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GARRISON ARTILLERY DRILL.

1899.

VOL. I.

PART I. INSTRUCTION.
,, II. COAST DEFENCE.

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LIST OF PLATES.

ABBREVIATIONS.

B.C.	... Battery commander.	P².	... Cubical 1½ inch (powder).
B.L.	... Breech-loading.	P.F.	... Position finder.
D.R.F.	... Depression range finder.	Prism.	... Prismatic (powder).
D.P.	... Datum point.	Q.E.	... Quadrant elevation.
E.L.	... Electric light.	Q.F.	... Quick firing.
E.X.E.	... Extra experimental (powder).	R.B.L.	... Rifled breech-loading (Armstrong).
F.C.	... Fire commander.	R.G.C.	... Range group commander.
F.G.	... Fine grain (powder).	R.F.G.	... Rifle fine grain (powder).
f.s.	... Feet per second.	R.L.	... Royal Laboratory.
G.G.C.	... Gun group commander.	R.L.G.	... Rifle large grain (powder).
G.C.	... Gun captain.	R.M.L.	... Rifled muzzle-loading.
G.L.	... Gun layer.	S.B.	... Smooth-bore.
G.S.	... General service.	S.B.C.	... Slow burning cocoa (powder).
H.A.	... High angle.	S.P.	... Selected pebble.
L.G.	... Large grain (powder).	T.E.	... Tangent elevation.
L.S.	... Land service.	§	... Paragraph of changes in war material.
M.L.	... Muzzle loading.		
M.V.	... Muzzle velocity.		
P.	... Pebble (powder).		

For further information on the subjects of this Manual, the latest editions of the following books may be consulted :—

"Treatise on the Construction of Ordnance."
"Treatise on Military Carriages."
"Equipment Regulations."
"List of Changes in Military Stores."
"Treatise on Ammunition."
"Text Book on Gunnery."
"Armour and its Attack by Artillery," by Orde Browne.
Handbook for each nature of Gun.
Regulations for Magazines, Ammunition Stores, and Laboratories.
Handbook of Gunpowder and Guncotton.
Siege Artillery Drill.
Manual of Hydraulics for G.A.
Notes on mechanism.

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THE CEREMONIAL PARADE OF A GARRISON COMPANY IN DRILL OR MARCHING ORDER PASSING SINGLY.

The company will, as a rule, parade as a battalion of two companies in "Infantry Drill," the senior subaltern acting as captain of the right company, and the second senior subaltern as captain of the left company. The junior subaltern will fall in with the right company.

The major (dismounted, without spurs and sabretache) and the captain will carry out the duties laid down for the battalion commander and major respectively in "Infantry Drill," but their posts in line (page 68) and column (page 200) will be half the number of paces laid down in that drill.

The company sergeant major will carry out the duties of the regimental sergeant major of infantry.

The trumpeters will fall in one with each company, in the post laid down for the drummers of an infantry company, excepting at "Open Order," when they will be in line with the front rank and three paces from the right of it—senior trumpeter on the right, ready to sound the "Flourish" when arms are "presented."

The inspection and march past, &c., will then proceed as laid down in "Infantry Drill" for a battalion, with the exception that artillery do not "fix swords," and are to "trail arms" when the infantry would "slope arms."

When a lieutenant-colonel's command of several garrison companies is parading as a battalion, each company will parade as above laid down; except that the captain will take command of the right company and the junior subaltern will fall in with the left company.

The organization of the company should not be interfered with unless absolutely necessary, and "sizing" should under

ordinary circumstances, be confined to special occasions, such as the Commander-in Chief's inspection, parades with other troops, &c.

A major of one of the companies will be told off by roster as mounted major; the other majors will, in all cases, including parades for the inspection of the Commander-in-Chief, fall in with their companies and be dismissed or ordered to fall in, in rear of the saluting base, before the battalion is moved from the passing line, according to circumstances.

NOTE.

The "Infantry Drill" will be used for instruction in :—

Recruit or squad drill.
Physical drill.
Company drill.
Ceremonial parade of a company battalion or brigade.
Guards.

The "Rifle Exercises," 1898. From page 23 to third line from top of page 28, for :—

Bayonet exercise—which however is never to be practised for G.O.C.'s inspection, or when parading with other troops.

The "Manual Exercises," for :—

Manual exercise of the carbine with which the company is armed.

The "Musketry Instruction," for :—

Carbine firing exercise.
Target practice.
Recruits course garrison artillery.
Trained soldiers course garrison artillery.

The "Instructions for fitting valise equipment" (1888) for :—

Fitting and packing valise equipment.

GARRISON ARTILLERY DRILL.

PART I.—INSTRUCTION.

SECTION I.—Preliminary Remarks.

It is not intended that the instruction should be imparted in the exact order as printed.

Practical gunnery and description of guns, mountings, gears, &c., should be taught at the gun, but everything connected with the theory of gunnery, as also all subjects which can best be taught indoors should be explained, as a rule, by an officer under the most comfortable circumstances to the hearers by means of lectures, or otherwise; use being made of models and of the black board, and advantage being taken of all available facilities for making the men, particularly when recruits, take a liking to their instruction. They should be given the best instructors and the best accommodation available, for men can hardly give due attention to, or profit by, explanations of theory, &c., conveyed to them by an indifferent instructor, or standing in the cold or wet under circumstances of physical discomfort.

The recruit should only be taught "essentials," but the "young soldier" should be completely instructed during his service as such. As regards the trained soldier the commanding officer will arrange to keep up his knowledge by periodical lectures, and instruction adapted as to matter and frequency to the classes into which the non-commissioned officers and men are divided.

Definitions of Gunnery Terms.

Note.—*Every gunner should be taught the meaning of those definitions marked with an asterisk.*

**Calibre.*—The diameter of the bore in inches; in rifled guns it is measured across the lands. *See* fig. 1.

**Windage.*†—The difference between the sectional area of the bore through the grooves and that of the projectile through the studs, gas checks, or the driving bands. *See* unshaded portion, fig. 2. Note.—With B.L. guns there is practically no windage.

