Fire Control *and* Direction for Coast Artillery

BY

CAPTAIN CLINT C. HEARN,
Artillery Corps

DEPARTMENT OF SIGNAL ENGINEERING
U. S. SIGNAL SCHOOL
1907

Fire Control *and* Direction for Coast Artillery

BY

CAPTAIN CLINT C. HEARN,
Artillery Corps

DEPARTMENT OF SIGNAL ENGINEERING
U. S. SIGNAL SCHOOL
1907

CONTENTS.

	PAGE.
History of Development	5
General Considerations	8
Definitions	12
Fire Direction of the Battery	14
Equipment	15
Primary Station	15
Secondary Station	16
Battery Commander's station	16
Gun Emplacement	16
Operations of serving a battery	16
Indication and Identification of target	17
Vessel tracking	18
Determining corrections	19
Transmitting data to guns	21
Ammunition Supply	22
Loading	23
Laying	23
Firing	25
Motars	25
The Fire Command	26
The Mine Command	30
The Battle Command	33
Plan of Defense to meet	35
Blockade	35
Bombardment	35
Deliberate Attack	37
Raids	39
The District	39
Searchlights	40
Power	43
Picket and Patrol Boats	44
Submarines	45
Land Defense	45

DEPARTMENT OF SIGNAL ENGINEERING

U. S. SIGNAL SCHOOL

FIRE CONTROL AND DIRECTION FOR COAST ARTILLERY

By CAPT CLINT C. HEARN, Artillery Corps.

The history of the development of the present system of Fire Control and Direction may be found by those interested in the subject, in the Journal of the U. S. Artillery. Prior to 1893, the efforts of those officers whose ambition had not been destroyed by the stagnation of promotion in their arm, were individual, isolated and unencouraged. Their thought and energies were devoted to improving target practice with guns and mortars which have since been relegated to the scrap-heap. This practice was, with a single exception, conducted at fixed targets. The vital questions of that day were to mix the powder thoroughly and to get a uniform density of loading. The armament consisted of great numbers of 10″ and 15″ smooth bores most of which were not mounted, a number of 8″ converted rifles, a few parrots, an occasional battery of 4.5″ siege rifles, some 8″ and 13″ mortars and a few 20″ mortars. The practice with these mortars was conducted at a land target which consisted of a barrel on top of a pole, and to enable the range party to obtain the errors quickly, circles were drawn with radii differing by one hundred yards and having a common center at the target. There were usually six of these circles and the practice was generally had at a range of about one mile. Those shots falling outside of the 600 yards circle had their co-ordinates estimated.

With the idea of developing an improvement in target practice and the best methods of utilizing the power of the armament in actual service, the editor of the Artillery Journal sent out in August, 1893, a letter inviting discussion in this journal by artillery officers. The beginning of modern artillery may be said to date from the commencement of these discussions.

With the advent of modern armament, these discussions changed in character; this new armament completely altered the methods of attack by vessels of war, necessitating consequent changes in the tactics of the defense. The installation of this modern armament which consisted of high powered rifles and rifled mortars, was begun in 1894. Even for a number of years after this, many of the senior officers of artillery advocated the retention of these old calibers in service, and at the outbreak of the war with Spain in 1898, orders were received at all artillery posts to mount, man and serve all available 8″ converted rifles and 15″ smooth bores. Many of our present coast defenses were either completed or well on their way toward completion, so far as their armament is concerned.

In May, of this year, was issued to the artillery the first drill regulations for coast artillery for the new armament. This manual failed to meet the needs of the service principally through the want of proper equipment for range-finding and for communications. In this manual, no definite system is prescribed, it being definitely stated that "The rules and instructions contained in this chapter are intended as a general guide; specific instructions will be given in orders." The result was as might have been expected; there were as many systems as there were batteries. The determination of the method to

be followed in each case was left to the ingenuity of the battery commander.

Some of the posts had been supplied with one type A, Depression Position Finder, others had improvised horizontal base-lines, the instruments used at the base-ends being, the type "B", D. P. F., the Azimuth instrument with micrometer or the old form of Transit with the vernier.

The means of communication were the old type of rented Bell telephones or the telegraph instruments, in both of which overhead wires were used. The installation of these communications was made by post labor, by men unskilled in electrical work, in other words the system of communications was "improvised", and was a source of constant trouble and discouragement to such an extent that many of the older officers of artillery declared that the new methods were too scientific to be of practical value. Some, even going so far as to declare that in case of the appearance of a hostile fleet, they would cut out all the "system" and direct the gun-commander to go ahead and hit the target. These conditions obtained until 1903.

Through the unflagging zeal of the officers participating in the discussions referred to above, their efforts were crystallized, in 1901, into two systems, known as the Wadsworth System and the Fort Monroe System, the distinctive features of the former being: that the base-lines of a Fire Command should be equal, parallel and nearly coincident; that fire direction should be exercised by the battery commander from his primary station; that case III. should be the normal method of fire, case I. and case II. being auxiliary. Those of the latter being: that the location of the base-lines of a fire command should be determined by local conditions independent of grouping them together; that fire direction

should be exercised by the battery commander from his battery; that case II. should be the normal method of fire, case I. and case III. being auxiliary.

From the date of the reorganization of the artillery into a corps with a chief on the staff of the Commanding General of the army, events followed each other in rapid succession. An advisory board, called the Artillery Board, was organized at Fort Monroe, Virginia, to which all artillery questions of importance were referred for its opinion and recommendation. At about the same time, the Wadsworth Board was convened at Fort Wadsworth, New York, for the purpose of submitting some temporary scheme for Fire Control and Direction that could be utilized at once for instruction. The report of this board was submitted September 3, 1901, and was published in full in May-June, 1902, number of the Artillery Journal which also contains a good description of the Fire Direction of the Fort Monroe system under the title of "A Battery Manning Drill". The practial working of the system was described in the January-February, 1902 number of the Journal in a report of the target practice of the class at the Artillery School, where both Fire Control and Fire Direction were exercised. Official reports of the practice at Fort Monroe were in the office of the Chief of Artillery, and in order to test the Wadsworth system, and compare it with the Monroe system, as well as to determine practically the equipment required for whatever system was to be adopted, the Board of Ordnance and Fortification made an allotment of funds, for the equipment recommended by the Wadsworth Board, to be installed at Fort Barrancas, Florida. The installation was completed by April 1, 1903, and the test was conducted under the supervision of the Board of Ordnance and Fortification, April 20-23, 1903, in the presence of the Artillery Board and of the

board of artillery officers appointed in the fall of 1902, to revise the drill regulations for coast artillery.

