatest range possible from whatever land artillery may be in the locality.

The development of special mission long range naval artillery having maximum ranges two or three times as great as that of the artillery normally carried on capital ships must be expected in war. Such guns mounted on naval vessels can conduct bombardment of cities, bases, utilities, etc., at ranges of 75 to 100 miles with possible effect due to the great size of their targets. No effect from bombardments of land defenses is to be expected, however, at any such ranges.

Direct naval attacks, like all other attacks in warfare, will vary with the positions to be attacked, the attacking force, etc. Whenever possible, land artillery will be destroyed by concentrating the fire of a large number of ships on single batteries or nests of batteries in succession. Land positions will be enfiladed whenever possible.

The following successive phases reasonably may be expected in direct naval attacks.

(a) Reconnaissance and removal of all barriers at long and medium ranges.

(b) Reconnaissance of the artillery positions.

(c) An attempt to destroy the artillery of the defense by fire from naval vessels, or by a combination of such bombardment with either aerial bombing or land raiding parties or both.

(d) Reconnaissance and removal of all barriers not previously removed or destroyed.

(e) The capture or reduction of all land defenses by fire at short ranges, aerial bombardment and landing parties; or a run by.

These phases may follow each other very rapidly and in some cases two or more phases may occur at the same time. Just as in all other types of warfare, the various phases of the attack may be combined when surprise is possible or when the offense has the necessary superiority.

In firing against land artillery and other defense elements, naval vessels undoubtedly will use high explosive shell for destruction. During many phases of the attack extensive use probably will be made of smoke and gas shell. Shrapnel fire may be expected from 6-inch and smaller naval guns.

Combined land and naval attacks on the defenses of harbors, etc., will consist of direct naval attack in conjunction with attack by land forces. In general, when the land forces are large the naval attack will not be carried out completely.

Attack of barriers, docks, utilities, etc., may be made by submarines as part of a direct naval attack. The mission of the submarines may be to draw attention from or assist other naval operations, or it may be to clear a passage for entrance into the harbor. The reconnaissance preceding such attacks and the submarine attacks themselves normally will be conducted beneath the surface.

Attacks of naval craft, utilities, etc., inside harbors when the harbor is known or believed to be covered by land artillery, will be conducted usually from beneath the surface by use of torpedoes. Future development of the submarine may result in its carrying sufficient armor to allow it to use gun fire inside of harbors.

Attack by landing raiding parties. Raiding parties in considerable force may be landed to operate against elements of the defense. When submarines are employed to effect such landings, they will appear on the surface only for the time necessary to disembark the landing parties and to allow them to reembark when their mission is accomplished. These two points of appearance on the surface may be at a considerable distance apart.

Naval attacks on portions of the coast between harbors, bases, etc., may be either in the form of raids or of landing operations on a large scale.

Raids will take the form of sudden descents by comparatively weak landing forces on unprotected or lightly protected areas to destroy, pillage and reconnoiter. Coastal railways, canals, telegraph and telephone lines, etc., are especially liable to such attacks. Sometimes the desired ends can be obtained by bombardment at comparatively short ranges but generally it will be necessary for the naval forces to land raiding parties for the purpose. The present submarines undoubtedly can undertake such operations, and lightly armed and lightly armored cruisers, destroyers, etc., also may be employed. Secrecy and surprise are essential for the success of such operations.

The naval operations connected with *landing operations on a large scale* will consist of convoy duty and of covering all landings by fire. The armored ships will attempt to neutralize or destroy all land artillery that can endanger the transports and thus allow them to approach closely to shore, so that the launches and other small boats used in landing troops will have only short distances to traverse in reaching the shore. The armed naval vessels will attempt also to neutralize or destroy the land artillery, machine guns and riflemen firing on the small boats, and to support, by artillery fire, the advance of the troops that succeed in landing.

EMPLOYMENT OF AIRCRAFT

At the present stage of development, we would anticipate that an enemy, before securing a foothold on our territory, would have available only a very limited number of aircraft. Whatever number he might have, however, would be a most valuable auxiliary in any form of attack. In blockades, they would be used for both reconnaissance and destruction; in bombardment of cities, utilities, etc., for observation of fire and bombing; in direct naval attack, for seeking out and destroying submarine barriers, for reconnaissance of artillery positions, observation of fire, bombing, etc., and in general for cooperation with land or naval forces in any form of attack, or for independent raids. The possibilities of future development of aircraft are so great, however, that it would be unwise to assume that, in any future attack on our coast, we will have a marked superiority in air forces at the point attacked. For this reason, our tactics should be conceived so as to allow us to operate efficiently even though the enemy have a preponderance of air forces at the point attacked.

TACTICAL PRINCIPLES

The accepted principles of tactics applicable to a field army are not necessarily applicable in the employment of artillery in seacoast defense. Certainly they are not applicable in the same sense and degree.

USE OF THE OFFENSIVE

The action of heavy artillery in harbor defense is essentially defensive, and the mission generally is to *ward off*. The accomplishment of a mission, however, may be effected in different degrees. An enemy may be warded off, without suffering any damage, by a display of strength however ineffective; or, he may be warded off by decisive defeat in which he sustains great losses. In order to accomplish the latter the coast defenses must, in a sense, take the offensive. In such offensive they do not have the privilege of selecting the time and point of attack, etc., such as may be enjoyed by a field army, but rather they turn a defensive opening into an offensive prosecution by conducting or withholding fire in such manner as to lead the enemy or a part of his forces into a position of greatest advantage to the defenders and then employing a prepared plan for his destruction.

To what extent a seacoast defense commander is justified in taking the offensive is wholly dependent upon circumstances. If his mission is the prevention of the bombardment of an important city, he must take the surest effective means, regardless of whether or not he inflicts material loss upon the enemy. If his mission is the defense against an attack not involving a long range bombardment against elements other than his own artillery, the importance of the point of attack determines, in a large measure, to what extent, if at all, he is justified in departing from a purely defensive plan and risking his mission in the attempt to inflict severe loss on the enemy. He can never hope for a decisive victory without taking the offensive; on the other hand, a decisive victory is more often than not a matter of secondary importance.

ARTILLERY POSITIONS

There are three essential conditions for a good artillery position, viz., (a) the position must permit effective fire on the enemy throughout the area in which he can maneuver, (b) it must afford concealment from the enemy, and (c) it must afford material cover from the enemy's fire.

(a) A position for effective fire means that in general our cannon should be capable of all around fire, and that the natural

configuration of the ground or the masks against hostile observation should not unduly limit the angles of departure.

(b) Concealment from the enemy is vital. No lesson of the World War is clearer than this. Safety when under fire is more dependent upon concealment than upon any material protection we could reasonably provide. Concealment of gun positions and of all dispositions for attack and defense was absolutely vital in the World War to both the attack and the defense. The attack on the Dardanelles demonstrated that artillery emplaced in positions visible from the sea can be silenced or neutralized by naval fire, and that hidden cannon cannot be so silenced.

Under average conditions of visibility, artillery emplacements, however located, would not be visible at long and medium ranges; but at short ranges, visible positions would be subjected not only to the observed fire of the naval primary armament but to an overwhelming fire from the secondary armament of capital ships and the armament of non-capital ships.

(c) The advantage of material cover has been well realized for many years. It has led to the construction of parapets, magazines, etc., for our artillery positions giving what was known as major caliber protection. This protection was well designed to resist shells from the primary armament of naval vessels fired at ranges of 15,000 yards or less, but is probably insufficient against the fire of the primary armament carried by the most recent capital ships. The great ranges now attained by such guns give much greater angles of fall. For complete protection of guns and ammunition today, massive overhead cover is required in addition to frontal cover.

In the World War cover against calibers corresponding to the secondary armament of capital ships and the armament of non-capital ships was commonly installed. A direct hit from calibers corresponding to the primary armament of capital ships was considered too improbable, due to the small volume of their fire, to warrant the installation of the extensive and elaborate protection necessary to keep out such shells. The installation of such cover was advocated at one period but it decreased the mobility of the artillery to such extent that it was shown to be unwarranted.

One very elaborate and heavily protected emplacement north of Nancy was occupied for almost two years altogether without a hit on it being obtained by the enemy.

The actions between ships and land batteries in the World War furnished the best basis for conclusion as to the degree of material protection required. These indicate that armament in fixed exposed

positions, i.e., non-mobile armament must be given much greater protection than has been provided in the past and that mobile armament can properly perform its functions and live through an engagement without heavy protection provided full advantage be taken of concealment and mobility. The communication and observation systems for all artillery must be given the greatest protection possible. The switchboards, central plotting stations, etc., wherever possible, must be protected against direct hits from primary armament.

In selecting artillery positions, it is to be remembered that the pieces of a battery and the batteries and larger groups of armament should be as widely separated as practicable, due consideration being given to difficulties of control of fire in cases of too great separation. At the same time, care must be taken that none of the armament is retired so far that it cannot take effective part in any phase in which its employment is contemplated. The effect of too great concentration of armament is to offer the enemy a concentrated target, where one shell may inflict damage on more than one piece, and where fire directed at one position will endanger other positions.

CONCENTRATION OF FIRE

The principle of concentration of fire generally so essential to success in military operations must be carefully considered in its application to seacoast defense. For centuries naval tactics have been built on the fundamental principle of overwhelming fractions of the enemy's fleet before the whole of his fleet could be brought into action. As applied to any force in warfare, a distribution of fire or force can seldom lead to a positive victory. It is to be remembered however that the action of the seacoast artillery in many cases may be purely defensive, and complete fulfillment of the mission may not include necessarily the infliction of heavy losses on the enemy. In general, the fire of the land artillery should be concentrated on those elements of the enemy's navy whose mission is most imminent, or most effective in defeating the missions of the land artillery. Fire should not be concentrated on one element of the enemy's forces, however, if such concentration would leave another element free to accomplish an important mission.

In the case of long range bombardment of a coastal city or utilities defended, the fire of major caliber cannon should be concentrated on ships successively reaching the firing point. In case direct naval attack is combined with such bombardment, it is

obvious that sufficient fire must be directed on the attacking forces to preserve the life of the land fortifications. This may necessitate concentrating the fire or dividing it.

The hydrography, fleet formation, etc., also may influence the concentration of artillery fire. A fleet in column in a restricted channel would invite concentration of fire on the leading ship. On the other hand, where the maneuver area is unrestricted, it may be advantageous at short ranges to assign different ships as targets for fire or battery commands. The advantages of this would be first, observation and adjustment of battery fire might be possible; and second, the group, scattered over a large area, may find itself subjected to such intense fire as to prevent unity of action.

Every coast defense fortification has certain definite missions that can be stated, and every possible naval plan or maneuver to defeat these missions can be anticipated; it is then a matter of no great difficulty to work out a plan in time of peace for the assignment of targets in the various circumstances that may arise in time of war, and this should be a matter of first consideration by all officers of field rank on duty in a locality.

KINDS OF FIRE

It may be assumed that only the following kinds of fire will be employed by artillery in seacoast defense:

- (a) *Neutralization fire* against enemy vessels attempting to bombard our coastal cities, bases, utilities, etc.
- (b) *Destruction fire* against all types of naval vessels including transports.
- (c) *Harassing fire* against enemy naval craft and forces that have succeeded in seizing a harbor or landing beach.
- (d) *Interdiction or barrage fire* to prevent enemy vessels passing certain lines at times of poor visibility.

TACTICS OF FIRE

AT LONG RANGES

Enemy vessels may appear within the long range zone of our seacoast cannon for the purpose of bombarding coastal cities, bases, etc.; firing at land artillery, or denying entrance or exit to our naval vessels.

When naval fire is directed at land artillery only, the effect necessarily will be small due to the small targets presented; and unless the enemy's fire becomes too effective it generally will be advisable to reserve the fire of the land batteries. The probability of inflicting any punishment of consequence on him is very small,

and at the same time we not only risk disclosing our strength and position but we fritter away the very short accuracy life of our cannon.

When the enemy is attempting to deny entrance or exit to our naval vessels, or when the enemy is engaged in bombarding coastal cities, bases, etc., it will be necessary, in the general case, to engage him in the most effective manner possible. Our mission will be to drive him beyond the maximum range of our cannon. If, in so doing, material damage can be inflicted upon him, so much the better; and it is indeed possible that it will be necessary to inflict damage before he is convinced of the necessity for retiring. It is therefore none the less essential that we be able to conduct effective fire at long ranges even though our primary object may not be the destruction of the enemy.

Let us consider then, what will be the most advantageous employment of long range artillery to bring about the desired results when long range fire must be employed against the enemy.

As previously stated we may reasonably assume the probability of hitting a capital ship to be from 5 per cent at 25,000 yards to 1 per cent at extreme range, when the target is in the 50 per cent zone one half the time. If our range finding facilities and our facilities for observation of fire are such as to insure this condition, then it follows that we may expect from one hit out of 20 shots to one hit out of 100 shots at the ranges considered. Allowing time between shots or salvos for observation and correction of fire, we may reasonably assume a firing interval of about 4 minutes. This would require from 80 to 400 minutes to insure one hit with only one cannon firing. Effective results within a reasonable time would then necessitate the employment of at least 8 long range cannon. This would reduce the time per hit to somewhere between 10 minutes and 50 minutes of continuous firing.

The facilities for observation of fire undoubtedly will not permit of each cannon adjusting separately, so fire must be conducted by salvos and adjustment effected accordingly. Such salvos would better be from 8 cannon if practicable, and if less than 4 cannon per salvo are employed the difficulties of observation and adjustment of fire probably would become too complicated.

It then follows that the long range cannon should be employed in groups of not less than eight, and that these must be carefully calibrated.

In general, no enemy vessels, other than capital ships, should be fired at while at long range, as the armament they carry is of no effect against land batteries, cities or utilities at such ranges.

AT MEDIUM RANGES

At these ranges the enemy's mission may be;

- (a) bombardment of cities, utilities, etc., protected by the artillery,
- (b) destruction of our naval vessels or hindrance of their movements,
- (c) reconnaissance of our positions,
- (d) attack of our artillery positions or outlying stations and accessories, or
- (e) removal of barriers.

Or, his complete mission may consist of a combination of two or more of these.

In the case of (a), (b), or (c), the employment of the land artillery would be much the same as just discussed under tactics of fire at long ranges.