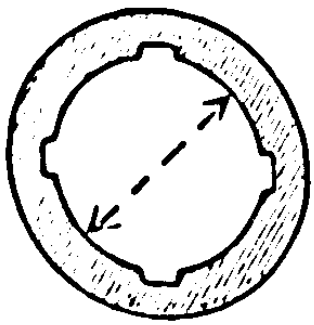


Fig. 1.

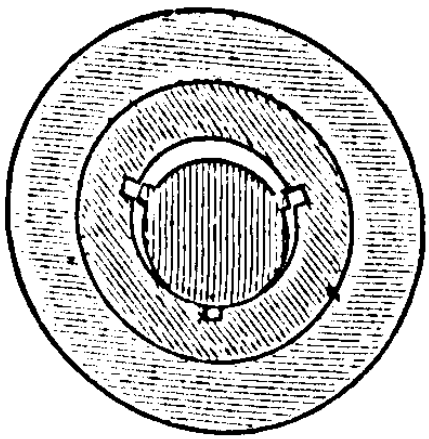


Fig. 2.

**Axis of the Piece.*—A line passing down the centre of the bore. *See* AB, fig. 3.

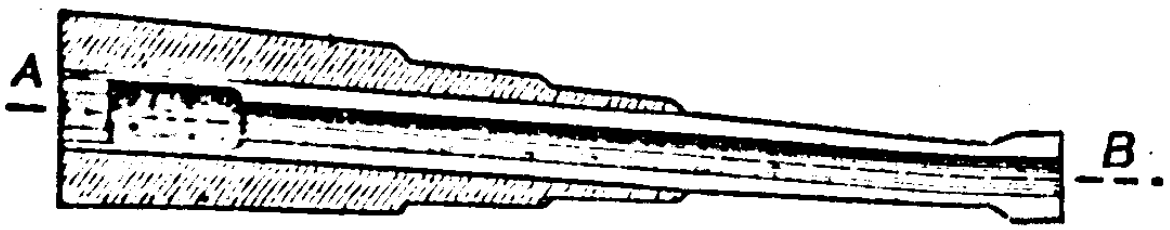


Fig. 3.

† Windage is sometimes expressed in linear units; it is then the difference between the diameter of the projectile and the calibre of the gun, irrespective of studs or grooves.

**Axis of the Trunnions.*—A line passing through the centre of the trunnions. *See* CD, fig. 4.

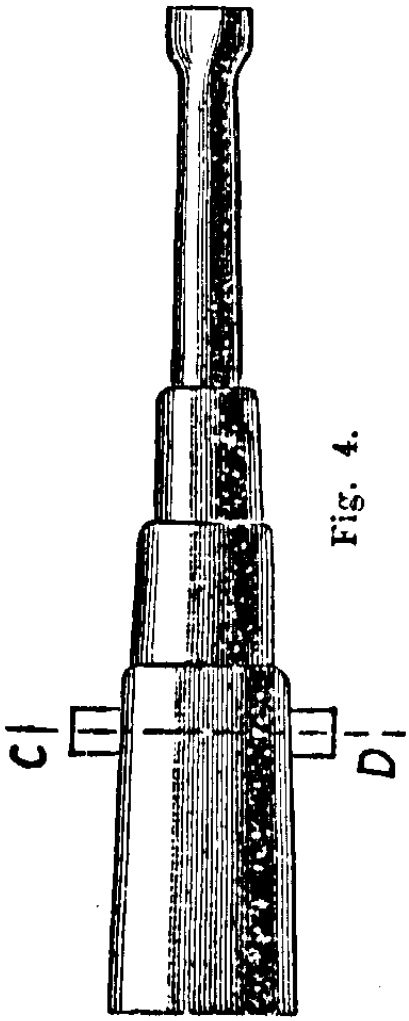


Fig. 4.

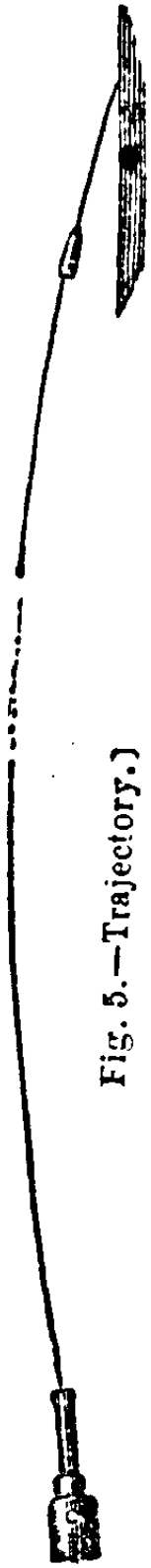


Fig. 5.—Trajectory.]

Section I.—Definitions.

**Trajectory.*—The curve described by the projectile in pas from the muzzle to the first point of impact. *See* fig. 5.

**Range.*—The distance from the piece to the second inte section of the trajectory with the line of sight. *NOTE.—I plain terms this is the distance between the gun and the targ fired at.

**Line of Sight.*—A line passing through the sights of the p and the point aimed at. *See* EF, fig. 6.

**Line of Fire.*—A line joining the muzzle of the piece and point aimed at. This term would be used instead of the preced one if firing from behind cover or in any case when the sights the piece are not used.

Plane of Sight.—The vertical plane passing through the l of sight.

Angle of Sight.—The angle which the line of sight makes wi the horizontal plane. *See* GHI, fig. 7.

**Angle of Elevation.*—The angle which the line of sight mak with the axis of the piece. *See* fig. 8.

**Quadrant Angle.*—The angle which the axis of the pie makes with the horizontal plane. It is termed *quadrant elevatio* or *depression* according as the piece is laid above or below th horizontal plane. *See* fig. 8. NOTE.—The angle of elevati and the quadrant angle are the same when the line of sight horizontal.

Line of Departure.—The direction of the projectile on leavi the muzzle, in other words, a tangent to the trajectory at t muzzle. *See* fig. 9.

Plane of Departure.—The vertical plane passing through t line of departure.

Angle of Departure.—The angle between the line of departu and the horizontal plane. *See* fig. 9.