The report of the board supervising the test adopted the recommendation of the Chief of Artillery, based upon a comparison of the two systems, which was that the equipment of the Wadsworth system was superior to that of the Monroe system, but that the latter system itself was superior to the Wadsworth system; the report of this board was approved by the Secretary of War, and was furnished the board for the revision of the drill regulations to form the basis of the new regulations. During the period in which the board was in session, many modifications were made in the adopted system; two type batteries, a 12″ gun battery, and a 12″ mortar battery were fully equipped in conformity with the recommendations of the board, the installation of the equipment being made by the Engineer Corps, by the Ordnance Department and by the Signal Corps, the latter being especially active in providing the equipment pertaining to communications, often taking the lead in designing special instruments or improving old ones. It is perhaps, entitled to greater credit than either of the others for the reason that it was entering a new field while the others had had more or less experience in this class of work. The work of all was of the very highest character.

The composition of the board was such, the members being taken from the former advocates of the two systems, as to command the confidence of the corps in result of its work, which gave the corps a single, complete and consistant system for the defense of our seacoast, and stimulated in the individuals of the corps, an interest and pride in their arm which goes far toward the development of a genuine esprit de corps. The board was dissolved in the summer of 1905.

The act of congress of February 2, 1901, fixed the size of the company, without regard to the duties required of it and failed to recognize the fact that some of these duties called for men of special attainments. It also failed to provide for the personnel to man the mine defense.

The act of January 25, 1907, separated the field from the coast artillery, provided for the mine defense and reorganized the personnel to conform to the needs of the service, by leaving the size of the manning bodies to be determined by executive order, the smallest tactical unit being designated a battery and the personnel necessary to efficiently operate everything that pertains to the battery being organized as a company.

Such, briefly; is the history of the present system of Fire Control and Direction.

Coast defense comprises all those military and naval dispositions and operations necessary to resist a naval attack on any part of a coast line.

The line of defense is the coast line; it consists of the fortified and unfortified portions. It has been our policy to fortify all those positions which give protection to cities and important harbors that might be used as bases for our own navy and all that could be used to any advantage by an enemy.

Organization is necessary here as in the field army to attain the best results.

There must be armament to give resisting power; a service of security and information carried out by certain vessels performing similar functions with the cavalry and provided with means of communication with the shore; and a mobile army to protect against attacks on the land fronts.

The coast line is divided into districts for tactical reasons; the districts are divided into battle com-

mands, the battle commands into fire commands and the fire commands into batteries; these are the units of the tactical chain of coast artillery command.

In order to make the armament effective, it has been found necessary to provide certain equipment and a personnel trained to operate and handle the armament and equipment; the equipment comprises the range equipment, the power and light equipment and the submarine mine defense equipment; there might be added the communication equipment, although this is included in the range equipment, there are other communications than those used for fire control and direction, such as the wireless telegraph, the telephone and telegraph connecting with observation stations along the coast line, etc.

The first step is to get information, the second, to transmit it to the place where it is to be used, the third, to use the information intelligently when it is received.

The first information of the enemy will come from the scout boats, as to the kind, number and apparent destination of the vessels composing his fleet; it will be sent by wireless and to insure delivery by a dispatch boat. He may next be reported by the picket boats, and lastly will be discovered by the observers if he approaches in daylight or by the searchlights if at night.

Before he reaches effective ranges of the armament, or as soon as discovered, the battle commander will inform his fire commanders and issue the necessary orders for employing the armament of his command.

In order to present the subject clearly it is thought advisable to begin with the lowest tactical unit and build up the district, describing the details of operation of each unit and its connection with the next higher. Following these, the functions of the

equipment mentioned above, of the picket and patrol boats, and of the land defense.

After giving some necessary definitions, the subject will be discussed under the following heads:

The battery,
The fire command,
The mine command,
The battle command,
The district,
Searchlights,
Power,
Picket and patrol boats,
Submarines,
Land defense.

As indicated by the titles, the discussion extends slightly beyond those of fire control and direction, embracing a part of battle tactics and a part of the broader subject of coast defense; this extension is necessary to indicate their relation to the general subjects of which they form an important part.

DEFINITIONS.

An *artillery district*, as a tactical unit, is a subdivision of the coast line, including the personnel assigned to duty in connection with the fixed defenses thereof.

A *battle command* includes the armament that covers a water area within which a naval attack may be expected and over which one man may exercise efficient control of the artillery fire action that may take place therein, together with all the material accessory to the service of the armament, the personnel assigned thereto, and the submarine defenses connected therewith.

There may be more than one battle command in an artillery district.

The water area covered by the armament of a battle command is designated a *battle area*.

A *fire command* consists of two or more batteries, not in general exceeding four, so located that their fire covers the same or contiguous water areas and that they can be readily commanded in action by one man.

The water area covered by the armament of a fire command is designated a *fire area.*

A *mine command* consists of such portions of the submarine defenses and rapid-fire guns for the protection thereof as may be efficiently controlled by one man. There may be more than one mine command in a battle area,

The water area in which the mines pertaining to a mine command are planted is designated a *mine field.*

A *battery* is a group of guns or mortars of the same caliber and power with the position-finder stations provided therefor and with the personnel assigned thereto. Under exceptional circumstances a single isolated gun, with its station and personnel, may constitute a battery.

The water area covered by the armament of a battery is designated a *battery field of fire.*

Fire control includes the exercise of all such technical and tactical functions of command, supervision, control, and direction as may be necessary to insure an efficient defense. This term now embraces within itself, the former terms "Fire control" and "Fire Direction".

Under the Drill Regulations of 1896 and up to the approval of the provisional Drill Regulations 1906, the term "Fire Control" is the conducting of the tactical operations of any system of defense; the term "Fire Direction" consists in the technical administration of fire under the orders of the officer exercising fire control. The fire commander exercises Fire Control and the battery commander Fire

Direction. Under the present regulations, the fire commander exercises general fire control and the battery commander limited fire control, unless independent action has been ordered by his fire commander, when he exercises all the functions of fire control within the scope of his command. It does not appear in the present authorized drill regulations.

In this discussion, the term fire direction has been retained because the title of Signal Manual No. 8, contains this term, and because it is descriptive of the functions of the battery commander.

In the Manual No. 8, Apparatus Fire Control and Direction, U. S. Signal Corps, 1906, the material supplied by the Signal Corps is described, together with its installation, adjustments, tests, care of and maintenance, in other words its technical use. Its tactical use or the part it is to play in the system of defense is not treated of in this manual. The details of their tactical function may be found in the Drill Regulations for Coast Artillery (Provisional), 1906, and in the Position Finding Service, 1905.

It is not the purpose here to go into these details except so far as may be necessary for clearness, but to connect the Signal Corps installation with that of the other departments in a general way as indicated above, showing its necessity and importance,

Fire Direction or the Battery. For technical administration the personnel consisting of the company is divided into gun sections and a range section. The gun sections are divided into gun detachments and ammunition detachments and reserves. The range section consists of the primary station detail, the secondary station detail, such special details as may be necessary and a reserve.

The range section determines the data for laying and transmits it to the guns, the ammunition detachment prepares the ammunition and delivers it to the

gun platform and the gun detachment loads, lays the gun and fires.