In the cases of (d) and (e) it would be best to employ only such armament as is necessary to defeat the enemy's purpose.

A consideration of the angles of incidence to be expected from primary armament shows that hits from guns on capital ships probably will be less effective at medium ranges than at either short or long ranges. On the other hand hits from howitzers and mortars would be most effective at these ranges. At medium ranges the enemy can do much more accurate and effective shooting than is possible at long ranges.

Under the conditions of position finding and observation of fire that we have assumed for our cannon, the probability of hitting would vary from 10 per cent at the interior limit to 5 per cent at the exterior limit. Since a target probably will remain only a short time in this zone a considerable concentration of fire should be brought to bear. It is probable that throughout a considerable portion of this zone, the conditions of visibility will be such that the same systems of position finding and observation of fire will have to be employed as were employed at long ranges. It follows therefore that practically the same system of salvo fire and the same number of cannon per salvo should be employed at medium ranges as would be employed at long ranges. Also the probability of hitting, together with the rate of fire and the probable time available would indicate that, in general, the employment of eight cannon firing in either one or two salvo groups on the same target would be best suited to the conditions.

At mid ranges we are likely to find the enemy employing his forces in two or more divisions, each with its separate mission.

In such circumstances it is essential generally that each division be denied its separate mission, even though it be necessary to distribute the fire of the land artillery to such extent that considerably less destructive fire can be brought to bear on any one target. However, the assignment of less than one group to a single target at these ranges probably would not be justified.

The ranges within which distribution of fire can be accomplished is variable, and depends upon visibility. Beyond the visibility range of the shore stations, concentration of fire will be necessary to a considerable extent. At any range whatever, a concentration of fire involving more than one group, must be conducted under one fire director, otherwise observation and adjustment of fire will not be possible.

Non-capital ships rarely should be taken under fire by the primary armament at medium ranges in harbor defense operations, unless it is believed that they carry landing parties, and even in such cases primary armament would be used only if the ships were armored. The medium range secondary armament should be used against such unarmored ships whenever it is present, and of sufficient power.

No distinction has been made above between the use of the medium range primary armament and the long range primary armament. The position and strength of the long range armament may have been disclosed while the enemy was still at long ranges. In this case, it might be advantageous to use the long range armament at medium ranges where it will suffice, and thus avoid disclosing the position and strength of the medium range armament. Where such is not the case, it is desirable to use the medium range armament only and thus conserve the life of the long range matériel. Where necessary, all armament having sufficient range, must be brought into action. This will normally be the case except when the enemy is conducting a reconnaissance.

In the coast defense operations in the areas between the harbors, bases and other heavily fortified points, fire at medium ranges may be of importance. Whenever it is possible to fire upon transports at these ranges, all armament having the necessary range should be brought to bear. In such cases it is desirable also to concentrate the fire of large groups on one target to insure, in so far as possible, that at least one such transport is sunk before it can get away. Both primary and secondary armament should be used for this purpose as enemy forces on transports are in the most vulnerable position in which it is ever possible to get them.

The percentage of secondary armament that can fire to any

considerable extent in the medium range zone is small. The probability of hitting is small for these ranges but the volume of fire of such guns is great. In general all large non-capital unarmored ships should be taken under fire by this armament whenever possible.

Destroyers are very difficult targets to hit, due to their great speed and their small size. They should be taken under fire at medium ranges only when attempting to produce a smoke screen, or otherwise actively influencing a duel between the capital ships and the primary armament of the defense.

Whenever fired at medium ranges the secondary armament should be used in groups of at least eight guns on one target. The rules applicable to grouping primary armament for salvo firing are applicable to the secondary armament.

AT SHORT RANGES

The probability of hitting varies widely with the range. It seems logical therefore to divide these ranges into three zones. These zones are taken as follows: 1st zone, from 15,000 yards to 10,000 yards; 2nd zone, 10,000 yards to 5000 yards; and 3rd zone, within 5000 yards. For the primary armament the following average probabilities of hitting are assumed: 1st zone, 15 per cent; 2nd zone, 35 per cent; and 3rd zone, 60 per cent. Similarly the following are assumed for the secondary armament: 1st zone, 5 per cent; 2nd zone, 25 per cent; and 3rd zone, 50 per cent. These probabilities agree with those given above and are based on the assumption that the target for the primary armament is a capital ship and for the secondary armament a destroyer.

Assuming that it requires five hits from the primary armament to put a capital ship out of action, and that a modern ship can traverse one of these 5000 yard zones in five minutes, it would require, on the average, the following number of rounds to put such a ship out of action while traversing one zone: 1st zone, 35 rounds; 2nd zone, 15 rounds; 3rd zone, 10 rounds. Even with a rate of fire of one shot per minute, this would require the assignment of 7 cannon per target in the first zone, 3 cannon per target in the second, and two cannon per target in the third.

If, then, targets were in the 1st zone and could not, or probably would not, approach closer to the land fortifications, the proper tactics for attacking them would be to assign a complete group to the same target.

During an engagement it would be the greatest fallacy to

attempt a change of tactical organization. A general engagement will open at long or medium ranges and whatever tactical organization is necessary at those ranges must be made to apply throughout all ranges. Groups of eight pieces properly calibrated seem to be best adapted to all uses, but in the employment of such groups, two or three targets in the second zone, or, three or four targets in the first zone should be assigned to a group.

Inside of 15,000 yards, the assignment of targets by group commanders will depend upon circumstances. If the enemy must commit himself to a channel or other restricted water area, then an entire group should be concentrated on a single target whatever the range. Targets should be assigned so that the leading ships of the column will come successively under fire for destruction. In this case each target of a group should be continuously tracked by a separate base line so that to change targets it would be necessary only to change base lines, and no delay would be occasioned.

In case it is possible for the enemy to come in to very close range before committing himself to a channel or other restricted maneuver area, it probably would be better to put battery base lines into operation and designate a separate target for each battery in the early stages of close combat, so that when control by the group commander becomes impracticable the batteries may fight independently on a prearranged plan.

Inside of 10,000 yards however the fire of the secondary armament of capital ships and the fire of non-capital ships becomes especially effective, and it is, therefore, to the advantage of the defense to obtain a decision between 20,000 and 10,000 yards.

The secondary armament, having to sustain the combat with unarmored non-capital ships, is practically confined to action at short ranges. The volume of fire that can be delivered by these guns, and their comparatively great accuracy life justifies their extensive use in the third zone even though the probability of hitting is small at these ranges.

The principal employment of this armament will be found in driving off destroyers, trawlers, etc., attempting to remove mine fields and other barriers; in combatting destroyers, scouts, etc., cooperating with capital ships in an attack; in combatting attacks by destroyers and other non-capital ships; in combatting transports attempting to land troops, and in destroying the small boats attempting to land troops from transports.

In all these cases a proper concentration of fire is essential. Many targets will be much larger than destroyers and the chances of hitting will be correspondingly larger. Such vessels, especially

if carrying no great amount of powder or other explosives, will require more hits to disable them. It would appear logical to organize this armament in groups of eight pieces in practically all cases; the employment of salvo fire for guns using direct aiming is not always advisable, however.

At night this armament is liable to be called upon to fire at fleeting targets illuminated for only a short time. In such cases a group of eight guns will, in some cases, be more or less unwieldy and hard to handle, and fire should be opened on the initiative of the battery commanders.

The use of interdiction or barrage fire may assume importance in the future, not only to deny passage through a channel or area, but to prevent raids by destroyers on barriers, shore stations, etc. Primary armament, if provided with instantaneous or super-quick fuses, may be used to increase the density of barrage ordinarily undertaken by secondary armament. The use of barrage fire at the longer ranges probably should be restricted to fire on a very narrow front with delay action fuses.

NIGHT ATTACKS

Such attacks by light craft of high speed are to be expected. They may come in very close at night without being discovered by any visual means. The employment of subaqueous sound detectors will give warning of such approach and probably will be developed sufficiently to supply firing data. Sound ranging may be necessary to supply firing data where the enemy opens fire with non-flash powder. In either case the data will not be sufficiently accurate or continuous to justify accurate ranging, and resort will be had to a large volume of fire scattered over a certain area or zone. Such fire covering channel or harbor entrances and other important areas must be pre-arranged so that it can be delivered in the most effective manner and on the shortest possible notice. Searchlights should be brought into play to discover the enemy *after his presence in searchlight range has been assured by other means*. Once picked up he is taken at a great disadvantage, because not only is he disclosed as an excellent target but he is badly blinded against navigation. Excepting the use of searchlights the same defense should be employed in weather too foggy for distant observation.

Channel entrances or narrow points in a channel are always critical points and should be kept under the closest possible observation. As great a portion as possible of the land artillery should be emplaced so as to protect such places. Not only are

they points of greatest disadvantage to an enemy attempting to enter, but they may be such as to invite blockade by sinking obstructions. Submarine mines guarding such places should be placed so that an enemy ship sunk by a mine would not obstruct the channel. In addition such places should be guarded by some type of vessel carrying a listening device or magnetic apparatus for the detection of approaching naval craft. Such guard vessel might be blocked out of the enemy's view by standing search-lights.

At all ranges and in all circumstances, it is essential to the efficient conduct of the defense that the targets be properly chosen, that the freedom of movement of the enemy be limited by obstructions, that the field of fire be properly illuminated, that the observation and information services be properly organized, that cooperation with our air and naval forces be effected, and that the system of command be properly organized.

CHOICE OF TARGET

The occasions will be rare when one capital ship only is in the field of fire of any group of artillery. When the natural features or temporary obstructions of the water area force the enemy to adopt the column formation, it will be advisable generally to sink or put out of action the leading ship in the shortest possible time. In some cases it may be advisable to concentrate the fire of two or more groups of armament on this ship, but the technical difficulties of observing and adjusting fire in such cases generally will render the fire of individual groups much less accurate than would be the fire by one group alone; and unless these technical difficulties can be solved in a given case, it probably would be more effective to distribute the fire by putting one group of armament on each of the leading ships.

When the freedom of action of the enemy is not so limited, it is impossible to lay down a rule always applicable for the selection of first targets. The general rule is to fire at ships that are most dangerous to missions of the defense, and generally the ships at the shortest range are the most dangerous. Exceptions to this rule may be encountered, as for instance, when ships at shorter ranges are bombarding the land artillery and others at longer ranges are bombarding utilities covered by the land artillery.

The same remarks apply in general to the choice of targets for the secondary armament. In this case the most dangerous enemy craft are likewise not always those at the shortest ranges. One of the most important missions of the secondary armament

is to guard the submarine obstructions; and enemy forces operating against such obstructions frequently may be of more importance than those conducting bombardments or other operations at closer ranges.

USE OF OBSTRUCTIONS

The use of submarine mines, submarine torpedo nets and other submarine obstructions increased greatly in the World War and their proper employment is essential to the complete defense of any harbor. Their use in the open sea to deny or hinder the enemy in an attempt to land at favorable beaches should also be considered. Whenever such obstructions are emplaced where they cannot be covered effectively by the fire of secondary armament they can delay the enemy only the length of time necessary to conduct sweeping operations. When covered by fire, however, they force the enemy to remove them at the expense of considerable periods of time and considerable loss to himself.

In harbor defense operations the maintenance of efficient submarine barriers is vital to the successful conduct of the defense. Such barriers must be so extensive and so well protected that they cannot be entirely removed or destroyed during periods of poor visibility. Damage to such barriers must be repaired continually so that their efficiency is constantly maintained. The protection of such barriers, in thick weather, is partially a function of the naval auxiliaries and will be discussed more in detail below.

ILLUMINATING THE FIELD OF FIRE

The only practicable methods so far developed for illuminating water areas at night are as follows:

- (a) High powered electric searchlights.
- (b) Illuminating shells.
- (c) Flares dropped from airships.

Illuminating mines also have been developed, but their practical usefulness in their present form is so small that they require no discussion.

Searchlights give illumination up to an average maximum of 3000 yards. They illuminate only very limited areas and it has been impossible so far to adjust fire satisfactorily at night when using searchlights. Their control is somewhat difficult when attempts are made to use them in large numbers. They are, however, a most dependable means for illumination of targets at close range, but must be employed with judgment and caution. The

use of roving lights must be prohibited, the use of searching lights must be limited to suspected areas, and the use of standing lights must be undertaken with caution and a knowledge of how they may assist the enemy. The enemy may range on a searchlight and may use it as an aiming point from a distance far beyond the visibility range of the light, and in addition he may discover whatever patrol or other auxiliary craft of the defense that the searchlights accidentally disclose.

Illuminating shells are still more or less in process of development. Their use presents many advantages. If properly developed they should allow of illuminating an area in the vicinity of any target, large enough to permit the observation and adjustment of fire. Their use in guns of approximately 6" caliber should permit observed night firing up to 17,000 yards or more.

Flares dropped from aircraft perhaps may prove to be an effective means of illuminating a particular area or target. Their use against naval targets is as yet undeveloped.

The importance of illuminating the field of fire at night cannot be overemphasized. Without means of illuminating any desired portion of the field of fire at medium and long ranges, as well as at short ranges, the effectiveness of our long range armament is greatly diminished.

Fire at night must be directed at targets difficult to keep continuously illuminated. The impossibility of keeping several targets continuously illuminated for the period of time necessary for several small groups of armament to put the several targets out of action is evident. At night, therefore, it is advisable to use large concentrations of fire in order that maximum advantage may be taken of such illumination as is secured. The grouping of armament into fire direction units of eight pieces arrived at above as the most logical for use in daylight combat, seems, therefore, entirely suitable for combat at night. An exception must be made, however, in the case of very short range combat with non-capital ships. Such vessels may appear and disappear very rapidly and in certain cases it would be necessary to instruct battery commanders to open fire at once on such fleeting targets. The normal unit for such combat would therefore be the battery.

THE OBSERVATION AND INFORMATION SERVICES

In the defense of a harbor or other strategic point, observation and information services must perform the following functions if maximum use is to be made of the capabilities of the armament:

- (a) Furnish continuously to all commanders and units inter-

ested, the location of all hostile naval craft in or liable soon to enter the field of fire of the land artillery, together with information as to the class of such vessels.