**Jump.*—The angle between the line of departure and the ax of the piece before firing. *See* fig. 9. NOTE.—Jump arise from the gun and carriage revolving in a vertical plane on the

Fig. 6.—Line of sight.

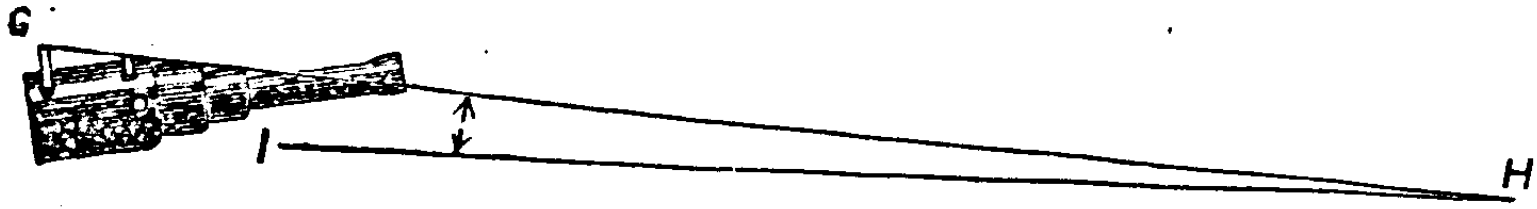


Fig. 7.—Angle of Sight.

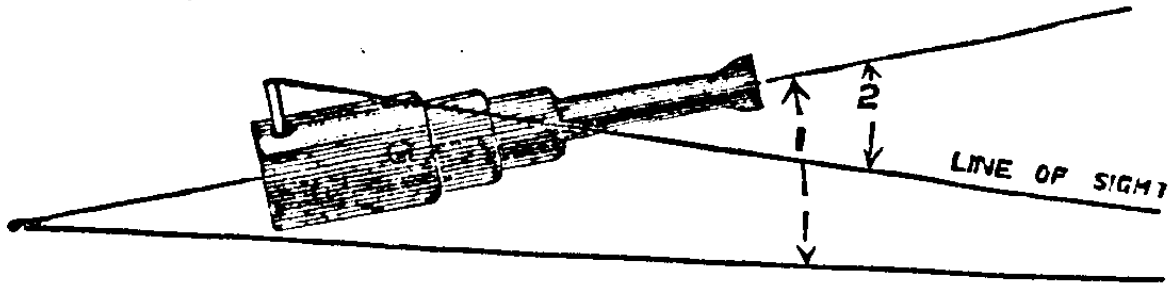
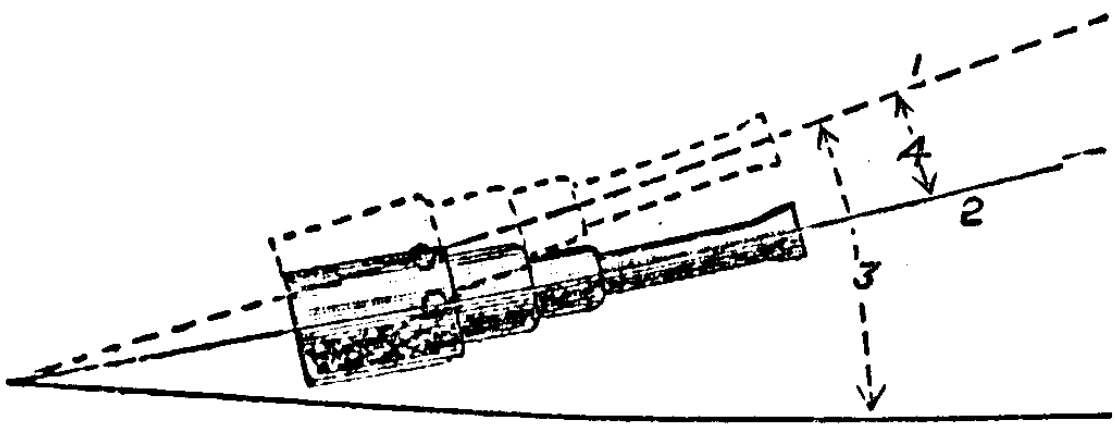


Fig. 8.
1. Quadrant Angle. 2. Angle of Elevation.

points of support in rear when the gun is fired, and takes e
before the projectile leaves the bore. With no jump the li
departure and the axis of the piece before firing woul
identical.



1. Line of Departure. 2. Axis of Piece. 3. Angle of Departure. 4. Jur

Fig. 9.

Angle of Descent or angle of Arrival.—The angle made
tangent to the trajectory at the point of impact with
horizontal plane. *See* fig. 10.

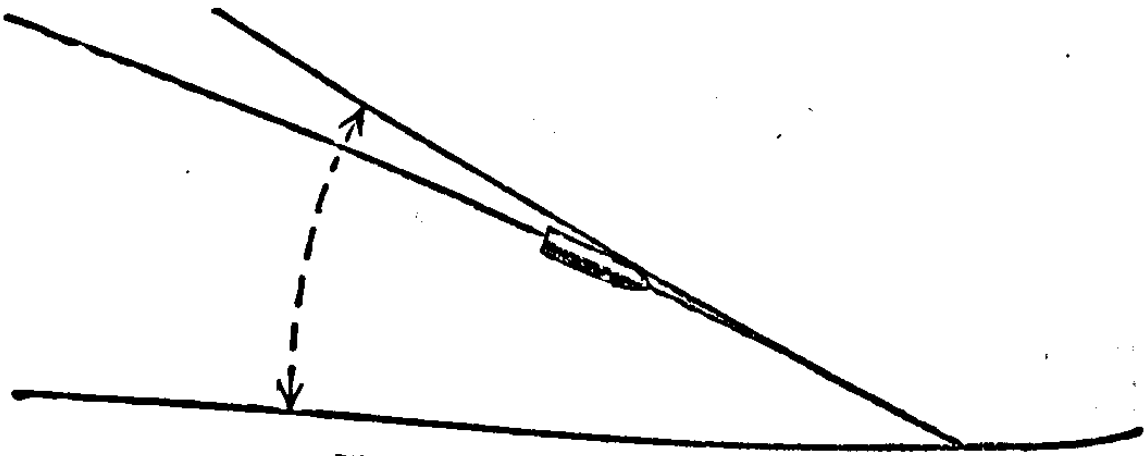


Fig. 10.—Angle of Descent.