The battery commander has two lieutenants as assistants, one known as range officer, the other as battery officer, the latter is at the battery, the former, in the primary station.

The battery commander commands the battery from his station or from such place as he may deem necessary. He must at all times remain in communication with his range officer, his battery officer and his fire commander.

In the normal type of a fire command, all the primary stations are grouped together, including that of the fire commander. The secondary stations are likewise grouped together. The stations of each group are all connected at the level of the plotting room, to enable the fire commander to visit in person any of these stations if he so desires. He is also in telephonic communication with them.

In addition to the equipment furnished by the Signal Corps are the following, supplied by the ordnance department:

PRIMARY STATION.

A depression position finder, Type A.

An azimuth instrument or type B depression position finder.

A plotting board.

A deflection board.

A range board.

A wind component indicator.

An azimuth prediction board.

A stop watch.

A harbor chart with scale arm.

A powder chart (constructed at the post).

SECONDARY STATION.

A depression position finder, type. "A"
Vessel symbols.

BATTERY COMMANDER'S STATION,

An azimuth instrument.
A megaphone.
A battle chart.
A difference chart.
Vessel symbols.

AT EACH GUN EMPLACEMENT.

A difference chart.
An abridged range table.
Vessel symbols.

The primary station has two rooms, the observing room and the plotting room. The range officer is in charge of both and has assigned to him an orderly during drill, target practice or action.

The observing room requires three men, an observer, a reader, and a telephone operator.

The plotting room requires eight men, a plotter with three assistants, a range computer, a deflection computer, a telautograph operator and a telephone operator, battery commander's line.

The secondary station requires three men—an observer, a reader and a telephone operator.

The battery commander's station requires an assistant to the battery commander, a telephone operator, and orderlies.

At the battery, the necessary gun detachments and ammunition detachments are told off in numbers each of whom has assigned specific duties.

The operations of serving a battery at drill, at target practice and in action are the same and are:

Identification of target.
Vessel tracking.

Determining and applying range and azimuth corrections.

Transmitting the corrected data to the guns.

Preparing and delivering the ammunition to the gun platforms.

Loading the guns with the ammunition so delivered.

Laying the guns according to the data received from the plotting room.

Firing according to the method prescribed by the battery commander.

The observing instruments and plotting boards are oriented and adjusted from the data given in the accurate triangulation of the harbor. The guns are oriented and their scales adjusted when mounted.

IDENTIFICATION.

All the means at hand will be used to insure the correct targets being taken by all instruments and guns. For this purpose, identification charts and symbols are furnished, which consist of the most elementary representation of the most salient features of the enemy's ships—the distinguishing features; these are outlined on the chart and numbered so that the numbers may be used for quick indication. In addition, the targets are briefly described. Where there is any probability of failure to recognize the proper target, the depression instrument is used to determine the position it is to occupy a few seconds later, relocating its position by means of the plotting board, to the secondary and battery commander's stations and to the guns. The range and azimuth of some point over which the vessel will probably pass within a short time is sent to these stations, their instruments are directed at this point and when the signal from the primary station that the vessel is passing the point is heard, the target nearest this point is the

target to be used. This may be verified by the chart and description. It is vital to correct practice to have all instruments observe the same target, otherwise, one of two things will happen. If the secondary instrument is directed at a different vessel from the primary, the range and deflection sent to the guns will be erroneous and although the guns may be aimed at the proper vessel, the projectiles will not hit the target. If the secondary and primary instruments are both on the same target, and the guns are aimed at a different one, they will fail to hit the target aimed at because the data furnished from the primary station will be for another target and will not apply to the one on which the gun is laid.

VESSEL TRACKING.

The target having been correctly identified, the next step in the operation is vessel tracking. Both primary and secondary instruments are directed upon the same target continuously, care being taken that the vertical wire is kept on the target until the third stroke of the time-interval bell; the observer stops his instrument long enough for the reader to send the azimuth over the phone to the plotting room where it is received by the assistant plotter who sets his corresponding arm at the azimuth received. The chief plotter marks the intersection of these arms on the plotting board, brings the edge of the gun arm to this point and calls off the range to the guns. He also determines the range travel, that is the difference in two successive ranges, or the rate of change in range due to the travel of the target. The deflection computer determines the rate of change in direction. These rates are determined mechanically by means of attachments on the gun-arm of the plotting board. Vessel tracking proper consists in locating on the plotting board, the successive positions of the

target as determined by the primary and secondary instruments. Just before the drill or action the plotting board is covered with paper held in position by thumb-tacks; the points are located on this paper which then becomes the record of the course of the target and is filed for use in making up the reports of the drill or action. As soon as the paper is fixed on the board, two points are accurately located on it in order that it may be placed again in the same position if it should be found necessary for any reason.

DETERMINING AND APPLYING RANGE AND AZIMUTH CORRECTIONS.

1. The range corrections are found by means of the range board, from the travel scale on the gun-arm, and from other data furnished the range computer. The board is a mechanical device from which all operations requiring a mental act have been eliminated. The range scale on the gun is graduated for normal conditions of atmosphere, wind, tide, velocity and for a constant range. Could all these conditions remain constant and at the normal, guns laid at the exact range to the target, would always hit the target within the limits of accuracy of the guns and carriages, themselves. Since these conditions are never all normal, it is necessary to lay the gun on some other point in order that the gun when fired, may hit the desired point; in other words, the gun must be laid at a fictitious range. This fictitious range is determined mechanically by means of the gun-arm on the plotting board, which permits the origin of the range scale being shifted by the amount of the correction determined on the range board. After the correction has been applied to the gun-arm, and the gun-arm brought up to the point of intersection of the station arms, the fictitious or corrected range may be read on the gun-arm scale at

once. The range thus read is not the true range to the target but that fictitious range at which the gun must be laid to hit the target. Since the corrections thus applied do not themselves change materially for small changes in range, these corrections may be found and applied in advance, that is; a set of corrections found for the range 6200 yards will be sufficiently accurate for both 6000 and 6400 yards or any range between 6000 and 6400 yards, the error in using these corrections will always be less than ten yards, even if all the effects on the range due to the maximum condition were in the same direction. Suppose the range is decreasing and the last range found is 6400 yards, the range computer finds the correction that must be applied when the target is to reach a range of 6200 yards, sets his correction on the gun-arm; the ranges read from the gun-arm will be accurate from 6400 yards till the target approaches the range 6000 yards, by which time he has determined a new aggregate correction for 5800 yards, which latter he applies as soon as the range 6000 is reached.

The range board consists of a graphic chart showing a set of curves for each of the conditions named above, the ordinates of these curves being *ranges* and the absciasas being *range corrections.* A sliding ruler is used to determine the aggregate of the corrections. The curves have reference numbers to obviate positive and negative signs.

2. The deflection, or the azimuth corrections are found by means of the deflection board in a manner similar to that employed in range corrections.