(b) Furnish all interested commanders with data as to the fall of all shots fired at such hostile naval craft.

(c) Furnish all interested commanders with data as to the effect of the fire on such naval craft as may be under fire.

In addition to the above, these services must furnish information as to all other activities of the enemy—of the movements and activities of his aerial forces, land forces, etc.

The first information of the location of hostile naval craft can be given best by aerial patrols reporting to Coast Defense and Fort Commanders.

For the complete fulfillment of (a), (b) and (c) it will be necessary to have a long and medium range position finding and observation of fire service for each group and in addition a separate short range service for each battery. The battery short range services, if they consist of long horizontal base lines, should be interconnected so as to allow the greatest possible flexibility. Normally the short range services should all be under the orders of the group commander, so that all targets assigned to the group may be tracked continuously and delay in changing group targets thus avoided. Furthermore, in fire with indirect pointing the armament is well-nigh useless if no base lines are in operation; thus a duplication of base lines is provided for. If, on the other hand, it becomes necessary to distribute the fire of a group, the short range services may be assigned to batteries of other sub-groups.

COOPERATION WITH OUR AIR AND NAVAL FORCES

Regardless of whatever other systems of observation and information we may have, the Air Service will remain the most important auxiliary of the Coast Artillery Service. Its functions in such capacity, besides the duties listed above, will include the patrol and protection of barrier fields; the prevention of bombing, reconnaissance and observation of fire by the enemy aircraft; combat of enemy air, surface and submarine vessels, and possibly participation in the Coast Artillery position finding service. For this reason, the very closest cooperation between the two services is essential in the highest degree.

In the present state of development of artillery it is apparent that submarines cannot be combatted effectually by land artillery in a great number of cases. Naval craft will be needed in the defense of any harbor to guard the obstructions from attack by

these craft, and by destroyers, trawlers, and other light vessels at night and in foggy weather. Such craft are also needed to furnish picket boats and regulate the use of the harbor by friendly vessels.

Our naval forces also have an intelligence service of far reaching proportions. Part of this service consists of a coastal patrol by land observers and air and naval craft. These forces also plant and maintain all non-controlled mines.

The necessity for the most effective cooperation between the land artillery and the naval forces is so well recognized that it needs no comment. It is most desirable that cooperation be practiced in time of peace by maneuvers and problems involving the air, naval and artillery services.

THE SYSTEM OF COMMAND

A consideration of the speed of naval vessels and of the characteristics of naval attacks on land defenses, shows that in a combat between land artillery and naval vessels the intensity and rapidity of action will be very great. It is evident that one commander, no matter how numerous and able his staff, can deal with only a limited number of subordinate commanders.

In the case of fortifications defending a harbor, the conditions of the combat render it imperative that all of the artillery and services auxiliary thereto, covering an entrance or water area, be under one superior artillery commander. In many cases this armament is divided in groups or forts in different localities, all bearing on the same general water area. In such cases the superior artillery commander, designated in our service as a Coast Defense Commander, would deal only with the local commanders of forts or other concentrations of heavy artillery. He has definite tactical duties and must have a definite post of command. The fort commanders and commanders of other heavy artillery, due to the involved and shifting conditions of combat, must be given great liberty of action.

A fort commander or commander of the artillery of an area must direct personally or closely supervise the direction of so much of the general observation service and illuminating service as is not under the direct control of the Coast Defense Commander. He may command land defense units of infantry, machine guns and artillery; units of secondary armament; units of primary armament; units of anti-aircraft artillery; controlled mine fields; and probably, in the future, automobile torpedo units.

During combat he should deal only with the following commanders: one land defense commander; one commander of anti-

aircraft artillery; one commander or staff officer in charge of the general observation and information services; one commander or staff officer in charge of the illuminating service; and in case there are a number of artillery groups, one commander of secondary and one commander of primary armament.

The commander of the primary armament should have under the use of the controlled mines and the automobile torpedoes if any are provided. He should have under his control, the group or fire commanders of the secondary armament; one commander of controlled mine fields; and one commander of automobile torpedoes.

The commander of the primary armament should have under his control the group or fire commanders of the primary armament.

The extent to which pre-arranged plans can be made for combat with naval forces will depend upon the locality in question. No detailed defense plan can be laid down as applicable to all localities. Defense plans for each particular locality should be worked up with utmost care and attention to detail, and should be the subject of exhaustive study by all subordinate commanders concerned. They should be applied in drill, maneuver and war game until all subordinate commanders are able to perform their several functions in furtherance of the general plan with a minimum of communicated orders, or even when communications are interrupted.

TACTICS OF ARMAMENT EMPLACEMENT AND MANEUVER

AMOUNT OF ARMAMENT

The amount of armament required to defend a harbor or other strategic point can be determined only by a consideration of:

- (a) The importance of the point.
- (b) The hydrography of the adjacent water areas.
- (c) The topography of the locality.

The importance of the point determines the degree of protection required for the locality. A point having little strategical or economic value manifestly need not be afforded the protection required for a port or other point of the first importance. This importance cannot be gauged by the size of the city alone, but is dependent upon its importance commercially, economically, and strategically from our own and from the enemy's point of view.

The hydrography of the adjacent water area determines the number and draft of enemy vessels that can be maneuvered in

the various parts of the field of fire, and the character of the maneuver possible. It therefore determines the amount of force the enemy can deploy and use at the various ranges. This to a large extent determines the amount and kinds of armament needed to defend the locality.

The topography of the locality determines the possibilities of effectually concealing the armament, and to some extent determines the amount of material cover that can be obtained economically. It also determines the practicability of reinforcing the artillery of the defense from reserves of mobile artillery. The efficiency of any group of armament is affected by the possibilities afforded by the locality for the observation of fire. These considerations all affect the amount of armament to be provided.

The conformation of the water areas and contiguous land areas has a great effect on the amount of secondary armament needed, as it determines the extent and location of submarine barriers, and therefore, the locations and strength of the defense armament necessary.

In general, a group of not less than eight long range pieces is required to defend any locality against bombardment. If such a group of armament can be emplaced so as to cover all water areas in which hostile fleets can operate, then one such group might be sufficient. If the configuration of the land and water areas does not admit of this, then one or more additional groups should be provided. The possibilities of covering part of such areas with existing medium range armament should also be considered in this connection. It may be possible also, in some cases, to cover parts of such areas with mine fields, if secondary armament can be installed for their protection.

In cases where all areas from which fleets can bombard the cities or utilities can be covered by the fire of medium range armament in advanced positions, the provision of long range armament, merely to prevent bombardment of such cities and utilities, is not necessary. Some long range armament is generally necessary, however, in order to prevent the reduction of the medium range armament by bombardments carried out from points beyond their maximum range. In some cases a group of less than eight pieces may be justified, in that it will prevent the enemy vessels from anchoring and thereby delivering their most effective fire against groups of medium range armament.

For defense against a determined attack, two groups of primary armament of eight or more pieces each seems to be the minimum

required. One of these groups should consist of long range armament, the other may consist either of long range armament or of medium range armament. Two such groups will be required in order that a division of the enemy's forces in which a long range bombardment and direct attack are undertaken simultaneously may be dealt with effectually. If there are two or more channels of approach through which hostile fleets may enter the harbor being defended, an additional group of primary armament, which may be either long range or medium range, will be required for each additional channel unless such channel can be so effectually obstructed as to insure that it will remain closed against the enemy.

The amount of secondary armament required is, in general, more variable. It probably would not be far wrong to assume as a general condition that the number of cannon of the secondary armament should be twice the number of the primary armament. In order effectually to combat raids on submarine obstructions at least two groups should be able to cover, at the shortest ranges permitted by the locality, every submarine obstruction that is designed to be protected by gun fire.

In addition, the whole water area from which any element of the defense, e.g., observing stations, searchlights, etc., can be attacked by non-capital ships, should be covered by the fire of at least one such group of eight guns.

Somewhat different considerations govern the determination of the amounts of armament required to defend the intervals between the points permanently provided with harbor defenses. These considerations are, in general, as follows:

(a) The topography and hydrography of the coast line and adjacent water areas.

(b) The routes of communication along the coast line, i.e., the roads, railroads, canals, etc.

(c) The expected efficiency of the information service, i.e., the amount of warning that can be expected of an attempt to land troops.

The landing of large forces on our shores would be a tremendous undertaking involving not only the landing of the troops themselves, but the landing of immense quantities of supplies and matériel. The installation of beach obstructions, machine gun nests, light artillery, etc., to resist such landings is the duty of the divisional or sector troops.

The mission of the heavy artillery in such cases generally is

accomplished when transports attempting to land troops are required to lie off shore at the limit of visibility or at a distance of say 15,000 yards; and all naval vessels are forced to remain so far off shore that their secondary armament cannot be used effectively against the works and troops of the defense. The long range fire of the primary armament of the hostile fleet generally can have little effect upon the defense unless railway centers or other sensitive points of the defense can be reached by effective interdiction fire.

Long range armament then is only necessary when sensitive points are so close to the shore that they cannot be protected by medium range armament or when medium range armament, because it must be emplaced in limited areas or in areas where concealment cannot be obtained, or for any other reason, is deemed to need the protection of long range armament. This is a local question and one that should be carefully considered in each case.

Secondary armament should be provided to keep all non-capital ships at such distance from shore that they cannot land troops, except by sending small boats a great distance and so that they cannot deliver an effective fire against the troops or works of the defense.

Such guns if provided with time or instantaneous fuses will be effective against small boats also. The artillery of smaller calibers normally forming a part of the divisional or sector troops assigned to the defense of these intervals should be sufficient, however, to prevent landings if the primary and secondary armament together can force the enemy to lie off at from 10,000 to 15,000 yards. Such therefore is their chief mission.

The armament required in each locality having been determined, it remains to consider the number of such localities at which the enemy is liable to attempt simultaneous landings. Having determined by this means the total armament needed in any interval, it is necessary to consider carefully the points at which this armament can be concentrated, so as to be transportable with greatest facility to possible places of employment. A careful study of roads and railways, and of the length of time the troops on duty in these localities can be expected to prevent landings in force, is necessary.

EMPLACEMENT OF ARTILLERY

The primary consideration in emplacing any piece is, ability to fire on the enemy. To fire effectively upon capital ships it is

advantageous, at medium and long ranges, to have the ship head on to the battery firing. At short ranges it is advantageous to have the target broadside on to the line of fire. The conformation of the water area and the positions available will determine the best areas for the emplacement of primary armament from this point of view. In many cases the field of maneuver of capital ships will be so wide that these considerations will have little weight.

It is vital to the success of the defense, however, to emplace the armament well to the front of the city or utility to be protected. The greater the range from the city or utility that hostile fleets can be taken under fire, the better.

The long range primary armament should be set back from the shore line and echeloned in depth. In general the forward elements should be several hundred yards inland and the rear elements may well be two or three thousand yards inland if this is necessary for proper concealment and dispersion.

Complete material protection can be given artillery pieces only by mounting them in turrets or casemates and such must be provided when artillery is emplaced in very restricted areas. When such are not provided, advantage should be taken of whatever sand dunes, embankments, hills, etc., are available to obtain as great a protection against shell fragments as possible. The field of maneuver available to the enemy will determine the minimum elevations that must be maintained. Powder, primers and fuses should be given such protection as time and materials available permit. Projectiles can be stored in the open.

The greatest possible use should be made of camouflage and mobility to secure protection. Generally, camouflage can prevent the discovery of a battery from the air, but when it does not, the battery should be moved. Smoke screens can be employed to hide batteries from observation from sea or from the air, and to prevent observation of fire by the enemy. False emplacements will deceive the enemy, and smoke screens in unoccupied localities will confuse him.

The ability of artillery to deliver accurate fire by indirect aiming is highly developed. The use of this method permits taking full advantage of concealment and also allows the greatest advantage to be taken of the protection afforded in any locality. No other method of aiming is practicable at medium and long ranges. For the defeat of a run by at the last stages of an action it is highly desirable, however, to have at least a portion of the primary arma-

ment emplaced so as to be able to use direct aiming at close range. The topography of the locality may permit of emplacing some of these pieces so that they will be entirely hidden from enemy vessels until they come around some turn in the channel or are otherwise forced to change direction at the shorter ranges. Where the topography does not admit of such a solution the ability to fire by direct aiming generally should be sacrificed, as the real decision normally will be reached at greater ranges, and furthermore pieces emplaced to use direct fire at all ranges probably will be so completely smothered by the enemy's fire before the last stages of any action that they will be of little use during the run by.

Secondary armament can best use direct aiming, as its targets are generally within the limits of visibility and have a greater field of maneuver than capital ships. It should be able to employ indirect fire, however, so that it may be fired effectively from hidden positions or from behind smoke screens. Such armament emplaced for direct aiming must sacrifice concealment. It may be possible, in some cases, to have alternative positions, some for use with indirect aiming and some for use with direct aiming. Whenever the amount of secondary armament is sufficient, at least one group should be emplaced in well concealed positions. The rate of fire as well as the caliber, power, etc., should be considered in assigning armament to positions for direct and indirect aiming. A high rate of fire is not necessarily essential in indirect aiming; in positions for direct aiming, however, rapidity of fire is a first essential.

It is most desirable to have alternative positions for all armament. This permits not only of moving pieces whose positions are accurately located by the enemy, but of deceiving the enemy as to the strength of the defense. An extended organization of emplacements also admits of the employment of a greater number of mobile pieces when such use is advisable and the armament is available.

Chapter III

EMPLOYMENT OF HEAVY ARTILLERY IN LAND WARFARE

THE GENERAL NATURE OF MODERN COMBAT

Since the importance of heavy artillery in land warfare is greatest when large forces are in contact, the general nature of

artillery combat in connection with such forces will be given chief consideration.

Large forces are organized into armies, and in some cases into groups of armies. An army consists of two or more corps—normally from three to five—and of certain auxiliary troops which include heavy artillery, anti-aircraft artillery, etc. A corps consists of two or more divisions—normally from three to six—and of certain auxiliary troops which include medium artillery. A division consists of two brigades of infantry and one brigade of light artillery, together with certain auxiliary troops.

When large forces are in contact they necessarily engage on a wide front inasmuch as there is a practical limit to the advantages to be gained by strength in depth; and wherever the nature of the front admits, constant efforts are made by each force to outflank the other. The line of contact is the *front* on which engaged.