Slope of Descent.—In some range tables this angle of d
is called slope of descent, expressed as 1 in 8, 1 in 6, 1 in
so on, this means that the shell at the end of its trajector

1 foot vertically while travelling 8, 6, or 5 feet horizontally, as the case may be.

NOTE.—The angle or slope of descent, as given in range bles, is only correct when the gun and target are in the same orizontal plane. If not in the same plane, the angle that a raight line between the gun and object makes with the rizontal, must be added to or deducted from the angle given range tables, according as the gun is in a plane above or low the object.

Dangerous Space.—Is the horizontal distance in which the ajectory would catch any vertical target. For instance a shell ith a slope of descent of 1 in 10 would hit the side of a vessel 20 feet freeboard over a space of 200 feet.

Angle of Incidence.—The angle which a tangent to the trajectory the point of impact makes with the surface struck. It may e considered either vertically or horizontally. *See* figs. 11 and 12.

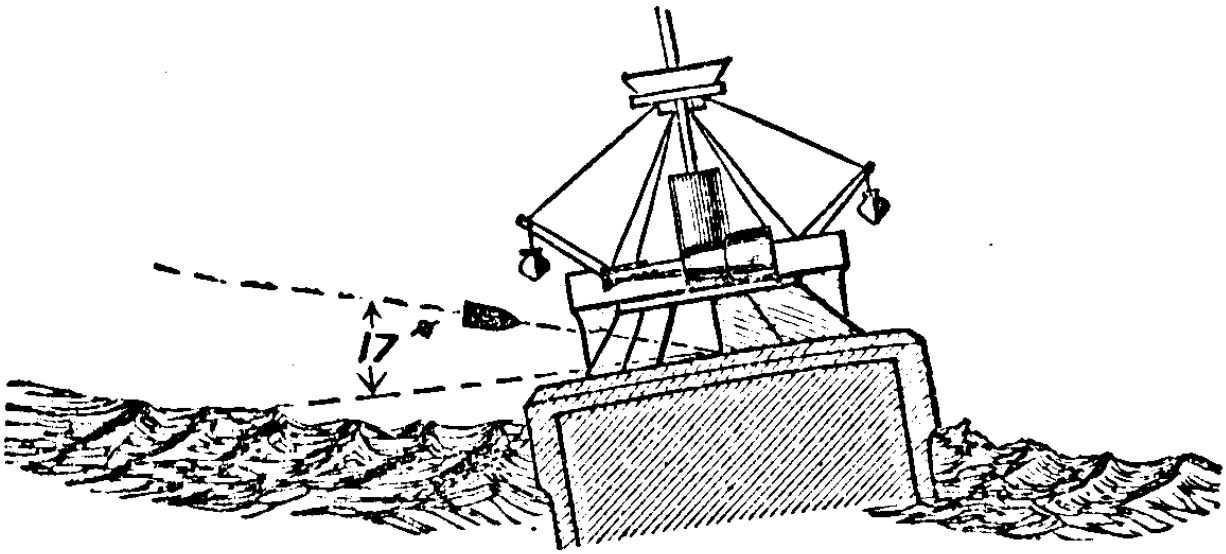


Fig. 11.—Ship's Deck.

Lateral Deviation.—The perpendicular distance of the point of pact of the projectile right or left of the plane of sight.

Section I.—Definitions.

**Drift.*—The constant deflection of the projectile from the pla of departure due to the rotation imparted by the rifling of t piece. *See* fig. 13.

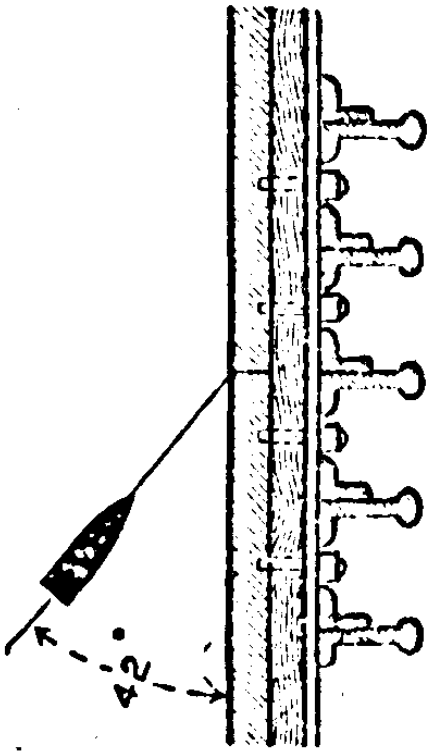


Fig. 12.

Fig. 13.—Drift.

**Point Blank.*—A gun is laid point blank when the line of sight is parallel to its axis. Point blank range is the range due to the jump of the gun.

Muzzle Velocity.—The velocity in feet per second with which a projectile leaves the muzzle.

Remaining Velocity.—The velocity of a projectile at any given point of its trajectory.

Striking Velocity.—The velocity of a projectile at the point of impact.

Forcement.—The pressure necessary to make the projectile take the rifling in B.L. Guns.

Energy (vis viva, live force).—Is the work stored up in a projectile at the moment considered. It depends on its weight and velocity.

The formula for finding it is—$E = \frac{WV^2}{2g \times 2240}$ foot tons.

Where W = the weight of the projectile in lbs.
V its velocity per second in feet.
g a constant expressing force of gravity = 32·2.

It is measured in foot tons, which means a force capable of raising a ton one foot in height, thence the necessity of dividing the numerator by 2240.

As the velocity is squared, it is evident that an increase of velocity has more effect on energy than an increase of weight, for instance the 12″ B.L. shell with a full charge, and a muzzle velocity 1,914 f.s., has a muzzle energy of 18,137 foot tons (meaning that work is expended equal to raising 18,137 tons one foot, or one ton 18,137 feet), but the 12″ R.M.L. shell of nearly the same weight, with a muzzle velocity of 1,390 f.s., has a muzzle energy of only 9,563 foot tons.