The corrections are made necessary on account of drift of the projectile, wind, and travel of the target. The reading of the board gives the aggregate which when determined, is set on the gun-arm azimuth correction scale. These corrections are sufficiently ac-

curate for all positions within 5° of the azimuth of the target and hence may be determined as in the case of the range corrections and applied on the gun-arm in advance of the position of the target. These statements have been verified by actual practice. This fact of corrections remaining practically constant through small changes of azimuth and range, justifies the method of combining predictions with corrections and applying the aggregate as a correction in advance, since the predicting interval is thereby reduced to the time required to read from the range scale on the gun-arm, the range to the guns. The time consumed from the third stroke of the time-interval bell till the gun is laid according to the data determined at this third stroke varies from four to eight seconds. This data includes all the corrections and is received at regular intervals at the guns, both on the telephone and on the telautograph. The range-setter learns to follow the range with his wheel, keeping the gun accurately laid for range all the time. The gun then may be fired at any instant, so far as range is concerned.

There are three methods of laying guns, technically known as Case I, Case II, and Case III. Case I, where the elevation and deflection or direction are both set on sight and the gun is fired by the gunner from the sighting platform; Case II, where the direction is given by the sight and the elevation or range is set by the quadrant, and the piece is fired by the gunner from the sighting platform; Case III, where the direction is given by means of the azimuth circle and the elevation by quadrant and the piece is fired from the battery commander's station or other place provided for this purpose.

TRANSMITTING THE CORRECTED DATA TO THE GUNS.

There are two systems of communication pro-

vided between the primary station and the battery, —by telephone and by telautograph.

Were it not for the great amount of noise at the battery, incident to the operations of loading and ammunition service, the telephone would be the ideal instrument for communications. When in addition to these noises, that of the guns firing, and of all the batteries and ships engaged is considered, it is doubtful if the telephone will prove more than a supplementary instrument at best. When it can be used, it is more rapid than any other up to the present designed, and is therefore valuable for giving orders, detailed instructions and explanations. It has one serious defect and that is it makes no record of what is transmitted by it. This matter of record is important, especially for orders and for data upon which the guns are to be laid.

The telautograph, while slower than the telephone, insures the same message being received that is sent, preserves the record, and is independent of noise or other disturbing conditions. The latest type is weather proof and shock proof, the receiver may be suspended by springs from the gun-carriage, and it is easy to keep in adjustment. It is useful in indication and identification, as the distinguishing features of a target may be drawn on the transmitter and reproduced on the distant receivers. Its most valuable feature is that it provides a written, visible record of the message sent and provides it at the place where the information contained in the message is to be used.

These records are preserved and filed for use in preparing the required reports.

PREPARING AND DELIVERING THE AMMUNITION TO THE GUN PLATFORMS.

The projectiles for use in action are of two kinds shot and shell, have distinctive marks and are kept

separate in the shot rooms. They both contain high explosive for the bursting charges, the walls of the shot being thicker and the amount of the bursting charge being less than in the case of the shell. The powder is kept in hermetically sealed cases in the powder room; the cases are not opened until the order for the ammunition is received by the chief of the ammunition detachment. This order designates the kind of projectile and number of rounds. In all modern batteries, the chain hoist is supplied for the delivery of the ammunition from the magazine to the delivery table on the gun platform. The projectile is sent up first, followed by the powder charge in each case. Shells are used at the longer ranges and until the vessel has arrived within the penetrating power of the gun for the main armor carried by the vessel when armor piercing shot may be used. The kind of ammunition is determined by the battery commander who gives the order for its service.

LOADING THE GUNS.

The ammunition is received by the gun detachment at the delivery table on the gun platform and is loaded in accordance with the manual for the particular piece, by hand, no machinery having, as yet, been installed for this purpose. The ammunition is carried on a truck and rammed from the top of this truck into the breech of the gun. (Disappearing guns are not allowed to appear above the parapet unless they are to be fired immediately).

LAYING THE GUNS ACCORDING TO THE DATA RECEIVED FROM THE PLOTTING ROOM.

In Case I., the gun pointer is mounted upon the sighting platform; he sets both the elevation and the deflection on his sight and causes the gun to be traversed until the vertical wire is on the target, at the same time he causes the gun to be elevated or de-

pressed until the horizontal wire coincides with the waterline of the target. Both of these wires must be at the waterline of the target when the piece is fired.

In Case II., the gun pointer is mounted on the sighting platform; he sets the deflection only, on the sight and lays the piece for direction only, keeping the vertical wire slightly in advance of the point of the target to be fired at, directing the piece to halt when it is to be fired, and firing when that point touches the vertical wire. The range is set by the elevating detail, and the piece is kept laid for range at all times, whether the piece is loaded or not; as the gunpointer has his sight set for the deflection at all times, the rate of fire is dependent only upon the rate of loading the piece and getting it into battery. With a 12″ gun mounted on a disappearing carriage, the rate of fire is with a well trained detachment, about one shot from each gun every forty seconds, executed with ease. Under stress this may be increased to one shot every thirty seconds. The smaller calibers have correspondingly higher rates.

In Case III; the range is set by the elevating detail as in Case II, and the direction is given by the gun pointer setting the gun at the azimuth received from the plotting room. In this case the rate of fire will be about one shot per minute per gun, with a possible increase to one every forty seconds. The rates of fire here given mean that they are to be taken as the normal rates,—for the "rate of fire" will be indicated by the battery commander—, and that this rate can be maintained without undue strain on the men serving the guns. Of course this presupposes thorough and continuous training of the detachments at their places at the guns. Men must be selected for each position, and trained for that position until they become experts in that position; this, it may be mentioned here, is true in all the operations

in Fire Direction, each duty requiring the services of one man must have a man permanently assigned to that duty, and if possible there must be a substitute for every man, in order that the post may always be filled; the old system of "changing posts" cannot be followed, because every man cannot become an expert in every position, but every man can be utilized in some position, and what may be ordinarily considered poor material in general may prove to be the best man for some particular place. This method not only permits the development of experts, but it provides for employing every man to the best advantage. Whatever a man can do best, he will more than likely take the greatest interest in, and in doing the best he can; it should be the continual aim of the battery commander to discover the fitness of the men for the positions and to assign them, as far as possible, in accordance therewith.

FIRING ACCORDING TO THE METHOD PRESCRIBED BY THE BATTERY COMMANDER.

There are two methods of firing. 1. By the gun pointer. 2. By the battery commander, or his assistant from the battery commander's station. In case I, and II, the firing of the piece is done by the first method, in case III, by the second method. In case I and II, the gun pointer is the only man who has the means of telling when the target is on the vertical wire, in case III, the only man who can tell when to fire is the man who is operating the battery commander's instrument.

MORTARS.