Not all parts of a front are held in equal force. In many cases it is not possible for a determined offensive to be prosecuted by either force along the entire front. Thus one force may be on the offensive on certain parts of the front, on the defensive at other points, and not heavily engaged at still other points.

Stabilized, highly organized fronts as they existed in France, Italy and other places at times during the World War are believed by American military authorities to be exceptional. It is recognized, nevertheless, that highly organized defensive positions are liable to be encountered in the future. Such positions include infantry and machine gun positions provided with at least splinter proof shelter for the garrison. These shelters sometimes are of great strength. The positions are organized in depth varying with the nature of the terrain, the time available for construction, etc. The depth may be comparatively small or as great as 1500 yards or more. These positions often may assume the character of defensive zones. They may consist of a perfect maze of firing, communicating and cover trenches with barbed wire entanglements and other obstructions both in front of and throughout the area. Certain points in these areas are organized for all around defense and are called *strong points*. A force on the defensive may organize a succession of such lines, which usually will be four or five miles apart.

Light artillery pieces may be installed in this area in limited numbers. In many cases trench mortars also are present in the

area, sometimes in large numbers, and all the auxiliary weapons of the infantry find employment there.

More or less closely in rear of this zone, the divisional artillery normally is emplaced. Farther to the rear, although not necessarily greatly so, the corps artillery generally is emplaced. The army artillery normally is emplaced somewhat to the rear of the corps artillery. In the attack all classes of artillery are pushed up as close to the front as practicable, although still maintaining a distribution in depth. In the defense, the artillery is echeloned in depth to a very great extent.

In general the more highly organized the position the more extensive is the use of artillery both in attack and defense. It is contemplated that no heavy artillery will be assigned permanently to the integral army artillery. The chief function of heavy artillery in land warfare will be to reinforce first one army or group of armies and then another. This either to increase its power in an offensive operation or to increase its defensive strength.

In operations where elaborate defensive positions are not involved, the use of heavy artillery perhaps will be less extensive, although always of importance. In operations of comparatively small forces its importance will vary with the nature of the operations.

MISSIONS OF HEAVY ARTILLERY IN LAND WARFARE

The missions of heavy artillery in land warfare can not be fully stated or correctly appreciated without at least a general understanding of the missions of the light artillery, (normally employed as divisional artillery), and of the medium artillery, (normally employed as corps artillery).

The following statement of the missions of artillery in land warfare is quoted from the approved report of a board of officers appointed by the War Department in 1918 to study "the armament, calibers and types of materials, * * *, to be assigned to a field army." This board is commonly known as the Caliber Board or Westervelt Board. Its report is the latest as well as the clearest and most comprehensive statement of the artillery policy of our army.

* * * * *

(a) *Division Artillery Missions*

"The division artillery, first of all, must have the mobility that will permit it to accompany the infantry of a division and

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

* * * * *

"The concensus of opinion of artillery officers is that the division artillery missions are best fulfilled by a light field gun and a light field howitzer having a range of at least 11,000 yards. While differing in mechanical features the field guns of the different European countries are practically of the same type and, though constant effort is being made to improve details they can be stated generally as satisfactory to their own governments and not liable to any radical changes. This general type of field gun, while capable of fulfilling most of the division artillery missions, must be supplemented by a proper howitzer. There are many instances where the terrain offers such protection to infantry that the field gun can not bring an effective fire. The howitzer has the great advantage that with a proper set of propelling charges and, therefore, a choice of trajectories for the same range, protected positions can be chosen for howitzers that guns could not use, and angles of fall on objectives obtained that the normal ammunition of guns would not give. The low muzzle velocity of howitzers admits of their almost continuous use in harrassing fire and allows the use of a projectile double the weight of that of

the field gun. Such a howitzer renders excellent service in wire cutting and is a useful projector of gas shells. To insure the mobility required of all divisional artillery the weight of the howitzer and carriage should not exceed that of the field gun and carriage, or about 4500 pounds.

In connection with the support of the division infantry by the division artillery the war has intensified the old question of accompanying guns for infantry. A solution of this question by the assignment of batteries of field artillery has been tried but the general opinion is that the field artillery gun is not satisfactory for this purpose; it is too vulnerable a target in motion; the ammunition supply is difficult; it is not sufficiently mobile because it can not be man-handled; and from the division artillery standpoint the loss of the control of these batteries breaks down the power of the division artillery. One of the most serious obstacles to the advance of infantry is the enemy's machine guns. If the machine gun nest is isolated it is relatively simple to maneuver in such a way as to neutralize it. If, however, there is a line of machine gun nests it becomes necessary to destroy a certain number in order to out maneuver the others. The infantry rifles, machine guns and 37 mm. guns are not sufficient for the latter mission. It is not always easy to obtain promptly the action of the division artillery, usually some distance in the rear, and it is difficult to indicate to the artillery the exact location of the machine gun nests. For the above reasons it seems proper that a special gun, designed for the destruction of machine gun nests and other light forms of enemy resistance, should be provided. This gun should have such mobility that it can be man-handled as a unit, that is, dragged along on a low wheeled mount, it should be accurate for its purpose up to 2500 yards and use a large capacity high explosive shell. Its carriage should also admit of ready adaptation for use in trenches.

(b) *Corps Artillery Missions*

It will be noted above that the division artillery missions did not include their own protection against enemy artillery. This counter-battery work is the principal mission of the corps artillery. There are American officers who advance the idea that, because of their actual experience in not receiving proper corps artillery support, the division should be supplied with counter-battery artillery; the matter is complicated because the 155 mm. howitzer which formed part of our division artillery brigades is an ideal

counter-battery weapon, and further by the fact that these howitzers did not form a part of our corps artillery, which organically consisted of guns alone. This should not divert us from the fact that the mission of counter-batterying the enemy's guns belongs to the corps which has the proper agencies for determining the position of enemy guns and for coordinating this work so as to fit in with the plans of the corps commander. The corps artillery has also the missions of extensive harassing and interdicting fire along the corps front and to a greater depth than the capabilities of the division artillery; also of destructive fire on strong points as well as on railroad facilities and points of supply. For the accomplishment of these corps artillery missions there are two distinct types of artillery necessary, a gun and a howitzer, each having about 16,000 yards range and each weighing with carriage, about 11,000 pounds.

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

"The first class gives protection from low flying air-planes to troops engaged in combat; it should, therefore, form part of the field army. The second class is part of the general anti-aircraft defense and works in coordination with the air service, balloon defense, searchlights and anti-aircraft machine guns, thus forming the anti-aircraft defense service.

(c) *Army Artillery Missions*

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

"Of the above additional artillery, a type of heavy field gun and a type of heavy field howitzer are considered normally necessary in the armament of a field army; the gun should have a range of approximately 25,000 yards, and the howitzer a range

of about 18,000 yards. Those weapons, more powerful than the medium field types, add range to the interdiction and harrassing, and to the neutralization and destruction possible with the corps types.

“It will be seen that the normal artillery mission of a field army can be accomplished by an assignment of six calibers, i.e., two light weapons, two medium weapons and two heavy weapons,—a gun and a howitzer in each class—and a satisfactory anti-aircraft gun.

“The surplus of field army types for strategic reinforcement of their respective units, the artillery of special purpose—pack artillery, trench artillery, obsolescent types, and super-guns and howitzers—are believed to be outside of the normal assignment of armament to a field army. At times all or any of the special types are necessary in field army missions; these types have no continuing purpose and should, therefore, be looked upon and organized as available reinforcement or reserve for the artillery of field armies.”

* * * * *

An examination of the above extract shows that when these new types of armament are perfected and issued, the normal zones of action of the various types of artillery will be as follows:

(a) Division artillery—i.e., light artillery—from enemy's forward elements to 11,000 yards from the artillery positions. This will give a zone anywhere from 3000 to 9000 yards deep in the enemy's territory, depending upon how far the pieces are retired behind our forward elements.

(b) Corps artillery—i.e., medium artillery—from the enemy's forward elements to 16,000 yards from the artillery positions. This will give a zone anywhere from 3000 to 14,000 yards deep in the enemy's territory, depending upon the distance the pieces are retired. The part of this zone beyond the exterior limit of the division zones will be particularly important to the corps artillery and will be the area on which a large part of its fire ordinarily will be delivered.

(c) Army artillery—i.e., heavy artillery—from the enemy's forward elements to 25,000 yards from the artillery positions. This will give a zone anywhere from 5000 to 23,000 yards deep in the enemy's territory, depending upon the distance the pieces are retired. The part of this zone beyond the exterior limit of the corps zones will be particularly important to the army artillery

and will be the area on which a large part of its fire ordinarily will be delivered.

The approved report of the Caliber Board, later amended as regards army artillery, provides that pending the development of new types, the division artillery shall consist of 75 mm. guns and 155 mm. howitzers having maximum ranges of approximately 10,000 yards and 12,000 yards respectively; corps artillery shall consist of 4.7-inch and 5-inch guns, chiefly the former, having maximum ranges of approximately 13,000 yards and 12,000 yards respectively, and 155 mm. howitzers having a maximum range of approximately 12,000 yards; and organic army artillery shall consist of 155 mm. guns and 8-inch howitzers having maximum ranges of approximately 17,000 yards and 12,000 yards respectively.

Short range heavy artillery is thus limited in range to fire on targets in the division and corps zones. The medium range heavy armament is similarly limited to fire normally on targets in the army zone. Some of it however can range about 8000 yards farther than the armament normally employed as army artillery, and some of the present long range armament can range as much as 22,000 yards beyond any of the medium range armament.

A consideration of the quotations given above shows that the heavy artillery ordinarily employed as the army artillery should find a large part of its targets beyond the normal corps zones, and that other heavy artillery may be used for special missions, e.g., to fire on targets beyond the normal army zone, to reinforce the fire of the army artillery, etc., or may be used to reinforce the fire of both divisional and corps armament.

In performing these missions heavy artillery will have to carry out harassing, interdiction, neutralization and destruction fire. This fire will be delivered against fixed points, utilities, etc. In addition this armament may be called upon at times to help protect the infantry by accompanying them with fire and putting down protective barrages, etc. Such fire is not normal for this armament, and only in very exceptional cases would it be justified.

In order to bring out more clearly the nature of the missions of heavy artillery in this direct protection of our infantry a discussion of the kinds of fire employed in land warfare is inserted.

KINDS OF FIRE

In addition to the kinds of fire discussed in the preceding chapter a further subdivision and regrouping may be made with advantage when considering artillery fire in land warfare.

A combination of neutralization and destruction fire on particular elements of the enemy, especially his forward elements; or just in front of or partially around our own elements, may protect our troops from enemy fire. Such fire is called *protection fire*. It may consist of *barrage fire* or of *concentrations of fire* or of a combination of both.

Barrage fire may be divided into:

- (a) *rolling barrages*, and,
- (b) *standing barrages*.

A barrage is a curtain or barrier of fire. It may consist of one or several lines of fire, and therefore, has a depth varying from about 200 yards to as much as 1000 yards. Any one part of this barrier may consist of the fire of one piece, or, the fire of certain units may be superimposed over that of others, depending upon the density and character of the curtain desired.

A *rolling barrage* is one that moves by small distances, usually about 50 yards, at more or less regular intervals of time. It is used in the attack to protect the assaulting troops who follow close behind it. It protects them both by forcing the enemy troops in their immediate front to take cover, and when smoke shells are used in sufficient quantities, it hides them from view of the enemy. These curtains of fire usually are not uniform either in density or in depth. They are adjusted to the nature of the ground, the character of the enemy works and the resistance expected.

A *standing barrage* is one that does not move, or that moves only at comparatively long intervals of time. It is used both in attack and defense.

In the attack its purpose is to neutralize troops or guns. It may be used also in conjunction with the rolling barrage. When so used it moves by large bounds, usually several hundred yards, at comparatively long intervals of time. A rolling barrage once halted becomes a standing barrage. The use of such barrages is frequent in attack to protect troops halted for rest, reinforcement, relief or reorganization. When troops are covered both in front and on the flanks by standing barrages, they are said to be protected by a *box barrage*.

In the defense, standing barrages are put down as closely as may be in front of our infantry at the first assault of the enemy infantry. It may not stop the first enemy elements, since they may advance so rapidly as to be upon our infantry before the barrage has fallen. In such cases the barrage is sometimes main-

tained to prevent the reinforcement of the enemy and cut off the retreat of such of his troops as have already passed the barrage.

The term *concentration of fire* is used to designate the delivery of fire on the same point or same area by several different units of artillery. The fire of the various units may be distributed on particular points or parts of the area, or the fire of two or more units may be superimposed on the same point or part. In general, concentrations of fire find their largest use in offensive or defensive operations when lack of time, lack of artillery or other considerations preclude the employment of barrage fire; and barrage fire finds its largest use in the more elaborately planned operations. Barrage fire is always an effective defensive measure, no matter what the character of the position, and is used in defense whenever it can be organized.

Destruction fire is divided into three classifications in land warfare, as follows:

- (a) Destruction fire.
- (b) Counter-battery fire.
- (c) Annihilating fire.

As commonly employed in land warfare *destruction fire* is fire delivered for the destruction of material objects, e.g., trenches, machine gun emplacements, observation stations, dugouts, ammunition dumps, depots, railways, command posts, etc.

Counter-battery fire is fire directed against enemy artillery.

Annihilating fire is fire delivered rapidly and in heavy concentrations to destroy enemy troops.

The terms *preliminary bombardment*, *artillery preparation*, and *counter-preparation* are in frequent use. They do not designate kinds or classes of fire, but phases of combat. All classes of fire may be used in any phase of combat. The terms *preliminary bombardment* and *artillery preparation* are used to designate the artillery fire of the attacking forces that is delivered immediately prior to an attack, a contemplated attack, or a simulated attack. The term *counter-preparation* is used to designate the artillery fire delivered by the defense in answer to the artillery preparation of the enemy and may be used to designate all artillery fire delivered immediately prior to the time at which an enemy attack is expected.

The term *retaliation fire* is sometimes used to define fire delivered in retaliation for fire delivered by the enemy, but is not a

class of fire inasmuch as any class of fire may be used. It is rather an expression of the motive behind the fire.