Energy is spoken of as "muzzle energy" when measured at the muzzle, or "striking energy" when measured at the target.

The following are the natures of artillery fire :

1. With Reference to the Vertical Plane.

Direct Fire.—Fire from guns with service charges at all angle of elevation not exceeding 15°.

Curved Fire.—Fire from howitzers at all angles of elevatio not exceeding 15°.

High-Angle Fire.—Fire from guns and howitzers at all angle of elevation exceeding 15°.

2. With Reference to the Horizontal Plane.

Frontal Fire.—The line of fire perpendicular to the front of th target fired at.

Oblique Fire.—The line of fire inclined to the front of th target fired at.

Enfilade Fire.—The line of fire parallel (or nearly so) to th front of the object fired at.

Reverse Fire.—When the rear instead of the front of th target is fired at.

SECTION II.—LECTURES.

The instructor in every lecture should never neglect to explain fully, in the simplest language, and with the aid of a blackboard, all technical terms, definitions of gunnery, and all words such as "vertical," "parallel," "elongated," "spiral," &c., &c., that he finds it necessary to use during his instruction. He will previously, when at gun drill, have pointed out and named the principal parts of the gun, such as muzzle, chase, trunnions, breech, cascable, bore, chamber, lands, grooves, vent, breech fittings, sights, &c. He will show the projectiles, fuzes, cartridges, tubes, briefly explaining the purposes for which they are used. He will point out the studs, gas-checks, driving-bands, &c.

First Lecture.—The Rifled Gun.

The instructor will explain that a gun having a number of grooves cut down the inside of its bore is said to be rifled, that these grooves are cut in a spiral direction in order to make the shell turn or spin on its longer axis. The longer axis of a shell is represented by a line passing through the centre lengthwise from base to tip. He will cause the men to look through the bore of a B.L. gun (or carbine) and observe the spiral grooves and the twist of the same.

Object of Rifling.—He will explain the object of rifling as follows:—

1. To increase the accuracy of flight of a shell.
2. To enable an elongated projectile to be used.

On account of the windage, a shot from a smooth bore leaves the gun in a direction dependent upon the portion of the bore last touched. This direction is uncertain and the deviation due to it cannot therefore be corrected.

In a rifled gun the projections (lead coat, studs, gas-check, driving band) on the shell are forced by the explosion of powder into the spiral grooves cut in the bore, and thus the sh is made to turn with the rifling at a great rate on its longer ax and as this rotation, which continues with slight diminuti for the remainder of its flight, is definite, the error in directi due to it is constant and can be allowed for, thus increasing t accuracy of the gun.

If an elongated projectile had no rotation, it would so turn end over end, but when the spin is sufficiently rapid, t longer axis is kept in the required direction, and the sh becomes steady in flight.

The chief value of rifling is that an elongated projectile c be used; and the advantages of using an elongated project may thus be summarised :—

1. A diminished surface for the same weight is offered the resistance of the air, and thus greater range a greater power at a given range are obtained.
2. The trajectory being flatter, the probability of hitting target is increased.
3. By varying the length, different kinds of projectiles the same gun can be brought to the same weight; a thus complications in range tables, &c., are avoided.
4. On the other hand, if desirable, a specially heavy project may be fired; *e.g.*, 7-pr. double shell.
5. A shell of the same weight as that of a S.B. Gun c be fired from a much lighter gun, or a heavier shell fr a gun of the same weight; the capacity of the shell f powder or bullets is thus increased.

Systems of Rifling.—The term "system of rifling" is appli to the method adopted in any kind of rifled ordnance for givi rotation to the projectile, but the twist of the grooves, t length, diameter, or form of the projectile must depend up

the purpose for which the gun is required, no matter upon what system the gun may be rifled.

The conditions especially desirable in a system of rifling for ordnance are :—

1. Accuracy of fire.
2. Simplicity and durability of both projectile and gun.
3. That the projectile does not jam in the bore either in loading or firing.

The systems of rifling now in the service may be classified as follows :—

(*a.*) The R.B.L. Polygroove (original Armstrong). Rotation given to the projectile by its soft metal coating being forced into a large number of grooves with sharp corners.

(*b.*) The R.M.L. Woolwich system, having a few broad deep grooves. Rotation imparted by means of soft metal studs fitted to correspond with the grooves, or, in studless projectiles, by a gas-check which takes the rifling.

(*c.*) The R.M.L. and B.L. modern polygroove. Rotation given in the former by gas-checks, in the latter by driving bands, which are forced into a large number of shallow grooves.

The disadvantages of the first system are :—

The shape of the grooves and the thickness of the lead coating on the projectiles cause considerable pressure and loss of velocity. Lead coatings are liable to damage in transport, deterioration in store, and to be detached in flight. They foul the bore and therefore necessitate a lubricant. The projectiles are, however, well centred.

The disadvantages of the second are :—

The gun is weakened by the deep grooves, and as windage is not entirely sealed by the gas-check, the rush of gas past the projectile scores the gun, injuring it and causing a waste of power. With a studded projectile, an excessive strain is thrown on the gun and projectile, the latter is not perfectly centred, the

studs are liable to injury in transport or store, and weaken th shell.

The advantages of the last are :—

Absence of windage, the grooves being numerous and shallow and the projectile an easy fit in the bore, the strain on the gu and projectile is lessened.

Twist of Rifling.—The spiral grooving or twist is either :—

1. Uniform or,
2. Increasing.

With the uniform twist the inclination of the grooves to th axis of the piece is the same throughout the bore. With a increasing twist the inclination increases towards the muzzle.

The uniform twist imparts the whole rotation to the proje tile immediately, whereas the increasing twist gives rotatio gradually, and thus causes a lower pressure in the powde chamber. With the latter twist only one driving band on th shell can be used ; and, consequently, the shell is not we centred.

The muzzle velocity is a little greater with the uniform twist.

Twist is measured by the distance in which the projectil makes one complete revolution, stated in calibres instead of fee

In some guns the first part of the groove is an increasin twist, the latter part towards the muzzle is uniform, this is don to give steadiness to the projectile on leaving the muzzle, but th method of combined twist has been discontinued in the late B.L. guns.