Fire direction for Mortars, differs from that for guns, in that its position finding service is confined to vessel tracking and to predicting, the only correction that is made, is for travel during the time of flight of the projectile—this work being done on the

plotting board; and in that the only method of gun laying, up to the present, is confined to that prescribed for case III.

It has been suggested that a reflecting sight be installed for each pit of a mortar battery, which consists of two pits of four mortars each, the sight and four mortars geared together in such manner as to keep their vertical planes parallel, whatever their azmiuth may be. Some experiments have been conducted, with a view to test the feasibility of the suggestion, but they were not exhaustive enough to be conclusive. Could this mechanical arrangement be perfected, it would double the possible effectiveness of mortar fire.

FIRE COMMAND.

The number and kind of guns are determined for each harbor, and depend upon the number of ships that may be put in action against the defense at any one time, and the character of the armament of these ships. It is then a problem whose solution depends upon the depth and size of the harbor or water area within the hitting range of the ships' guns. The discussion of this problem has no place in this paper, as it belongs to the broad general subject of coast defense, nor has it to do with the location of these guns nor with their grouping into batteries. But the grouping of the batteries into fire commands is one proper to this discussion, as that is still an open question. The whole system of naval construction has undergone modification time and time again. The type and armament of war-ships today are entirely different from those launched ten years ago. Our coast defenses were planned, in greater part prior to that time. The most recent of our defenses are designed, in type and in their proposed or actual location, to meet naval progress. As with the replacement of obsolete vessels, so must our out-of-date defenses be

replaced by those of the most modern type and located with a view to their best tactical employment.

A fire command is a group of batteries under the control of one man, the fire commander, for the purpose of being used as a tactical unit in the operations of defense of a fortified harbor. Under the present organization of a fire command, batteries are grouped in a fire command which are contiguous and without reference to their power or caliber. At some posts are found in the same fire command 12″ rifles, 12″ Mortars, 10″ Rifles and 6″ Rifles, while there are other batteries at the same post of similar calibers. The fault in the first place, was committed in locating batteries of the same type and caliber, without reference to their tactical use; they have been distributed over the line of positions. In the second place, the batteries have been grouped into fire commands for no other reason than that they occupy adjacent parts of this line. Under the authorized system of fire control and direction, there is no sufficient reason to justify such grouping, while there is for grouping the base-lines. The system of communications has reached a state of perfection, that it is no longer necessary to have the base line near the battery to which it pertains—it is not vital to efficient defense, although it is no doubt advantageous from minor considerations. As the problem of fire control is a tactical one, tactical considerations should govern first in the location of the batteries, and second, in the organization of the fire commands after the location has been decided, although the latter may be faulty in a tactical sense.

It is conceded by the best authorities that the armament should consist of 12″ Mortars, 12″ Rifles (possibly 14″ Rifles), 6″ Rifles against battleships and cruisers, 3″ Rifles against torpedo boats and destroyers and some type of machine gun against pos-

sible landing parties. There would seem to be no question as to how these batteries should be organized into fire commands.

Fire Central. The fire commander fights his command under the orders of the battle commander, except in cases of emergency, when he becomes a local battle commander.

His primary station is equipped like that for a battery, in order that it may be turned over to a battery when for any reason the base line or any part of it pertaining to that battery is out of commission for the time being.

The fire commander, having received orders from the battle commander to open fire on vessels designated, issues his orders in accordance therewith, to his battery commanders, directing what batteries are to fire and indicating the target for each battery His orders should be as general as possible. He makes sure that order and designation are understood. He controls the beginning and ending of the firing, and the number of shots fired by each battery. He distributes or concentrates the fire according to the demands of the action. Where targets are assigned him at long range, he will do well to distribute his fire, directing each battery commander to determine his velocity and report when he has control of the placing of his shots. He may then decide to concentrate all batteries on the same target or certain batteries on two or more targets. He must decide according to the progress of the action, as to the manner of employing the units of his command. Every opportunity must be taken by the battery commanders to observe the effect of the fire of their batteries, for the simple reason that the velocity of the powder at any particular hour of the day cannot be determined, with the present knowlege of powder, by any other method than by actual firing; without knowing the

velocity of the powder, the probability of hitting is exceedingly small. Without the ability to hit, concentration of fire becomes worse than useless, as it raises the morale of the enemy's forces, permits the ships to reach effective ranges for their quick-firing guns, and is hopelessly demoralizing to our own troops. A system of accurate observation of fire will entail a slight reduction in the rate of fire, but as this observation of fire will be necessary only for the first two or three rounds, the loss of time will be immaterial. The rate may be as slow as one shot per minute for the battery, but it is believed that the rate need not be less than one shot per battery every forty seconds, and will not cause any interruption in the other operations of the position finding service. Whenever, during an engagement, opportunity offers for observing the fall of a shot, the battery commander should avail himself of it.

Accurate observation of fire will enhance the tactical value of the fire command an hundred fold. The fire commander will know exactly what his batteries can do, and will use them to the best tactical advantage; he may decide that one battery will be ample to put a vessel out of action, thus conserving his ammunition as well as the life of the guns, at present a disturbing question in seacoast defense. A fire commander should be held accountable for every round fired in excess of those needed to solve his tactical problem.

The fire commander is responsible for the technical training of his command and for its correct tactical employment in action. He is in constant communication with his battery commanders and with his battle commander. Even when independent action has been ordered, this contact must not be broken if it is possible to maintain it, as it is his duty to keep the battle commander informed of every circumstance

affecting the result of the action. When he orders independent action for his batteries, he should aid their commanders without interfering with their freedom of action until he can resume control of the action in person.

THE MINE COMMAND.

Mines serve two purposes in the defense of a harbor, first, as an aid to the gun defense, and second constituting the entire defense within themselves.

As an aid they play the same role as obstacles play in the defense of a land position occupied by a field army,—they hold the vessels under an effective fire at ranges beyond the effectiveness of their rapid fire guns. The weakness of coast fortifications lies in the exposure of its searchlights and observing stations to rapid fire from the enemy's ships. So long as the mines are in an efficient condition, they are an impassible barrier for any kind of hostile craft.

They become the main defense when from any cause, the field of fire—the channel or, the water area—cannot be observed from the shore, such as fog, rain or snow, or if the searchlights should be damaged or destroyed.

Mines are of two kinds, ground which are used where the water is less than twenty feet in depth, and buoyant which are used when the water is over thirty five feet, but does not exceed 150 feet in depth.

Either may be used when the depth of the water is between twenty and thirty-five feet.

Mines are classified also with reference to the means used to fire them, as mechanical and electrical.

Electrical mines are further classified as controllable, in which the firing device is under control after the mine has been planted, and non-controllable, in which no control can be exercised. Mechanical

and non-controllable mines are intended to be fired only when struck by a passing vessel. They are used only when controllable mines cannot be obtained or when the channel is unimportant for commercial purposes, for the reason that they are as dangerous to friendly as to hostile vessels. Controllable mines can be rendered safe or dangerous at the will of the operator, and may be made automatic, that is to be exploded when struck by a vessel. When not acting automatically, they are set to give, when struck, a signal in the mining casemate so that one may be fired by the operator if the striking vessel be hostile. It may also be fired at any time by the operator, as when the position finding service locates a vessel within the destructive radius of a mine.