HEAVY ARTILLERY AVAILABLE FOR LAND WARFARE

The available heavy artillery adapted to use in land warfare is as follows:

Caliber	Type of Cannon	Type of Mount	Fire Angles (degrees)	Maximum Range
6"	Gun	Wheeled	0 to 38	19,600 yds.
155 mm.	Gun	Wheeled	0 to 35	17,186 yds.
7"	Gun	Caterpillar	0 to 40	24,000 yds.
7"	Gun	Railway	4 to 15	16,900 yds.
8"	Gun	Railway	0 to 42	23,950 yds.
8"	Howitzer	Wheeled	0 to 45	12,230 yds.
8"	Howitzer	Caterpillar	0 to 45	12,230 yds.
9.2"	Howitzer	Wheeled	15 to 55	10,060 yds.
9.2"	Howitzer	Wheeled	15 to 55	13,084 yds.
240 mm.	Howitzer	Wheeled	1 to 50	14,200 yds.
10"	Gun	Railway	15 to 54	28,000 yds.
12"	Gun	Railway	15 to 38	29,000 yds.
12"	Gun	Railway	15 to 40	45,000 yds.
12"	Mortars	Railway	20 to 65	15,000 yds.
14"	Gun	Railway	10 to 43	46,100 yds.
14"	Gun	Railway	0 to 50	47,450 yds.

The maximum ranges given above differ in some cases from those given for the same pieces in the previous tabulation. Those previously given were for armor piercing projectiles. Those given here are for common steel land warfare projectiles, which in several cases are lighter.

This armament also may be divided with advantage according to its maximum ranges. No better classification as to ranges presents itself than that used in the preceding discussion with reference to fire against naval targets. Short ranges are therefore all ranges up to 15,000 yards, medium ranges those from 15,000 to 25,000 yards, and long ranges those in excess of 25,000 yards. The corresponding classification of armament would be: those having maximum ranges less than 15,000 yards as short range armament, those having maximum ranges from 15,000 to 25,000 yards as medium range armament, and those having maximum ranges in excess of 25,000 yards as long range armament.

The short range armament then consists of 8-inch, 9.2-inch

and 240 mm. howitzers. All of this armament is of the wheeled mount tractor-drawn type except one type of 8" howitzer which is of the self-propelled caterpillar mount type.

The medium range armament consists of the guns of 6-inch, 155-mm., 7-inch and 8-inch caliber and the 12-inch mortars. The 6-inch and 155 mm. are wheeled mounts tractor drawn. One type of 7-inch gun is mounted on caterpillar treads but is tractor drawn. The rest of this armament is of the railway type.

The long range armament consists of 10-inch guns, two types of 12-inch guns and two types of 14-inch guns. All of this armament is of the railway type.

The approved policy in our service contemplates that eventually the heavy artillery normally employed as army artillery will consist of:

(a) Guns, about 155 mm. in caliber, on carriages permitting a vertical arc of fire of from 0 degrees to plus 65 degrees; with horizontal arcs of fire of 360 degrees. This gun is to fire a projectile weighing not over 100 lbs. to a range of over 25,000 yards. A majority of these guns are to be mounted on self-propelled caterpillar mounts.

(b) Howitzers, about 8-inches in caliber, having all the characteristics given above for the 155 mm. gun except that this piece should fire a projectile weighing about 240 lbs. to a range of about 18,000 yards.

The development of the following special mission types is also contemplated.

(a) A gun about 8-inches in caliber having the same general characteristics as above, but firing a projectile weighing about 220 lbs. and having a maximum range of about 35,000 yards.

(b) A howitzer about 9.5-inches in caliber having the same general characteristics as the above pieces and firing a 400 lb. projectile to a range of about 25,000 yards.

The development of the following types of railway artillery for coast defense purposes and for assignment to field armies for special missions is contemplated in addition to the above.

(a) A gun about 8-inches in caliber having all around traverse, firing a 240 lb. projectile to a range of 35,000 yards and capable of being transported on 60 cm. trackage.

(b) A howitzer about 12-inches in caliber, having all around traverse, firing a 700 lb. projectile to a range of 25,000 yards.

(c) A gun of about 14-inches in caliber, having all around fire

from prepared positions and limited traverse on field platforms, firing a 1400 lb. projectile to a range of 40,000 yards.

(d) A howitzer of about 16-inches in caliber, having all around fire from prepared positions and limited traverse on field platforms firing a 1600 lb. projectile to a range of 30,000 yards.

Pending the development and manufacture in quantity of this contemplated armament, the heavy artillery listed above, which includes 36 of the new 14-inch guns, must be used for all heavy artillery missions.

EFFECT OF HEAVY ARTILLERY FIRE

An understanding of the effect that can be produced by heavy artillery projectiles is necessary before attempting to outline the tactics applicable to the employment of heavy artillery.

The projectiles at present on hand for supply to heavy artillery in land warfare operations consist largely of common steel shell. There are some forged steel shell on hand. Common steel shell include the cast steel and the so called semi-steel shell. Cast iron shell are unsatisfactory and are not supplied. No shrapnel is supplied at present for any of our heavy artillery matériel.

Our approved policy contemplates the supply of common steel shell carrying a large bursting charge, for all purposes other than destroying material cover, and of forged steel shell carrying a large bursting charge, for use when it is desired to secure appreciable penetration in material cover.

Experience shows that the course taken by a shell after impact depends on the angle of impact, the nature of the ground, the remaining velocity and many other factors. In the average case angles of impact from 0 degrees to 15 degrees give ricochets without penetrations. Angles of impact from 15 degrees to 25 degrees give slight penetration; the projectile in such case either ricochets after slight penetration or remains close to the surface of the ground. In general angles of impact from 25 degrees to 40 degrees give no great penetration; the projectile follows a sinuous course underground and tends to return to the surface. Angles of fall of 40 degrees or more give maximum penetration; the course of the projectile being practically straight.

FUSES

The effect of any projectile depends upon the fuse used with it. The following kinds of fuses are to be developed for use by our heavy artillery: time, super-quick, instantaneous, short delay

and long delay. Time fuses are those which burst projectiles at a pre-determined instant by the burning of a powder train or the action of clock work. All other fuses are actuated by the shock of impact alone. Super-quick fuses are those which burst on the surface, with very slight crater or no crater whatever. Instantaneous fuses are those which burst projectiles outside of a hard surface, such as concrete, without any penetration and before ricochet. Short delay and long delay fuses are those having the characteristics indicated by their names; the latter burst their projectiles after complete penetration into hard ground. The fuses now on hand are various. Delay fuses are on hand for all calibers. Few calibers, however, are provided with time or super-quick fuses.

The super-quick fuses so far developed generally will not function for angles of impact smaller than 10 degrees. All others will function at angles of impact greater than 1 or 2 degrees. The long delay fuse is for use where mining effect is desired. The others are for use against personnel and matériel on or above the surface of the ground.

Combination time and percussion fuses are furnished for the 155 mm. G. P. F. No time fuses are now furnished for other heavy artillery matériel. Such fuses are used for firing against balloons and for high burst ranging and may be used against personnel or to sweep steep reverse slopes.

Forged steel shell with long delay fuses will give maximum penetration and are therefore suitable for use against all heavily protected works and structures including concrete and armored gun emplacements, concrete and other dugouts; masonry, etc. Common steel shell with short delay fuses are suitable for use against lighter structures.

Common steel shell give the proper fragmentation for use against all personnel; works, structures, etc., not heavily protected; obstacles; batteries not in casemates or turrets; and similar targets.

Super-quick fuses produce an excellent effect against personnel, wire entanglements and similar obstacles, and against matériel in the open. At angles of impact up to about 15 degrees the instantaneous fuses produce nearly the same effect as the super-quick fuses. At greater angles of impact their action against such targets is somewhat less effective, however their effect on structures above ground is greater. When ricochets are obtained, short delay fuses produce an excellent effect against targets on the

surface of the ground. When used with common steel projectiles and when ricochets are not obtained they produce excellent effects against dugouts not too heavily protected.

DESTRUCTION OF BATTERIES

A considerable number of direct hits is required actually to destroy either the protection afforded a battery or the artillery matériel of a battery. This number varies with the caliber of the battery firing, the caliber of the target battery and the protection afforded the target. The percentage of hits to be expected in a given case will vary with the probable error of the cannon firing, the area presented by the target, etc. The probable errors of different calibers and types of armament vary widely, and the probable error of any cannon varies as the range and somewhat as the number of rounds previously fired from it. It is impossible, therefore, to specify the exact number of rounds required from any particular cannon to destroy any particular class of battery.

The experience of the World War did demonstrate that on the average a certain amount of ammunition must be expended by particular calibers to insure the destruction of batteries. In the following table it is assumed that the targets for the 155 mm., 6-inch, 7-inch, and 8-inch guns are provided with all protection possible other than concrete overhead cover and that the targets for the 8-inch howitzers and larger calibers are provided with concrete overhead cover. It is assumed also that no cannon is used at ranges for which its probable error is over 50 yards and that all fire is observed.

Firing Battery		Average Ammunition Expenditure to Destroy an Enemy Battery
Caliber	Type	
6"	Gun	400 to 600 rounds according to range
155 mm.	Gun	400 to 600 rounds according to range
7"	Gun	350 to 500 rounds according to range
8"	Gun	300 to 400 rounds according to range
8"	Howitzer	250 to 350 rounds according to range
9.2"	Howitzer	200 to 300 rounds according to range
240 mm.	Howitzer	200 to 300 rounds according to range
10"	Gun	200 to 300 rounds according to range
12"	Gun	150 to 250 rounds according to range
12"	Mortar	100 rounds
14"	Gun	100 rounds

When using the larger calibers against more lightly protected batteries the above amounts may be reduced by about one half for batteries in the open and by about one quarter for those well dug in but not provided with strong overhead cover.

The above amounts are only roughly approximate. Only a few of these calibers were extensively used in the World War. The number of rounds given for the calibers not so used was obtained in each case by comparison with cannon of similar calibers and similar characteristics that were extensively used. This table is useful mainly as a guide in determining ammunition allowances and supply. Another rule that was widely used, although differing considerably from the above, is that from 200 to 300 rounds are required to destroy a battery equal in caliber to the one firing.

To determine the amount of ammunition to be expended on any particular target, the angle of the line of fire with the line of front of the target battery; the caliber, protection and range of the target battery, and the caliber of the firing battery must be considered.

Unless fairly efficient observation can be secured the above amounts will have to be doubled at least. There can be no certainty, no matter what the expenditure of ammunition, that unobserved fire will destroy a target.

When enemy artillery is concentrated in a limited area it sometimes can be destroyed with a smaller total expenditure of ammunition than would be the total as figured from the table above for all of the batteries in the area. In such cases each firing battery should be adjusted accurately on a particular target battery. The economy results from the fact that the dispersion of even the most accurately adjusted fire is so great that hits may be obtained on batteries other than the one fired at.

DESTRUCTION OF WIRE ENTANGLEMENTS

The 6-inch and 155 mm. guns are the largest calibers used for wire cutting. They are used only when, for any reason, lighter calibers are not sufficient. Their use is therefore exceptional, and confined generally to ranges beyond the maximum range of 155 mm. howitzers. At 6000 yards it will require from 300 to 400 projectiles to open a breach 20 to 25 yards wide in entanglements having a depth of 20 yards. This can be accomplished even though the entanglement be reinforced. For deeper entanglements these amounts have to be increased. A slope that decreases the angle of impact will increase, and one that increases the angle of impact will decrease, the expenditure of ammunition.

DESTRUCTION OF "CHEVAUX DE FRISE"

Chevaux de frise are particularly difficult to destroy when

they are well made. It is necessary to obtain direct hits to destroy them. The 6-inch and 155-mm. guns are used for this work when smaller calibers cannot accomplish the task. The ammunition required can be taken as that for ordinary wire entanglements of twice the depth.

DESTRUCTION OF MACHINE GUN SHELTERS

These shelters usually present small targets and are at relatively short ranges. Guns ordinarily have less effect against them than do howitzers and mortars. This is due to the greater probable errors and the smaller angles of fall of the guns. On the average, two direct hits are required from 6-inch or 155 mm. guns to destroy a shelter having protection equal to three layers of logs. For more solidly constructed shelters larger calibers should be used. 8-inch guns or howitzers should be able with two direct hits to destroy those having even the strongest cover. 70 to 80 shots will be required from mortars or howitzers to obtain two direct hits. 80 to 100 shots will be required from guns to obtain two direct hits. These are average values for comparatively short ranges.

DESTRUCTION OF TRENCHES

The use of heavy artillery against trenches is unusual except when the trenches are provided with deep dugouts, concrete protected shelters, etc. Howitzers and mortars are used against heavily protected works as they alone give the requisite mining effect at the short ranges at which these targets usually are encountered. Due to the great variety of such works it is impossible to give definite numbers of rounds necessary for their destruction. In particular cases this can be determined from a consideration of the size of the target and the probable error of the cannon to be used.

DESTRUCTION OF LOCALITIES

The destruction of localities includes the breaking in of the cellars or basements, the demolition and firing of houses and the destruction of special works constructed therein. No rules can be given in this case, as conditions vary so greatly. The destruction of the cellars and basements if undertaken before the houses are destroyed can be accomplished by using the 9.2-inch howitzer or the 12-inch mortar with long delay fuses. From 4 to 6 rounds per each 100 square yards will be required.

The fire of guns is better adapted to the destruction of houses

than is the fire of howitzers or mortars. About 4 rounds per each 100 square yards is required. About every fourth round should be with incendiary shell. Short delay fuses should be used. Guns smaller than 12-inches in caliber will give satisfactory results in such destruction.

At long ranges the large caliber guns will give excellent results against both basements and buildings, although the expenditure of ammunition will be large.

DESTRUCTION OF PERMANENT FORTIFICATIONS

When attempting the destruction of a permanent or semi-permanent work it is important to know the exact construction. Each important element should be taken under accurate fire with the type and caliber of artillery best suited to the work. In general the howitzers and mortars are the most effective. Guns rarely should be used except to fill in ditches with enfilade fire. In general from 150 to 200 rounds from 12-inch mortars will be required to destroy any one well protected element such as a magazine, casemate, storeroom, armored gun turret, etc. The 9.2-inch and 8-inch howitzers can be used against elements more lightly protected.