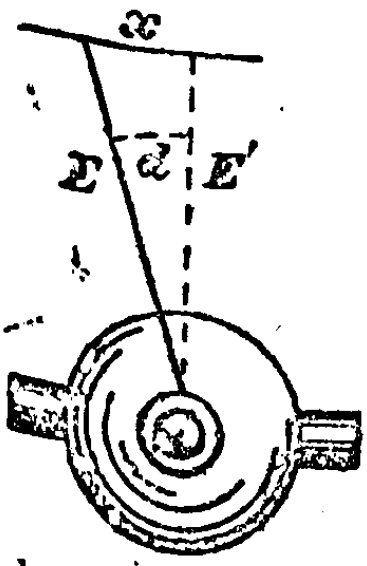
In designing a gun, the twist is made more or less rapid suit the length of the projectile and its intended velocity Generally speaking, reduced charges and long projectiles neces sitate rapid twist to make the shell steady in flight.

Second Lecture.—Centring, Drift, Muzzle or Breech-Loading.

Centring.—Is causing the axis of the projectile to coincide with the axis of the gun, this is effected by means of rotation.

Should it be imperfectly centred, a higher velocity of rotation is necessary to keep the axis of the projectile in the required direction, for if this velocity is insufficient, the projectile becomes unsteady and noisy in flight, and the shooting will be irregular.

Drift.—The direction of the rotation given to all service projectiles being right-handed, causes the shell to drive towards the right. This is called "drift." The amount of it is determined for each nature of piece by actual experiment, and is compensated for in modern ordnance, except howitzers, by inclining the tangent sights to the left.



This angle of the inclination of the sights is only true for the conditions under which the Range Table was constructed. An increase of the MV. due to the use of cordite, or the use of a smoother surface on the projectile, abolition of studs, &c., will alter the conditions, and the permanent angle will no longer be true.

In the diagram the number of minutes of deflection given by the angle of drift is denoted by x. The amount the tangent scale is raised for any range is represented by E degrees and the permanent angle of drift is shown as d degrees.

As E' is practically equal to E,

Tan $d = \frac{x}{60\ \mathrm{E}}$ (E being in degrees must be multiplied by 60).

For small angles 60 tan $d = d$.

Therefore $d = \frac{60\ x}{60\ \mathrm{E}}$ or $d \times \mathrm{E} = x$.

That is, the number of minutes of deflection given by the set of the tangent sight is equal to degrees of elevation due to the range multiplied by the permanent angle of drift in degrees.

Muzzle or Breech-Loading.—Whether a gun is loaded at the breech or muzzle, the accuracy of the shooting depends (supposing the rifling and length of bore to be the same) on the absence of windage, on the projectile being of the same weight and properly centred, the uniformity of the powder, and on the space occupied by it being the same for each round.

The large charges of powder required for modern guns in order to attain a high velocity, have rendered longer guns and larger powder chambers necessary.

It is very generally admitted that it is easier to carry these conditions out with B.L. than with M.L. guns. Further, the loading Nos. with B.L. guns are generally less exposed. The bore can be more easily examined. The gun can be of any length. The difficulties of chambering are reduced.

Third Lecture.—Forces Acting on a Projectile.

1. *In the Bore.*

a. The Force of Projection of the Powder-Gas.—The forward velocity attained by a projectile at the muzzle of a gun, is due to the sum of the pressures of the powder-gas during its passage through the bore. The more gradually this velocity is imparted to the projectile the less will be the strain upon it and the gun. The object sought is to distribute, as far as possible, the pressure over the whole length of the bore and to obtain the maximum work from a given charge of powder without undue strain on either gun or projectile. Theoretically the last atom of powder should be converted into gas as the projectile leaves the muzzle.

b. The Forces imparting Rotation to the Projectile, viz., the reaction of the Grooves on the projectile.—See first lecture.

2. *During Flight.*

a. The force of gravity.—The projectile leaves the muzzle of the gun with a certain velocity and rotation, due to the force of projection of the powder gas and the rifling in the bore of the gun, and if a projectile were acted on by the force of projection alone, it would proceed in a straight line, and pass over equal spaces in equal times. The force of gravity, however, causes the projectile to fall with a constantly accelerating velocity, so that it describes a curve instead of a straight line.

The force of gravity is the natural attraction which causes every unsupported body to fall towards the centre of the earth; it is an accelerating force, *i.e.*, it draws a body down quicker and quicker in proportion to the time that the body is exposed to its influence; thus a body falls from a height, about :—

16 feet in the 1st second of time.
48 „ „ 2nd „ „
80 „ „ 3rd „ „

that is, a total of 144 feet in the first 3 seconds; and hence this force, acting upon the shell immediately it leaves the muzzle, draws it down from the line in prolongation of the axis, faster and faster the longer it flies.

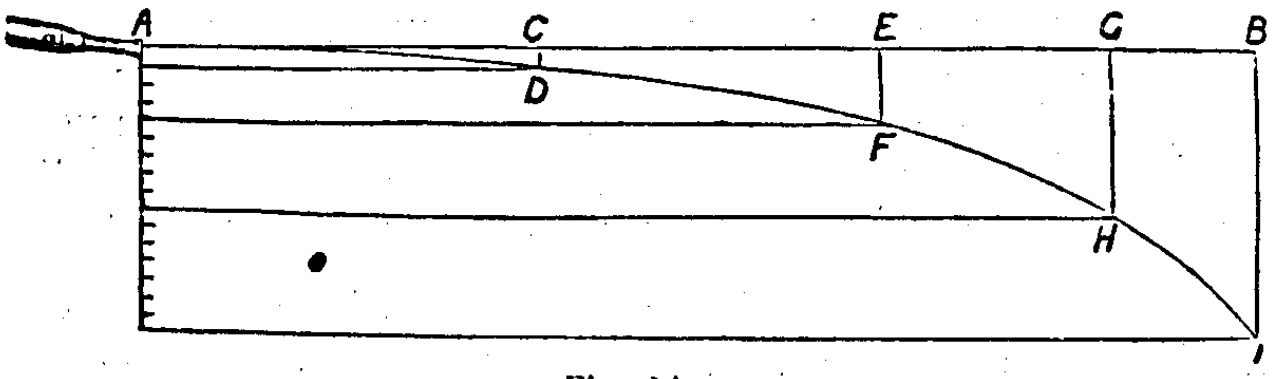


Fig. 14.