A Ground mine consists of from 200 to 300 pounds of high explosive contained in a steel case whose form is a section of a sphere, and which is heavy enough to act as its own anchor; it also contains the firing device.

A Buoyant mine consists of a spherical case loaded with 100 pounds of high explosive and containing a firing device; it is attached to an anchor by a mooring cable of such length that the mine will be held about five feet below the surface of the water at mean low tide.

A mine field, in general, consists of a line of groups of mines extending entirely across the channel or waterway to be defended.

A group of mines consists of 19 single mines or less, depending upon the width of the waterway. The mines of the group are planted approximately 100 feet apart and generally in a straight line, each connected by a single conductor cable through a junction box and a ninteen conductor cable to its own block on the operating board. Any mine can be

fired without disturbing any of the others, or any number of them may be fired simultaneously.

In general, every channel to be defended should have not less than three mine fields.

These fields are located by a board and approved by the Secretary of War, the location depending upon tactical as affected by local considerations, which latter deal with the width and depth of the channel,. the swiftness of the current, variation of the tide, and the relative importance of the harbor.

Tactical considerations deal with the positions of the mines with reference to the other defenses. The outer mine field must not be beyond 4000 yards from the mine illuminating light or the rapid fire batteries under the control of the mine commander, because that distance is the limit of the effectiveness of the latter. It must be at least 3000 yards from them or from any of the position finding stations of the defense, as inside of this distance the rapid fire of the attacking fleet becomes destructive to these stations and their personnel. In addition, the mines should hold the fleet under the fire of the mortar batteries which are not effective much inside 3000 yards.

In time of war, each harbor should have a planter, a heavy launch and two light launches, to plant the mines and to maintain them in an efficient condition at all times. With this equipment, mines can be re-laid after a raid, in a few hours, even though the whole mine field should be destroyed.

The mine as soon as planted, is accurately located on the plotting board by means of the position finders, and is numbered to correspond to its firing switch on the operating board.

The mine commander is normally at his primary station, and fights his command from this station which is equipped with the usual instruments of com-

munication and a plotting board without the gun-arm and its attachments.

The operations of the position finding service are similar to those for the mortar batteries, except that in the latter the *position* of the target is predicted for a *certain time.* While for the former, the mine is fixed, and the *time of the target's arrival* at this point is to be determined. With *mortars* the time is known and *the position must be found,* while with mines, the position is known and *the time must be found.* The predicting scales are constructed accordingly.

The mine commander is under the direct control of the battle commander; he has rapid fire batteries assigned to his command for the protection of the mine field; he operates the searchlights for the illumination of the mine field; his status is similar to that of a fire commander, in the same battle command.

BATTLE COMMAND.

In our scheme of defense for our seacoast ports, the battle command is the highest tactical command to be exercised at any one fortified place, and consists of all the fire and mine commands in the harbor over which one man can efficiently exercise control of the fire action in meeting a separate attack from a naval fleet. It is purely a tactical command and results from the same necessity for organization that exists with mobile forces. It may be one of the divisions of the district or it may be co-extensive with the district; in the latter case, the district commander becomes the battle commander. Under the present state of development, the battle commander conducts the fight of the defense, while technically under the orders of the district commander. He issues his orders to his fire commanders and his mine commanders. The general rule in regard to the character of

orders holds good here,—they should be as general as possible. The nature of the problem renders it possible to prepare the plan of defense beforehand, issue general and specific instructions and train the whole battle command in accordance therewith. From information furnished by the district commander, from reports of his scouts and outposts, and from his own personal observation, he decides as to what part of his command he will use in the opening —what fire commands he will employ. The order should indicate the targets and designate the fire commands to engage them, leaving to their commanders the details of execution—as to how many and what batteries the latter will cause to open fire.

The necessity of properly grouping batteries in a fire command is here made manifest. If properly grouped, the battle commander may be able to terminate the action by the transmission of a single order, whereas if they are not so grouped, it may be necessary to involve every fire command in order to employ the right calibers for the phase of the action in progress. There is the same necessity here for husbanding the ammunition and saving the guns as in the case of the fire commands, only in a more marked degree. Even where the demands of the fight call for the employment of every available element of the defense, proper organization and thorough training simplify the technical operations of the battle commander's functions. Without this organization for the fire command, there results, under the conditions just cited, a new fire command controlled by the battle commander, through the fire commanders by devious channels of communication. The unity of the fire commands is broken, and the battle commander is called upon to perform duties which pertain to his subordinates.

The plan of defense to be prepared, will depend upon the character of the water area that can be occupied by the attacking ships and will be designed to frustrate the operations of the enemy which may take one or more of the following forms:

1. Blockade.
2. Bombardment.
3. Deliberate attack.
4. Raids.

This is properly the subject of "Battle Tactics" and can only be touched upon in a paper of this limited scope.

Blockade. There is nothing to be done by the defense except to increase its vigilance, in case a blockade is established. The blockading vessels will remain out of range of the guns of the coast forts while engaged in this duty, but will take advantage of their presence near a fortified place to harry the defense by numerous false attacks, feints, etc. The initiative lies with the navy and it will use this advantage to the greatest extent the circumstances permit. The blockade may change into any one of the other forms and at any time selected by the naval commander. The general rule holds good, whenever the presence of a fleet is reported or discovered, re-doubled vigilance must be maintained, especially at night, in rain, snow or fog.

Bombardment. In the case of a bombardment, when the intentions of the enemy have been clearly developed, the battle commander must be governed in his decision by circumstances. If the fire of the ships is directed against a city or a fleet within the harbor and which cannot retire out of range of the attacking ships' guns, it will be necessary to silence this fire or to drive the attacking ships away. If the fire is against the fortifications, it may be better to refuse to reply to it as little damage can be done to

the defenses, this is especially the case if the bombardment partakes of the nature of a reconnaissance in force the object of which is to discover the location of the defense's guns. It may be better to lure the enemy into closer ranges, where the effectiveness of fire is material, and where the probability of hitting justifies the expenditure of ammunition. Bombardment as a rule will be executed while the vessels are in motion, and when against ships within the harbor or against the guns of the fort, accurate ranging will be necessary. The plan usually adopted to accomplish this is to have all the vessels move in a closed curve only a short portion of which is within the range of the shore guns, When the leading vessel arrives at the nearest point in this curve, it fires, signals the range used to the other ships and moves out of the way. Each of the other ships observes the fall of the shots, corrects the range used by the preceding vessel, fires when it arrives at the same point and passes out of the way, at the same time signaling the range it used to the others. The first ship may drop a buoy at the firing point, or this point may be indicated by other means. It is immaterial to the shore batteries what method is used, as the point can be accurately located by means of their position-finding equipment.