Guns can be used either with reduced charges or at long ranges if the angles of fall are sufficient to give penetration. The probable errors of guns so used are apt to be excessive and the expenditure of ammunition correspondingly large.

DESTRUCTION OF RAILWAYS

The most important points to destroy on railways are:

- (a) bridges and culverts.
- (b) the parts of the track on embankments, and
- (c) yards (watertanks, switches, roundhouses, etc.).

Enfilade fire with shells containing large bursting charges and delay action fuses gives the best results. The following table gives the approximate number of rounds required from the various calibers for the various kinds of targets using enfilade fire.

Targets	Calibers	Number of rounds required
Bridge or viaduct	9.2 and	250
	12" Mortar	150
Embankment	6", 7", 155 mm.,	600
	8" and 10" gun	400
Switches	6", 7", 155 mm.,	400
	8" and 10" gun	200
Yards	6", 7", 155 mm.,	400
	8", 10", 12"	200
	and 14"	150

As stated, the above applies only to enfilade fire. If frontal fire must be used, about four times as many rounds will be required.

EFFECTIVE RADIUS OF PROJECTILES

The effective radius against material targets, of heavy artillery projectiles using super-quick or instantaneous fuses, or short delay fuses when ricochets are obtained, may be taken at from 10 meters for 6-inch to 30 meters for 14-inch cannon.

The effective radius of these projectiles against personnel when similar fuses are used is variable. It is greater laterally than in depth, and varies with the angle of fall. The greater the angle of fall the nearer the effect in depth approaches the lateral effect. The largest dimension of the zone effectively covered may be taken at from 70 yards for the 6-inch projectile to 200 yards for the 14-inch projectile.

A limited number of large fragments are effective to much greater distances. In general forged steel projectiles have a greater effective radius than do common steel projectiles. For common steel projectiles the radius of effectiveness of large fragments may be taken at from 200 yards for the 6-inch projectile to 600 yards for the 14-inch projectile. Occasionally man killing fragments may be thrown much farther from the point of burst.

When long delay action fuses are used so much penetration is obtained with the howitzers and mortars, and even with the guns when ricochets are not obtained, that the effective radius of action is limited practically to the area of the crater produced, although some fragments are effective beyond this area.

SIZE OF CRATERS

The size of the crater produced by any projectile depends upon the fuse used with it, the angle of fall and the nature of the ground or other material at the point of impact. Short delay fuses produce small craters, which are sufficient however to demolish light dugouts.

With long delay fuses the maximum craters are produced. These vary for hard soil from about 10 feet in diameter and 5 feet in depth for the 155 mm. to 30 feet in diameter and 20 feet in depth for the 14-inch gun when the angles of fall are favorable. In soft or loosened earth they may be much larger.

When angles of fall are in excess of 40 degrees, shells with long delay fuses may penetrate to such depth that the earth above

the point of burst will not be ruptured. The force of the explosion is then exerted on the surrounding earth. Thus, deep dug-outs may be blown in if the shell penetrates to a sufficient depth and carries a sufficiently powerful bursting charge. The depth reached by the projectile in hard ground may vary from about 9 feet for the .155 mm. to about 20 feet for the 12-inch mortar or even 30 feet for the 14-inch gun. The force of the explosion extends considerably below the point of burst.

TACTICAL PRINCIPLES

The principles of tactics applicable to the employment of heavy artillery in land warfare may be stated as follows:

(a) *The offensive alone promises decisive results.* This applies to all elements of the armed forces. It is evident when artillery is part of a force acting on the offensive that its action will be largely offensive. In cases where our main force is on the defensive our artillery should act on the offensive as far as is practicable. The initiative should be maintained both in maneuver and in counter-battery firing.

(b) *The essential conditions for a good artillery position are: first, the ability to fire effectively on the enemy throughout the maximum area; second, concealment from the enemy; and third, material cover against enemy fire.*

Where possible the first condition must obtain in all positions. Where one position does not afford the necessary field of fire an additional position should be organized so that a change of position can be made when necessary. In so far as possible all artillery should be capable of effective fire action at all times.

Concealment of positions and of all dispositions for the attack or defense is essential to success. Not only is "a battery seen, a battery lost" but a battery located is a battery that has lost a large part of its usefulness. The existence of alternative positions and frequent changes of position are means of deceiving the enemy and keeping him in ignorance of the positions of our artillery.

All the protection should be given to the matériel and personnel that the facilities of the locality and the means at hand permit. This is a practical question in each individual case. Material protection is, however, subsidiary to the first two essentials. The nature of the combat will determine to a large extent the necessary amount of protection.

(c) *Artillery fire must be concentrated or distributed so as to produce the maximum effect upon the enemy.* To obtain the

maximum result with the force at hand this force must be economically used. This requires that artillery fire be properly directed, and concentrated or distributed. Each target should receive enough fire to insure the execution of the mission and no more.

(d) *Fire superiority should be maintained.* This requires not only that our artillery be able to dominate the hostile artillery with its fire, but that it be able to deliver a more effective fire against all enemy troops and works than the enemy artillery can deliver against our troops and works. Artillery superiority is one of the essentials for success in combat.

(e) *The pieces of a battery should be as widely separated as the control of fire permits.* This necessitates distribution of the enemy's fire, requires him to search large areas, confuses him as to the strength and position of our artillery and in general decreases the effectiveness of his fire. It permits taking full advantage of the topography in order to secure the maximum protection and concealment. In so far as conditions permit, no two cannon should be so close together as to be endangered by the same shell. On the other hand, the pieces should not be so widely separated as to decrease the efficiency of fire of the battery. From 50 to 200 yards, depending upon the characteristics of the matériel and the topography of the locality, is a suitable interval for the pieces of a heavy artillery battery.

(f) *Batteries should be as widely separated as the control of fire permits and where possible should be echeloned in depth.* Such separation has all the advantages given above for the separation of the pieces of a battery. When it can be avoided no two batteries should be so close together that either is in danger of being hit by observed fire directed at the other. The difficulty of maintaining communications and the area available generally are the only limitations to the extent of such separation.

Batteries should be echeloned in depth in order that no matter how intense the enemy's fire, some return fire always will be possible. On the defensive they should be echeloned in depth to such extent that no matter how rapid the progress of the enemy in his attack a large part of our artillery constantly may be effective. The chief limitation to the distribution of heavy artillery in depth is that it should be emplaced so as either to deliver effective fire from the very beginning of an enemy attack or to support our own troops in an offensive move.

(g) *Advanced elements must be constantly supported by*

artillery fire. Advanced elements are those actually in physical contact with the enemy and on their success the issue of the combat depends. This requires that they be supported constantly by effective artillery fire against both the enemy's personnel and his artillery.

In the defense, this principle influences the distribution of heavy artillery in depth, since artillery support to be most effective must be rendered by the maximum artillery strength.

In the attack, this principle requires that the advanced elements be constantly accompanied by artillery fire no matter how great their progress. This, in turn, requires the advance of the artillery when the attack has proceeded a certain distance. The artillery makes as large an advance as possible each time in order that the number of moves may be as small as possible and that its fire may suffer as little interruption as possible. It advances by fractions in order that its fire may be delivered at as near its maximum intensity as possible whenever such is required.

FIRE TACTICS

Mobile heavy artillery is organized into batteries, battalions, regiments and brigades. The battalion is the normal combat unit. It consists of two batteries. Each battery mans either two or four pieces. Batteries assigned to 12-inch guns and larger calibers normally man two pieces each and those assigned to 12-inch mortars and smaller calibers, four pieces each.

The battery is the normal fire unit. Battalions manning 12-inch guns and larger calibers are sometimes used as fire units.

The experience of warfare has demonstrated that for the smaller calibers, four pieces is the most efficient size of fire unit for land warfare. Experience with the heavier calibers is limited practically to the World War, and is not entirely conclusive on this point. Such data as have been compiled indicate that the organization given above is, in general, satisfactory.

In the World War a larger proportion of unobserved fire was delivered than in any previous war. It was apparent however to all artillerymen that observation of fire was of more importance than ever before. This is evident when one considers the almost universal practice of using indirect aiming, and the materially increased ranges over any previously used.

Other things being equal, the efficiency of artillery fire is directly proportional to the accuracy and continuity of the observation of fire. Given the means and opportunity for observation

of fire the most expeditious and accurate data as to the adjustment of the fire is obtained when only one fire unit is firing on a particular target. On the other hand, with limited means and opportunity for observation, the maximum amount of data as to the adjustment of fire are obtained when the maximum number of fire units are employed for which it is practical to provide observation of fire on the same target.

The fire of any unit should be observed continuously if the maximum effect is to be secured. Such continuous observation is essential when firing at a moving naval target whose direction and range are constantly changing but is less essential to reasonably effective firing in land warfare where the targets for heavy artillery are in general stationary.

It was customary therefore in the World War to observe fire only until a satisfactory adjustment had been obtained and then to deliver so called fire for effect, checking its effect by observation from time to time when possible, or to adjust fire on various so-called witness points in order that reasonably effective fire for effect might be opened on any target in the vicinity of such points without further observation of fire. These points were sometimes assumed points in the air and the process of adjusting fire thereon was called high burst ranging. Air bursts by means of time fuses were necessary in this case.

Another method much in use was the adjustment of fire in succession on a number of targets in order that, later, fire for effect might be opened without loss of time on any one of the targets on which an adjustment had been secured. Such fire was commonly called registration fire.

Those were simply expedients or practical measures to increase the effect of fire when continuous observation was not possible. Such expedients were of great value to light and medium calibers during the World War, but were of less value to the long range heavy artillery. The observation of fire was, in general, very unsatisfactory for these calibers. The solution of this problem is largely a technical matter, and its satisfactory solution is vital to efficient tactics of fire for heavy artillery.

When such expedients can be used, or when fire without observation must be used, the number of fire units that can be used advantageously on any one target is limited only by the effect desired, the number of targets, the batteries available, and the time available for securing the desired effect on all targets. Change of targets leads to loss of time and complicates such observa-

tion as is available. It is usually advisable therefore, to concentrate only a sufficient number of fire units on one target to secure with certainty the desired effect in the time available.

It is thus evident that the size of the fire unit is not of the same importance in land warfare as in coast defense operations. The amount of fire that should be concentrated on a particular target is dependent upon the conditions of the moment and is not susceptible, in general, to such rules as were deduced for fire against naval targets.

It is evident from what has been said above that the importance of proper organization of the information and observation service cannot be overemphasized. This system normally is administered by the chief of artillery of the corps, although flash and sound ranging sections are under the chief of artillery of the army for technical matters. Each unit of heavy artillery establishes, in addition to the above, such observing stations as the topography permits.

Artillery fire during the World War, especially of the heavier calibers, was dependent to a very great extent upon the use of accurate maps. Lacking such maps, the control and direction of such fire becomes much more difficult, and the importance of observing stations for each fire unit becomes of even greater importance.

An analysis of the missions, types of fire, etc., discussed above shows that artillery fire can be considered conveniently under the following headings:

- (a) Destruction fire.
- (b) Counter-battery fire.
- (c) Concentration of fire.
- (d) Barrage fire.
- (e) Fire on communications, etc.

DESTRUCTION FIRE

The fire for the destruction of the enemy positions, machine gun emplacements, wire entanglements, etc., can be effective only when properly coordinated. This coordination ordinarily is a function of the division artillery commanders, who call upon the corps for such assistance of heavier calibers as is necessary. The corps in turn may call upon the army for heavy artillery to perform certain destructions which are beyond the power of the artillery available within the corps or when the amount of artillery

within the corps is inadequate. Units of the corps and army artillery may be assigned to the divisions to assist them in their missions, or such units may be retained under the control of the chief of artillery of the corps or of the army and simply assigned to specific missions as requested by the divisions.

The corps and the army carry out such destructions as may be considered necessary beyond the normal division and corps zones respectively.

The time available for the greater part of this destruction will vary from a very few hours to three or four days immediately preceding the delivery of or the defense against any attack. It is important that elements once destroyed be not repaired by the enemy. For this reason any program for destruction should include provisions for harrassing or prohibitive fire against all such elements to prevent their repair. Such harrassing fire frequently can be carried out to better advantage by lighter calibers than by those used to effect the destruction.

COUNTER-BATTERY FIRE

All enemy artillery must be dealt with effectually and every effort made to destroy as much of it as possible. All that cannot be destroyed must be neutralized whenever an attack is being made either by our own or the enemy's troops. Counter-battery fire is largely a corps function and is effected largely by corps artillery. Such assistance as may be desired is called for from the army artillery. Army artillery units either may be attached to the corps to assist in such missions or may be assigned to special missions of this nature by the chief of artillery of the army. Army artillery also performs counter-battery missions when called upon. Neutralization of artillery is, in many cases, most efficiently effected by the use of gas shells. No gas shells are now furnished the heavy artillery.

CONCENTRATIONS OF FIRE

Concentrations of fire are delivered against enemy assembly places, nests of batteries, etc., and may be ordered by either division or corps commanders when the means at their disposal permit. They are ordered frequently by army commanders also. When based on accurate information they are more effective than barrage fire in many cases. The Germans used concentrations rather than barrages whenever possible during the last months of the World War, due largely to their reduced artillery strength.

BARRAGE FIRE

The division artillery principally is used for this purpose.

The details are arranged by division artillery commanders co-ordinated by the chiefs of artillery of the corps and army who either issue orders for such participation of corps and army units as is desired or attach corps and army units to divisions as necessary.

FIRE ON COMMUNICATIONS, ETC.

This class of fire is a function of division, corps and army artillery within their respective normal zones. Army artillery units normally will fire at important cross roads; portions of roads in ravines, mountain passes, etc.; and on railway yards, tunnels, bridges, embankments, etc.

At the great ranges normally employed by army artillery units this fire must be either observed or conducted with varying ranges and directions so that a pattern of fire large enough to include the target will be delivered. To secure effect with one or two pieces in such cases will require considerable time. This, in itself, decreases the effectiveness of such fire.