Hence in fig. 14, if AB is the direction in which the shell started, supposing in the first second it might have gone as

far as C, it would, owing to gravity, have dropped to D. At the end of the next second if it had travelled as far to the front as E, it would have dropped 4 times as far, viz., to F; in the 3rd second, 9 times as far, and so on. In a vacuum the fall is equal to $\frac{1}{2}gt^2$, where $g = 32{\cdot}19$ feet and t = the time of flight in seconds.

With a heavy body like a bullet or shell, the distances fallen are but slightly lessened by the air, which acts as a cushion and tends to support the projectile. For example, a 10″ R.M.L. shell will drop below the prolongation of the axis of the bore (AB in fig. 14), in :—

1 second	15·3 ft.	CD.
2 seconds	60·5 „	EF.
3 „	137·3 „	GH.

but by the above formula, that is without the support of the air, the shell would fall in :—

1 second	16·1 ft.
2 seconds	64·4 „
3 „	144·9 „

b. The resistance of the air.—The air which surrounds the earth consists of innumerable small particles, pressing against each other and everything touching them ; the shell, though started with a very high velocity, meets and has to thrust aside those particles which happen to be in its way, and thus rapidly loses its velocity : for instance, the velocity of a shell from the 6″ B.L. gun, which at the muzzle is about 1920 feet per second, is at 1000 yards about 1650 feet per second, at 2000 yards about 1410 feet per second, and at 4000 yards about 1060 feet per second.

The retardation due to the resistance of the air varies as the square of the diameter, and inversely as the weight, therefore it is evident that if two projectiles are of equal diameter and start with the same muzzle velocity, the heavier will lose its velocity more slowly and range the further ; or, if the two pro-

jectiles are of the same weight but of different diameters, the one with the smaller diameter will have the advantage.

This is well shown in the following table, which gives a comparison between the shooting of a 12-pr. S.B. and a 12-pr. B.L. gun, their respective calibre being $4\frac{2}{5}$ and 3 inches.

Gun.	Diameter. inches.	Muzzle Velocity.	Range and Elevation.		
			1°	3°	5°
12-pr. S.B.	4·4	1769	700	1200	1600 yards.
12-pr. B.L.	3·	1700	1200	2140	3050 ,,

The remaining velocity of the two projectiles at 2000 yards would be—

12-pr. S.B. .... 506 f.s.
12-pr. B.L. .... 993 f.s.

The velocity of the elongated projectile is thus nearly double that of the spherical one at 2000 yards, though it started at a slightly lower velocity.

The retardation due to the resistance of the air is also affected by the shape of the head of the projectile.

The weight of a projectile can be increased—

By increasing its length.
By increasing its density.

The power of a projectile to maintain its velocity varies directly as its weight, and inversely as the square of its diameter, but with similarly shaped elongated projectiles the weight varies nearly as the square of the diameter multiplied by the length, hence it may be said that the power of a projectile varies as its length.

Thus the longer the projectile (other things being equal), the harder will it hit at any given range, and the greater will be its absolute range for any given muzzle velocity; but other con-

siderations limit its length, such as the strength of its walls, for the pressure of the powder-gas being directed on the base of the shell, if the pressure is high and the shell long, there will be a tendency in the walls to set up, and prematures may occur; or again, if too long it is liable to turn over in flight.

Fourth Lecture.—Trajectory.

Trajectory.—The result of the three forces acting upon the shell, (viz., the force of the explosion tending to drive it forward in a straight line in prolongation of the axis, the force of gravity drawing it down more and more below that line, and the resistance of the air tending to stop its progress more and more in each successive instant of time,) is, that it describes in its flight a curved line called the trajectory, ADFHI in fig. 14.

The instructor should now explain why a low velocity gun requires more elevation to attain the same range than is required by a gun with a high velocity.

Taking as an example two similar shells, one with a muzzle velocity of 1300 f.s., and the other with 1900 f.s. fired with the same elevation. The low velocity shell will have travelled only about two-thirds as far as the other in one second of time, but both will have been acted on by gravity during the same time, and will have dropped the same height, and consequently, the low velocity shell will reach the ground much before the other.

It is evident from this, that in order to obtain the same range, a gun with a low velocity requires a higher trajectory, that is, greater elevation than a gun with a high velocity, and conversely.

The instructor should give instances of when a high trajectory is required, such as to hit the decks of ships, and on land fronts to search out cover and breach hidden walls; and the advantages of a flat trajectory with the necessary high velocity, such as giving a larger dangerous space, also greater accuracy, &c.

Fifth Lecture.—How the Axis of the Piece must be Directed in Order to Give the Gun Elevation.

Referring to fig. 15, the instructor will show that if the "axis" be pointed at a mark, say at S, the shell will not hit that mark, but owing to the force of gravity will fall below it, say to D; and therefore, to allow for the fall, it is necessary at all distances to point the "axis" so that the line in prolongation of it will pass as much above the object to be hit as the shell would have fallen below that object if the "axis" had been pointed straight at it. This act of tilting the gun so as to allow for the curve of the trajectory, thus giving the shell time to range before it is drawn down to the ground, is what is meant by the expression "giving elevation."

The instructor will illustrate the theory of giving elevation at all distances by referring to the flight of the shell for the first 100 yards; explaining that a shell fired from the 64-pr. gun with the service charge, would fall, were there no jump, about 11 inches below the line of the axis of the gun produced in passing over the first 100 yards of its flight; and assuming that S (fig. 15) is 100 yards from the muzzle, and that SD represents 11 inches, he will show that in order to hit the mark at S, the "axis" must be elevated so that it would, when produced, pass 11 inches above S, viz., through F (fig. 16).

Here elevate the axis, draw the new line MF and the new trajectory from M to S; and rub out the old line MS and the old trajectory.