If the battle commander decides to reply to the bombardment, he will, in the beginning, allow each fire command of large caliber and the mortar batteries to verify their velocity, and will then employ such of them as he judges to be necessary to put the ships out of action as they approach the firing point. It is well to use a set-back point so that all the shots may arrive at the same instant,—the instant when the ships' gunners are aiming their guns. Bombardments are usually undertaken to cover some other operation and should not be taken too seriously, not

more so than their results justify. As they are always at extreme ranges, there is plenty of time to provide against any change in the tactics of the attack.

Deliberate Attack. A deliberate attack on the defenses of a harbor would probably be undertaken for the purpose of seizing and holding the harbor as a base, of destroying such ships and other property as would be of no value to the captors, or of covering other operations. It may take the form of a naval attack, or a land attack, or of the two in combination.

The naval attack may include one or more of the following phases:

Reconnaissance and attack of the mine field.

Reconnaissance of the gun defenses.

Attempts to run by.

The latter will be attempted only after the completion of the first two.

The reconnaissance and attack of the mine field may precede or follow that of the gun defenses. The object of the former is to locate the mine field and then to clear a passage through it preparatory to an attempt to run by.

This operation will be undertaken by swift cruisers, by torpedo boats and destroyers and by submarines.

A mine field may be rendered harmless:

By cutting the cables near the shore.

By "creeping", that is: by dragging the mine field with grapnels for cables and junction boxes, in shallow water.

By "sweeping", that is: by dragging a weighted rope or chain through the mine field, the ends being attached to boats, the boats moving parallel and at some distance apart.

By countermining, which consists of planting and exploding countermines in the mine field.

By the use of submarines.

The mine field is protected by gun-fire, by torpedo destroyers belonging to the defense and by submarines, and may involve the whole armament in case the heavier ships cover the attack. Whatever form the attack may take, the battle commander must be prepared to meet it with such of his defenses as will make repulse certain. If delivered in rain or fog, or at night under conditions where the beams of the searchlights fail to disclose the attacking boats, reliance must perforce be placed in the mobile defense. These boats must be used in such numbers as to preclude the possibility of entrance to the mine field.

Reconnaissance of the gun positions is for the purpose of locating accurately the guns of the defense and of developing the whole strength of the defense. If the battle commander is assured that the enemy is making a reconnaissance, he will refuse to be drawn into opening fire except with mortars, the knowledge of whose position is of no value to the attack since they cannot be injured by direct fire from ships. The reconnaissance may resemble a bombardment or a run by, or it may prepare the way for either.

The fire from the defense should be sporadic or be by salvo from the entire battle command. Batteries whose positions cannot be concealed may be used freely.

Every element of the defense should, during this operation, be kept in a state of perfect readiness, without undue fatigue on the personnel.

Attempts to run by will be made only after the enemy is reasonably sure that he has a clear channel through the mine field and that he has either silenced

the guns of the defense or can get by without being discovered. Should he make the attempt otherwise, the whole power of the defense would be used.

They will be successful when the ammunition of the defense is exhausted, when the mine fields are destroyed and when the floating defenses are put out of action. It is almost certain that it will never be attempted so long as the shore defenses are fairly intact.

The stronger our sea defense, the more imperative becomes the land investment, with blockade from the sea, if the enemy is to establish a base for either naval or land operations.

Raids by torpedo boats or destroyers will be undertaken in the earliest stages of the war or even before war is declared against vessels within our naval bases which are being fitted for active service and unless prevented might cause irreparable injury at the very outbreak of hostilities.

It is important, then, whenever our relations with a foreign power become strained, to take active measures to put our coast defenses in such a state of preparedness as will effectually check these early attempts.

In every form of attack, raids against position finding stations, or outlying observing stations, floating defenses, patrol and picket boats, will be essayed whenever the conditions of the action promise a measure of success.

THE DISTRICT.

The district is one of the divisions of the chain of coast defenses, established for administrative and tactical reasons.

The district commander exercises supervisory control over his district; both tactically and administratively. Under the present assignment of artillery officers, he commands the post at district headquar-

ters and is the battle commander for that battle area. This is necessary on account of the deficiency in personnel. With a sufficient organization to man all coast fortifications, the district commander would not command a post and should have his headquarters removed from any post, unless the number of fire commands at any harbor should be greater than can be efficiently controlled by one man, in which case, more than one battle command would be organized, and the district commander would exercise active tactical command through his battle commanders.

He is responsible for the efficient condition of his district. He has control of all means for security and information and of the floating defenses, furnishes his battle commanders with such information as is of value in the intelligent exercise of their functions—the whereabouts of the enemy, the measures taken by and the dispositions of the troops protecting the land approaches to the fortifications. He is responsible for the maintenance of communications, ammunition and supplies. In time of war, he should receive orders from and report direct to the *Division Commander*.

The tactical units of the coast defense and of the mobile army, in time of war, would be relatively, as follows:

The battery=the company.

The fire command, the mine command=the battalion.

The battle command=the regiment.

The district=the brigade.

SEARCHLIGHTS.

The absolute necessity for searchlights in warfare has been demonstrated beyond question by the two most recent wars; especially is this true for coast defense, where naval attacks against coast fortifications will seldom be conducted in broad daylight.

Searchlights have two uses, searching—to discover the presence of a hostile vessel,—and illuminating—to illuminate the target for the purpose of utilizing the power of the defense against those within the defense zone, whether this power be of the gun or mine defense. Until the presence of the enemy has been disclosed, illuminating lights may be used as searching lights, but this use must be under such regulations as not to interfere with each other, nor with their legitimate function when they are needed. There are certain lights in the battle command which are used for both purposes, such as the battle commander's light, the fire commander's lights.

The problem of searchlights has not yet been satisfactorily solved. The number, power, location and method of using remains to be determined. The concensus of opinion of those who have had most experience indicates that these depend, more or less, upon local conditions and will have to be determined for each locality.

There are some things with reference to these lights, however, that seem to be pretty well established. No part of the surface of the water should be illuminated, the beam should be directed so that its axis is practically parallel to the surface of the water; any object passing underneath the beam will be illuminated by diffused light. The projector should be above any observing station in order that the observer may look under the beam instead of through it. No place has yet been equipped with a sufficient number of searchlights. It would, perhaps be wise to select one post, install at least enough lights for all purposes and then by experiment, find out the lights that can be dispensed with, in order to learn the number that are actually necessary for efficient defense. Every fire command needs more

than one light, perhaps one for each battery in the fire command. Lights are expensive, but want of them may prove far more so when the critical period arrives.