In principle then it is advisable to assign a sufficient number of pieces to one target to insure that material effect is constantly being attained or interdiction continuously accomplished. This is of special importance when firing at railway yards or lines whose continuous operation is vital to the enemy. The use of a smaller number of pieces may secure in such cases occasional interruptions of enemy traffic and disorganize that traffic to some extent. The use of a sufficient number of pieces on the other hand should actually preclude any use of the yard or line while the firing is in progress and oftentimes secure such destruction that an occasional burst of fire may prevent its repair and thus permanently interdict the use of the road. When fire can be observed a much smaller number of pieces will secure the desired result.

GENERAL PRINCIPLES OF FIRE

In the interest of fire effect all pieces should be adjusted on witness points or probable targets as soon as emplaced. This will disclose the presence and location of the artillery however, and for that reason frequently is not permissible. When such adjustments are made they should be checked from time to time. In preparing for an offensive it is essential to keep the enemy in

ignorance of the part of the front at which forces are being concentrated. In such cases, it is necessary that the normal amount of artillery fire be not increased. Such an increase will give warning to the enemy. Therefore when preparing for an offensive it is necessary to emplace artillery gradually and spread the registration fire over a considerable period, to open the fire without preliminary adjustment of a considerable portion of the artillery or to allow the enemy to deduce the probable front of attack. The general situation will determine the procedure to be followed.

The following technical principles govern the delivery of effective fire and must be complied with if efficient tactical use is to be made of artillery:

- (a) Fire must be observed if it is to be of maximum effect.
- (b) Varying ranges and directions must be used when firing without observation.
- (c) The pattern of unobserved fire must be as small as is consistent with the certainty of including the target.
- (d) Enfilade fire is more effective than frontal fire.
- (e) Fire must be carefully prepared, taking into account all conditions affecting the ranging of the projectile.
- (f) The various missions must be carried out by the types of cannon and projectiles best adapted to their accomplishment.
- (g) The ammunition available must be expended so as to produce the maximum effect on the enemy.

DAY OF FIRE

In operations involving large forces it is convenient to have a large unit of measure and comparison as a basis for the supply of ammunition. The French artillery established a *day of fire* as a gauge or unit to be used in estimating the amount of ammunition necessary in any contemplated operation.

The day of fire was arrived at by them by averaging ammunition consumption in actual operations. It was the average amount of ammunition per cannon per day required at that period of the World War for active attack or defense. Averages obtained in this way were affected by the possibilities of supply and manufacture of ammunition.

Our army adopted the French *day of fire* and amended it for certain calibers. As in effect at the time of the Armistice, the days of fire for the various calibers are shown on next page.

These amounts cannot be considered as normal consumptions. In several instances heavy artillery of these or equal cali-

bers actually fired triple the above amounts in one day. These days of fire at best give a relation between the amounts generally needed for the various calibers and afford a convenient unit for use in calculating amounts required, and in fixing ammunition allowances.

e	Type	1 Day of Fire
75 mm.	Gun	300
4.7-inch	Gun	180
155 mm.	Howitzer	150
155 mm.	Gun	150
6-inch	Gun	150
8-inch	Gun	60
8-inch	Howitzer	100
9.2-inch	Howitzer	80
240 mm.	Howitzer	60
10-inch	Gun	50
12-inch	Gun	40
12-inch	Mortar	60
12-inch	Gun	40

TACTICS OF ARMAMENT EMPLACEMENT AND MANEUVER

The essential conditions of a good artillery position, as given under tactical principles above, were: an extensive field of fire, concealment and material protection, in the order named.

In emplacing batteries, stations, etc., concealment can be effected only by concealing each stage of the operation. Artillery camouflage, where required, must be established before work is commenced and must be maintained throughout the operation. The strictest camouflage discipline is essential.

The labor involved in constructing shelters and emplacements at artillery positions is very great when elaborate and extensive protection is provided. It is, therefore, impossible to change positions frequently and to install any great amount of protection for either personnel or matériel. Again, if such protection be provided and a battery occupy the position for any considerable period of time, it will be located ordinarily by the enemy as soon as any considerable firing is conducted from the position. A common practice therefore is to construct well protected positions and to move the battery or one or more pieces of the battery to other positions for ordinary firing, thus saving the protected emplacements for the crucial period of the combat. This practice has many advantages but is of limited application to many heavy artillery types due to the time necessary to change positions.

In general, such protection is installed as the time available

permits, exercising all possible precautions to keep the locations hidden from the enemy.

Heavy artillery usually is not limited in its choice of emplacements to any particular portion of the front of the troops it is supporting. Its great range thus allows full advantage to be taken of enfilade fire. A large proportion of its targets are definitely known before its emplacement. It is, therefore, possible to install it so as to secure the most favorable line of fire.

Concentration of fire is desirable in many cases but this does not require the concentration of armament. The principle that the pieces of a battery and the batteries themselves should be dispersed has already been discussed. In practice, only a limited number of artillery positions will be available and crowding will be necessary in many cases. In such cases concealment attains added importance. When such crowding is necessary, as for instance, when installing artillery for an offensive, it often will be possible to install a part of the artillery only a short time before the crucial stage of the engagement. This cannot well be done if batteries are to be registered. The amount of registration fire permissible per day will have to be considered in such cases.

Care must be exercised, whenever attempting to install a large mass of artillery in a short time, to have all pieces installed in time for their intended use. Attempt should not be made to install too many pieces in one night as this may lead to confusion and congestion of traffic. Proper distribution, careful concealment and proper judgment as to the time of installation are essential to the best results.

Heavy artillery must be installed so as to be able to withdraw from position quickly. In general, it has less tactical mobility than the light and medium calibers. It is, therefore, necessary to preserve all the tactical mobility that it does possess.

Heavy artillery due to its greater ranges need not make as frequent changes of position as must the lighter calibers. Its displacement either to the front or rear can be made in larger bounds. It is, nevertheless, necessary to preserve its power of maneuver and to maintain it in positions from which it can support continuously our other forces.

Great ingenuity and constant effort is required to keep heavy artillery well forward in a continuing attack. The supply of ammunition is a difficult problem. The general adoption of caterpillar transport apparently offers the greatest possibilities in this respect.

Chapter IV

EMPLOYMENT OF ANTI-AIRCRAFT ARTILLERY

MISSIONS OF ANTI-AIRCRAFT ARTILLERY

The missions of Anti-Aircraft Artillery are:

(a) To prevent enemy aircraft flying at such heights over our positions that they can observe and photograph, direct artillery fire, attack our balloons, drop bombs with accuracy or attack troops with machine guns.

(b) To prevent enemy aircraft dropping bombs on vital points behind our lines.

(c) To compel enemy aircraft flying in formation to lose their formation and thus to render them more vulnerable to attack by our own aeroplanes.

While the ideal is actually to destroy enemy aircraft, the real efficacy of anti-aircraft artillery should be evaluated by its ability to disturb the morale of the aviator, to force him to change continuously his course and altitude, and to fly so high that he will be beyond the range for good visibility. If these aims are accomplished it will be impossible for the enemy aviators to make accurate observations; aeroplanes directing artillery fire, as well as those making photographs, will work under extreme difficulties; bombing planes will be ineffective because of the great altitude at which they must fly, and hostile fighting aeroplanes will be prevented from carrying on their combat missions against troops, aircraft and observation balloons.

Since the vulnerable part of an aeroplane consists of less than two cubic yards, very few direct hits can be expected. Therefore it must be the endeavor to establish a danger zone in the vicinity of the aeroplane. The largest and most effective danger zone is established by using high explosive shell of the largest caliber consistent with the necessary rapidity of fire.

ANTI-AIRCRAFT ARMAMENT AVAILABLE

For the purpose of carrying out the missions enumerated above, we have on hand or in project the following anti-aircraft armament:

3-inch guns, Model 1917, pedestal mount,

3-inch guns, Model 1918, trailer mount, and

75 mm. guns, Model 1916, truck mount.

In addition we have a large number of mobile mounts upon which

will be placed the 3-inch seacoast guns now mounted on obsolete fixed mounts; and experiments are under way with a view to mounting 4.7-inch guns on mobile carriages, and providing self propelled mounts for a number of both 3-inch and 4.7-inch guns.

TACTICAL PRINCIPLES

The tactical principles applicable to anti-aircraft artillery are as follows:

(a) Anti-aircraft artillery must be disposed so as to defeat the more important missions of the enemy's aircraft. To this end, it must be distributed so as to cover as nearly as possible the probable maneuver area of aerial targets in the execution of their more important missions, and at the same time must be sufficiently concentrated to afford mutual support and permit concentration of the fire of several batteries on the same target when conditions warrant.

(b) Anti-aircraft artillery must be able to change position very rapidly in any case where enemy aircraft objectives are subject to frequent changes in position or relative importance.

(c) When protecting the mobile forces, the location of anti-aircraft artillery must be secondary to, and must depend upon, the location of other elements of the command.

(d) Fire must be distributed or concentrated so as best to defeat the missions of the enemy air forces.

(e) The essential conditions of a good anti-aircraft artillery position are: first, ability to fire on enemy aerial forces, throughout the greatest possible field of fire; second, concealment from the enemy, and third, protection for the personnel and, to as great extent as is practicable, for the matériel as well.

(f) An extensive, well organized and efficient information service covering the entire defense area is essential.

DISPOSITION OF ANTI-AIRCRAFT ARTILLERY

For carrying out (a) and (c) of the missions listed, as distinct from (b), the tactical employment of anti-aircraft artillery falls under two general classifications, viz:

Front line defense,

Seacoast and back area defense.

The latter includes the protection of cities and other points of vantage. In field operations this would embrace such places as headquarters, depots, railroad yards, ammunition dumps, lines of communication, etc.

For front line defense it is necessary that the leading troops be protected from aeroplane attack, and that all aircraft crossing the line for operation in our immediate rear be observed and brought under fire as early as possible. For this reason, the first line of guns must be as close to the front line of battle as possible, due consideration must be given to concealment and protection. This distance will vary usually from one to three miles. To fulfill condition (a) of the tactical principles set forth above, a second line of guns should be established in rear of the front line; batteries of the second line breaking intervals with the batteries of the first line. Thus the area in rear of the battle line may be organized into triangular sectors. Usually four batteries of two guns each constitute a sector defense; two batteries at the extremities of the side of the triangle paralleling the front, a third at the vertex of the triangle to the rear of the first two, and a fourth in reserve either to strengthen the second line of defense or to reenforce the first line.

The distance between batteries in this case will depend upon the trajectories. Each gun has a dead space directly overhead which should be protected by neighboring batteries. For the 3-inch gun the distance between front line batteries and the distance of the second line from the first should not be materially greater than 4000 yards. Also this distance will permit the concentration of several batteries on the same target.

Seacoast defense, in the event of invasion by an enemy army of the air, might be comparable to front line protection in field operations. Generally speaking, however, seacoast and back area protection are identical.

The arrangements for the defense of towns, harbors, etc., must depend upon both military and political considerations. The grouping of whatever guns are allotted must be determined by consideration of probable lines of approach and in cooperation with the Air Service.

Generally there will be certain lines of approach which enemy aircraft must follow in order to locate objectives far in the rear. Disposition in depth of anti-aircraft artillery should be made with such approaches as a probable front. This will tend to early information of the approach of hostile aircraft, will be a basis for the most effective location of batteries, and will permit of opening fire at the earliest moment and keeping the retiring planes under fire as long as possible.

For the protection of rail-heads, ammunition dumps, etc., guns should be placed at least 2000 yards from the point protected—

this in order to cover the maneuver field of the attacking force and to permit a concentration of fire at the most effective ranges and elevations on aircraft immediately over their objective.

The disposition for the defense of fortifications usually will necessitate consideration of the general principles applicable to both the defense of towns, harbors, etc., and the defense of rail-heads, ammunition dumps, etc., as discussed above.

MOBILITY OF MATERIEL

Fortification defense may be carried on effectively with permanently emplaced guns, since the fortification will remain fixed in position, and its military importance is not subject to frequent variations. Generally, however, both front and back line defense will necessitate frequent changes of position and concentrations at various points, and consequently mobility of matériel is essential. Especially is it essential in front line defense where anti-aircraft positions must be close up to the front line and must be continually conforming to the movements of the other arms.

DISPOSITION WITH REFERENCE TO OTHER ELEMENTS

In its relation to the other ground forces, anti-aircraft artillery is essentially for their protection from overhead attack. In furtherance of this mission, the anti-aircraft artillery should conform to the movements and dispositions of other ground forces, and should in no way interfere with the functions of any other arm. In taking up positions for protection, care must be exercised not to interfere with the employment, movement or supply of other arms or troops.

Distribution of Fire

Concentration of fire may be used to advantage in many ways, e.g., to break up enemy fleet formations, to render inaccessible a certain limited area over an enemy's objective, to destroy the pilot machine of a fleet starting out on a bombing expedition, etc., and it may be justified at almost any time when such concentration will not employ artillery needed to prevent other enemy aircraft from accomplishing their separate missions. However, when a number of enemy aircraft bent on a number of different missions are in the air at the same time, each one should be denied his mission, and in the general case, no employment of anti-aircraft artillery that would allow freedom of movement to any one plane would be justified.

THE SELECTION AND OCCUPATION OF BATTERY POSITIONS

It is of course impossible to lay down absolute rules for choosing a battery position, since such positions must depend so largely on the nature of the ground available, the missions and the circumstances. The important rules of general application are:

(a) The battery position should have an all around field of fire at angles of site as low as ten degrees if possible.

(b) The position should not allow direct observation from hostile lines; such observation will certainly invite the destruction of the position by the enemy artillery.

Dark backgrounds such as trees and shade should be avoided. Buildings, crossroads and other places marked clearly on the map probably have been or will be registered by the enemy artillery, and consequently the immediate vicinity is dangerous. Close proximity to field and heavy artillery positions should be avoided.

Open spaces, provided they are screened from enemy observation offer good battery positions; and orchards or sparse clusters of trees may be used provided the foliage is not dense enough to interfere with the field of view or the field of fire. The position should be rendered as inconspicuous as possible by artificial means, but the arrangements for concealment should not interfere with the mobility of the guns. After the position has been selected, the entire surroundings should be camouflaged, wheel tracks from the road to the battery position should be covered with branches and awnings or other camouflage material. Care should be taken to avoid forming pathways to the guns. Trucks should be hidden by using brushwood and screens. The personnel should be supplied with camouflage coats. It is possible in some cases partly to bury the pieces, but in this as well as in masking or sheltering them, care must be taken not to impede the rapidity of fire.