Owing to the large quantity of water vapor in the atmosphere along a seacoast, beams from a searchlight are very marked, the particles of the vapor being illuminated by the light. Any object appearing within the beam is made visible by contrast, and should a beam from a searchlight be interposed between the observer and the object, the latter becomes invisible for the reason that the contrast between the illuminated object and the illuminated vapor is not sufficient to define the object. (For this same reason, searchlights are without value in the gray dusk of evening or in the early dawn of day; during these hours picket and patrol boats must redouble their vigilance.) The beam of a light may then act as an effective screen for incoming vessels, unless care is used in handling these lights. The problem, then, becomes for searching lights, to have enough of them of sufficient power for the longest ranges, located properly, and to so manipulate them that nothing can enter the battle area without being discovered in time to employ the different elements of the command to their best tactical advantage; for illuminating lights, to have enough of them in each fire command, of sufficient power for the effective ranges of the fire area, so located and so handled as to utilize the highest tactical power of the fire command without interference with the action of any other unit of the battle command.

Lights may be used for purposes of signaling when such use does not interfere with their regular functions. By a simple system of signals they may aid greatly in indication and identification of the targets. As an example of how they may be employed,

suppose the searching lights discover a squadron of battle ships approaching within the battle area; the battle commander covers the leading vessel with his light, the searching light immediately moves his beam to another part of the field. The battle commander then orders the first fire command (12″ Rifles) to cover with his number one light, the battle commander's light covers the second vessel, when the second search-light is released, and directs number two light of the same fire command to cover target in battle light, which then covers the third target, when the third search light is released. The first fire command is ordered to open fire on the squadron. The fire commander orders one of his batteries to open fire on the target in number one light at the same time elevates the beam of number one light, causing the target to disappear for an instant, when he re-covers the same target with the same beam. The target has been indicated and completely identified to every necessary part of that battery. In a similar manner another of his batteries may be assigned to another target, or all batteries may be concentrated on a single target. By some such pre-arranged code of signals with the lights, batteries may be assigned, concentrated, distributed, etc., with no other commands than those indicated by means of the lights. It may be found advantageous to concentrate the lights of a fire command upon a single target, to double the lights, to concentrate the lights of two or more fire commands, and so on. As said before, it is a new field and can be developed only by experiment. Theorizing is of value only as a *guide* in experiment.

POWER.

The power to operate the various elements of these tactical units, is of two kinds, viz.: mechanical and electrical.

The operations of loading and laying the piece or handling the ammunition before it gets to the ammunition hoists, etc., are performed by mechanical, or man power. In addition to these, power is required for telephones, telegraph instruments, telautographs, searchlights, lighting, mines, motors for ammunition hoists, etc. This electricial power is supplied from two *immediate* sources, from motor-generators and from storage-batteries.

The system adopted for creating the power needed for all electrical purposes, is known as the Central Energy System and consists of a power house centrally located and thoroughly protected, in which is installed a plant of generators whose combined output is sufficient to operate all the elements of the battle command simultaneously. Power is distributed to the various units through distributing panels, pertaining to these units on the switchboards in the fire commanders stations. In addition each battery has a reserve storage battery upon which it can draw in case of failure of supply from the central energy system.

PICKET AND PATROL BOATS.

These boats play the same part in the defense of a fortified harbor that is played by the cavalry in land operations. They form a screen outside of the harbor entrance and operate at considerable distances by means of the patrols maintaining contact with each other and with the pickets in front of the entrance, keeping in constant communication with the district and battle commanders by means of wireless equipments and by employment of dispatch boats to supplement electrical communication. This service is maintained until driven in by the enemy. These boats will be employed inside of the harbor when outside operations are impossible. They are independent

of the navy of the defense and are under the control of the district commander, otherwise they might be withdrawn by our own navy for offensive use with their fleets.

SUBMARINES.

The advent of the submarine is of such recent date, that it has not yet passed the experimental stage, but there can be no question that when its function has been determined, it will prove a powerful adjunct to an attacking fleet as it seems better adapted to offensive work. A type which permits, while submerged, the exit of a diver would seem particularly well adapted to attack the mine field. This boat could manuever under water until one of the buoyant mines is discovered, drop the diver on the bottom, who following down the cable to the anchor then following the single conductor along the bottom to the junction box, could cut the nineteen single conductor cables, or the nineteen conductor cable conductor itself might be cut, thus putting the whole group out of commission. It can also be used against the hostile ships, using its torpedoes for attacking them with little risk to themselves.

LAND DEFENSE.

A close study of the history of naval operations against fortified harbors, from the time of the introduction of cannon to the last war in the far east, shows a steady adherence to the practice of combining the naval attack with the attack by the army against the land defense of the fortified place.

The naval attack will partake of the nature of a blockade, with raids and bombardments as occasion may offer, and without seriously involving any of the more powerful vessels, until every vestige of opposition has been swept from the sea, or when its own supremacy has been so completely established.

there is nothing to fear from the consequences of the loss of a few ships; not till then will a naval commander risk a serious engagement with the fixed defenses of a fortified harbor, and even then only in conjunction with the investment and siege operations of its army. Its principal objective will be the remnants of the navy which has obtained refuge under the protection of the coast guns, and which might be of inestimable service to the defense. It is to the field army, then, that we must look for final defense against reduction of our coast defenses.

The same principle will govern it in its operations here as elsewhere. Its first care must be to prevent landing in bodies of sufficient size to gain a foothold. Failing in this, its next move is to attack these and destroy or capture them before they can concentrate. Should the enemy be powerful enough to succeed in establishing a base, our army in the field of operation must exhaust every means to contain this force until reinforcements can arrive in sufficient numbers to justify a decisive engagement. In addition to these operations of our army acting on the offensive, a cordon of field works more or less permanent must be constructed to cover all the land side of the coast defenses, kept partially garrisoned at all times, into which the army if defeated can retire. These works should be at some distance from the coast defenses, and should be designed to resist a prolonged siege by all arms. Stores, ammunition and food must be procured and stored in quantities great enough to prevent capitulation being dependent upon their exhaustion.

To make our field forces available at the threatened point, the service of security and information must be in perfect working order, and adequate means of transportation with ample sidings for rail-

ways should be constructed before the naval contest has been decided.

With a view to learning what means of transportation are needed and where they should be provided, it would seem that combined exercises might be had, employing all our available land and naval forces, dividing them into two parts, one to act as the enemy, using transports, and the other to take the part of the defensive.

In any war with a foreign power of any magnitude, should the naval struggle go against us, the theater of war would be in our own territory. Our first concern is for the safety of our frontier—our seacoast. The problems involved should be carefully worked out and tested as far as possible by maneuvers on a grander scale than has yet been attempted, and over those sections of territory which may become actual theaters of operations through hostile invasion.

Through them may be learned that co-ordination of arms or of services which leads to harmonious action in all; that the limitations of each are supplemented by the power of some other; that "preparedness" has a meaning beyond organization, beyond equipment, beyond instruction, beyond discipline, beyond solutions of hypothetical problems,—it includes rehearsals on the probable battlefields of the future.