(c) Ammunition trucks should be kept under cover convenient to the battery position but no nearer than 50 yards at the least. Additional ammunition should be in a dump where it can be procured within one hour.

(d) There should be means of easy egress from the battery position. Guns should be placed so that they can be moved straight out if sudden change of position is necessary. The difficulty, and at times the impossibility, of moving the guns on bad ground makes it advantageous to place them in the immediate vicinity of roads, especially in bad weather.

(e) The battery position should allow ample room for working detachments and for facility of ammunition supply. If the

guns of a battery are brought too closely together not only are they more vulnerable but the working detachments will be in each other's way during the fire. On the other hand, guns too far apart give rise to difficulty in the transmission of orders, especially in case the telephone is not operating. The correct distance between guns appears to be about 50 yards.

METHODS OF FIRE

The methods of anti-aircraft firing are as follows:

(a) Single rounds:—In this case each round is fired with the last measured data. The data are almost always different for each round even though the rate of fire may reach fifteen shots per minute. Almost all day firing involves this method.

(b) Combing fire:—This is a sweeping fire along the future angle of site with ranges corresponding generally to about 100 meters difference in altitude.

(c) Volley fire:—By volley fire is meant firing several rounds with given data, suspending fire while new deflection and range corrections are made, and then firing again when ordered. This is the method generally employed in night defense against raiding airplanes.

(d) Fire with indirect pointing:—On low flying aircraft, observed from the fire control station but not visible from the gun emplacements, indirect pointing is a necessity. Also at night when the control of the guns is effected by means of sound locating instruments, indirect fire is a necessity.

NIGHT FIRING

Any anti-aircraft mount designed for day firing is suitable for night service if it incorporates all the devices required for indirect laying.

Indirect fire at night is executed:

- (a) By volleys of 4 to 8 shots to a piece.
- (b) By prepared volleys.

In volley fire each piece fires with the same data and as rapidly as the matériel permits. The volleys are separated by intervals as short as the determination and utilization of data will permit. The greater the number of pieces in the unit, the more effective the fire.

The data given to all the pieces of a unit are the same, and the area or volume covered by the fire is increased, if need be, either by stepping all correctors by proper increments or by

staggering the reading indices of the azimuth circles. As dense fire alone is capable of effect, the stepping of the bursts should not exceed 300 meters. For instance, in a group of 4 pieces, the object may be to place bursts at the 4 corners of a square whose sides are 200 meters in length; or in a group of 8 pieces, the object may be to place the bursts at the eight angles of a parallelopiped having sides of 200 meters in length.

Prepared fire is sometimes called barrage fire but the word barrage is misleading. To spread an impassable curtain of shells over a vertical surface 1 km. square would require 10,000 cannon. To intimidate seriously an airplane, with small chance of material effect, the shots which form the curtain must be at a distance of 200 to 300 meters from each other and at intervals of 3 to 4 seconds. Such a barrage for one square km. demands from 12 to 25 cannon.

From this it results that the portion of vertical area covered by a prepared fire rarely can exceed 500 meters by 1000 meters. In other words, to barrage a vertical area, the point towards which the airplane is heading must be determined and a prepared fire must be chosen which will suit that direction.

Premature or late opening of fire will render the preparations useless. Volleys of a prepared fire generally should not consist of more than 8 to 10 shots. The volleys can be repeated if the planes of a squadron seem to follow one another on the same path.

The projectiles to be used are high explosive, tracer and star shells.

INFORMATION SERVICE

Telephone communication between adjacent batteries and sectors, and with distant posts, Anti-Aircraft Headquarters, Headquarters Air Service, etc., must be established. Communication with the Air Service is useful for getting meteorological data at different periods during the day. Telephone connection to the rear must be provided in order to give adequate warning throughout the defense areas and to the nearby population, of the approach of enemy aircraft. The entire system will constitute an immense network of observation and signal stations extending from the coast line or front back through the defense area. The system should be perfected so that no hostile airplane may approach its objective before adequate warning can be given.

Communication with friendly airplanes by means of wireless and searchlights should be perfected, so that the presence and direction of hostile airplanes may be signaled to friendly ones.

SEARCHLIGHTS

In the World War searchlights were successfully employed in connection with anti-aircraft operations, and since then the development of a suitable type for such use has received considerable attention in our service. Whatever may be the developments in portability, control, operation, etc., the tactics of searchlight employment will remain much the same.

The employment of searchlights in the forward areas will allow their exact positions to be disclosed to the enemy and will bring very quickly a destructive artillery fire. For this reason such lights must be highly mobile; and in selecting positions for them it must be borne in mind that all other personnel and matériel in the immediate vicinity will be endangered by artillery fire directed at the searchlight positions.

In the World War when searchlights were employed at all in the forward areas, they generally were located, one line in triangular formation near the front and a second line in triangular formation some ten kilometers back. Their employment in back areas, however, was very general and was attended with excellent results where properly handled.

In the back areas, they are an important auxiliary to the anti-aircraft defense of cities, depots, dumps, etc. In such cases and in the case of anti-aircraft defense of permanent fortifications, the location and employment of searchlights must be considered in connection with the location and employment of anti-aircraft artillery, and each has an important influence on the other.

Since the anti-aircraft artillery will be located to cover the approaches to the enemy's objective, the searchlights must be located with reference to the approaches so as to serve the artillery, i.e., the lights must be located so that a target in the beam of any light will be visible from both the searchlight operator's station and the firing batteries. At the same time, the lights must not surround the objective in such way as to outline it and indicate to the attackers where bombs should be dropped. No matter how well placed, lights should not be put in action on both sides of the objective at the same time.

In back area or fortification defense, a high degree of mobility is not so important as in forward area defense, but a certain degree of mobility is essential. Lights must never be allowed to become landmarks for the enemy, and should be moved at least after each raid. In thus moving the lights, if the same relative location of lights (formation) is maintained it may serve to deceive the enemy.

as to the location of the objective relative to the lights. This is illustrated in the report of an American officer on his investigation and inspection of the defense of one of the largest British ammunition dumps, an extract from which follows:

"Along the best line of approach, and at the usual distance from the area actually to be defended, were placed three batteries of artillery and three triangulated lights. These guns and lights were poorly camouflaged, so that when a high flying plane came over to photograph the dump they would show in the pictures, and at the same time it would appear that the British did not want them to show. Thus the enemy knew the relation of these guns and lights to the location of the dump. However, about a mile in advance, along the same line of approach, was the exact duplicate of the same layout with the exception that this installation was perfectly camouflaged. The result was that when an enemy plane came over at night and these latter batteries and lights opened on him, he knew from study of the photo that very soon he must drop his bombs to hit the dump. This he always did and the bombs therefore hit in advance of the dump. Then before daylight the British would go out and fill in the bomb holes and dig holes with the same relation to the inner defense that the actual bomb holes had to the outer defense. It was in January, 1918, that I saw this defense and it had operated successfully through the entire war until that date without the ruse being discovered."

It is entirely probable that our fixed lights in permanent fortifications would offer valuable landmarks to enemy aviators as well as to the enemy naval forces.

Wherever employed, all the searchlights in a particular area should be under the command of a searchlight officer who is in telephone communication with all the control stations. If the defense area is so large, or if for any other reason the searchlight officer cannot see all lights from his station, he should have a map board showing the area to scale and the location of all searchlights and other elements of the defense. By means of suitable displays on the board to indicate batteries and lights in action, he can get at any moment a fairly comprehensive view of the situation as it would be outlined to the enemy aviators.

In the World War, listening or sound ranging apparatus frequently were employed as auxiliaries to the searchlights. These gave approximate azimuths and elevations of the target and permitted the lights to be snapped into action only when the target was reported to be within the visibility range of the light. The

development or improvement of the methods of locating aircraft by sound will increase the usefulness of the searchlights as well as the efficiency of anti-aircraft fire.

Chapter V

EMPLOYMENT OF TRENCH ARTILLERY

CHARACTERISTICS OF TRENCH ARTILLERY

Our Government now has on hand a large number of 6-inch Newton Trench Mortars. No other trench mortars are on hand in quantities except certain mortars used by the chemical warfare service for special gas attacks. The 6-inch Newton fires a bomb weighing about 50 pounds to a maximum range of about 1800 yards. The bomb carries about 10 pounds of high explosive. The rate of fire is from 8 to 10 rounds per minute when using a fixed laying, but changes in laying consume considerable time.

The total weight of one mortar, including platform and accessories, is about 830 pounds. When provided with carts and reinforced bases this material is quite mobile and can then be emplaced in a few minutes. Since the weight of the largest single piece of this mortar is only 350 pounds, it is an excellent weapon for mountain fighting especially where the material may have to be hoisted by tackle.

Our approved artillery policy contemplates the development of only one type of trench mortar. This mortar will have the following characteristics: caliber, about 6-inch; projectile, about 50 pounds; high percentage explosive; maximum range, about 4000 yards; great mobility.

Due to the limited ranges of trench artillery it is limited to fire on objectives in a narrow zone. This zone is from 500 to 1500 yards deep with our present mortars and covers only the most advanced of the enemy elements. Objectives usually can be taken under fire at a minimum distance from our own troops of about 500 yards. When our troops are in trenches or behind other cover this distance in some cases may be reduced to about 100 yards. The large angles of departure and fall characteristic of these weapons make them especially useful in mountain fighting.

The zone on which these pieces can fire is so close to our infantry that they must be employed under the direction of the Division Commander. This artillery, however, is not an integral part of divisions in our service; but is assigned for limited times and under special conditions.

Comparing these weapons to the present artillery armament of the division, their shells carry approximately six times as much explosive as those of a 75 mm. gun and nearly as much as those of a 155 mm. howitzer. With their greater angles of fall they can reach many targets that cannot be reached by the 75 mm. guns and also some targets that can not be reached by the 155 mm. howitzer. Their rate of fire is slightly inferior to that of the 75 mm. gun but over twice that of the 155 mm. howitzer. Being smooth bores and using small pressures and low muzzle velocities they have a much greater accuracy life than either of these pieces. Their first cost is only a small per cent of that of either of the other pieces. Due to the fact that they can use chlorinated explosives, their ammunition is much less expensive and can be produced in quantities without decreasing the capacity for the manufacture of the nitrated explosives used for all other artillery.

When equipped with carts and reinforced bases these pieces are more mobile than the 75 mm. They are in fact nearly as mobile as the accompanying artillery now being developed for the infantry regiments. Their ranges are nearly as great as those of the accompanying artillery and their power is much greater. They require, however, a larger personnel and are therefore more vulnerable than the accompanying artillery and, due to the weight of their projectiles, their ammunition supply is more complicated.

MISSIONS OF TRENCH ARTILLERY

The Division Commander or his Artillery Brigade Commander would normally assign the missions of the attached trench artillery. These missions may consist of:

- (a) Destruction of enemy trench systems, dugouts, machine gun emplacements, artillery, etc.
- (b) Fire on enemy personnel.
- (c) Destruction of wire entanglements and other obstacles.
- (d) Barrage fire.
- (e) Sweeping steep reverse slopes.
- (f) Firing large quantities of gas, smoke or incendiary bombs.

In other words this artillery, up to the limit of its range, is well adapted to perform any of the missions of the divisional artillery. Due to the limited ranges of the present matériel, its use in defensive operations ordinarily will be somewhat limited. It finds its greatest employment in the offensive. Whenever cover is available either in trenches or in rugged ground, it can be pushed up close enough to the leading infantry unit to be most effective.

This artillery, if present in sufficient strength, can be depended upon to destroy almost totally a most highly organized front line position. Ten to fifteen projectiles per yard of front will flatten all trenches and destroy all wire, machine gun emplacements, etc., over a zone, 250 yards deep.

It can be used also in barrage fire where two or more lines of fire are desired. Due to its great rate of fire and the power of its projectiles, which have a killing radius of about 100 yards, it is especially adapted for such use up to its limit of range.

SYSTEM OF COMMAND

Being part of a general reserve and therefore not assigned permanently to tactical units of all arms, trench artillery should be organized for training into battalions and regiments. In action, on certain occasions, whole regiments may be assigned to a division. In such cases the regimental commander may be employed by the division commander in an advisory capacity, or in direct command of the regiment. The battalion commanders ordinarily should command their battalions directly in order to insure uniformity of action. They must in all cases insure the ammunition supply.

The experience of the World War demonstrated that a proper organization would be four batteries per battalion; three batteries manning six mortars each, and the fourth being employed for the service of ammunition.

It may be desirable in many cases to attach batteries or battalions directly to infantry battalions or regiments, but ordinarily only for use after the infantry has advanced beyond the maximum range of these pieces. In all cases the closest touch must be maintained with the infantry at the front and flanks.

STRATEGICAL AND TACTICAL EMPLOYMENT

From the above it is evident that this artillery can be used best as a mobile reserve. It can be employed with great economy where, in making an attack, serious resistance in well organized positions is expected at short ranges from the line of departure of the attacking forces. In such cases it should be employed in considerable masses, but must be protected by other artillery prior to its use. Secrecy in emplacing is more important with this than with other artillery, inasmuch as the mortars would be pushed as far to the front as possible.

The problem of delivering accurate fire is simpler with trench artillery than with artillery having greater ranges. It is necessary

nevertheless to adjust accurately their fire and to continue observation of fire. Ordinarily, in destroying organized positions these mortars are used to cover the whole zone with fire, regulated so as to put the greatest density of fire on particularly strong points.

The small weight and great power of this class of artillery makes it especially suitable for use in rough or mountainous country. In many such cases it may be the only powerful artillery that can be used in quantity. Whenever operating in such country it must be anticipated that the enemy will make extensive use of this class of armament and our own forces should be supplied accordingly.

In mountainous country the tactical use will be different from that indicated above, in that battalions, and in some cases batteries, will be assigned directly to infantry regiments and battalions.

The rapidity of fire and large capacity of the projectiles of this armament make it especially suitable for use in firing special shells. It can throw over large quantities of smoke, gas or incendiary bombs in a very short time.

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