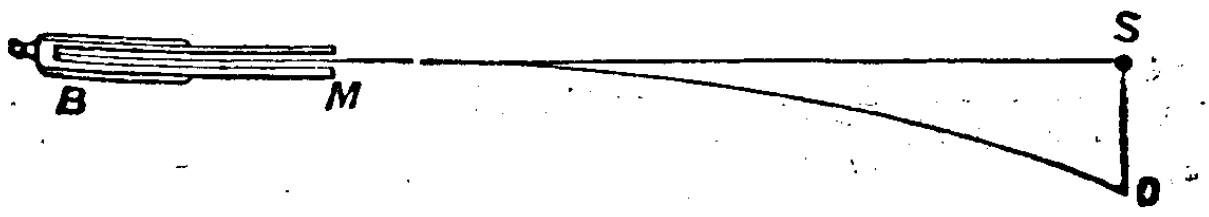


Fig. 15.

Fig. 16.

How elevation is given by means of the tangent sight.—The instructor will explain that if there were no sights upon the gun, the layer would have to look along it, and take aim, as near as he could judge, the necessary height above the object to be hit, but that if he were to try to do this he would lose sight of the object, and be uncertain of the true elevation and direction. Further, that it is very important to keep the object in view, and that for this purpose the gun has been furnished with two sights, which are placed either vertically over, or parallel to, the axis, the one near the muzzle or on the trunnions, called the muzzle or trunnion, sight, and the other one near the breech called the tangent sight, upon the latter of which the elevations are marked, and by means of which the layer, if he knows the distance, is enabled to give the gun the necessary elevation and at the same time lay on the object.

Here draw the line of sight LOS (fig. 17) through the sights to the object.

The instructor should now cause the men to observe the relative positions of the three lines in fig 17, viz., the line MF, the trajectory MS, and the line of sight LOS; and explain that

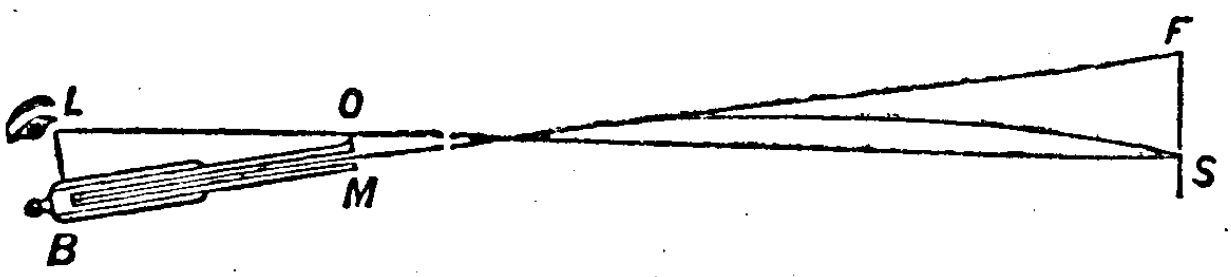


Fig. 17.

he diagram shows at a glance the principle of getting elevation t all distances by means of the tangent sight; he should also oint out how the spaces between the lines on the yard scale of he tangent sight become greater and greater, thus enabling the ecessary allowance to be made for the increased curve of the ajectory as the range becomes greater.

The use of the tangent sight shown by means of a carbine barrel moved from the stock.—The principle of the tangent sight can e further shown by placing a carbine barrel* on a tripod at a ew yards from the blackboard, and causing the recruit to aim a spot, with the leaf of the back-sight perfectly upright, and djusted (say) to 1000 yards; then without moving the barrel t the recruit look through the bore, and observe that the ne of fire, or the axis of the gun produced, meets the black-oard considerably above the spot aimed at.

While the barrel is upon the tripod, the structor will show the importance, with a gun, keeping the axis of the trunnions (*i.e.*, the ucks or wheels) level, and will explain that if is is not done, the shell instead of hitting the ark, will strike low and on that side to which e tangent sight is inclined; and that the eater the inclination and elevation of the sight, e greater will be the error on this account.

To make this clear, draw a vertical line, AB, g. 18), on the black-board, with A as a spot to n at. Cause the men to aim at this spot with e 1000 yards sight, which must be perfectly right, and afterwards to look through the car-ne barrel, directing attention to the fact that e "axis of the piece" cuts the vertical line at C

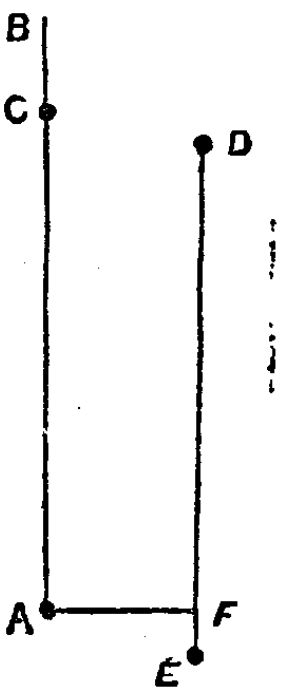


Fig. 18.

* A B.L. gun may be used for the illustration if convenient.

above the spot aimed at. Then cause them to aim at th same spot with the same sight, *but inclined to one side*, and t look through the barrel again, when they will see that th "axis of the piece," instead of being directed upon C as befor is now directed low, and to that side to which the sight i inclined, as at D; consequently, as the "trajectory" always co forms to the movement of the "axis of the piece," the bulle instead of hitting the mark, would strike as much below D as A below C. Draw a new vertical line through D and measure off o it a distance equal to CA; this will give the spot E, which th bullet would hit. From A draw a horizontal line AF to the ne vertical line DE, then AF will show the error of direction, an FE the loss of elevation due to the degree of inclination to th right given to the back-sight. Supposing the barrel to be t yards from the board, then the distance for which the sight adjusted is 100 times as great, and consequently, the bullet w strike 100 times AF to the right, and 100 times FE too low.

The instructor will next explain how the angle of elevatio that is the necessary amount of tilting up of the gun requir for a certain range, can be given by means other than the ta gent scale.

~ This will be best demonstrated practically with a gun follows:—Mark out a vertical line A D on any board plac some little distance in front of the gun, a divide it in 3 or 4 places (fig. 19) A, B, C, D.

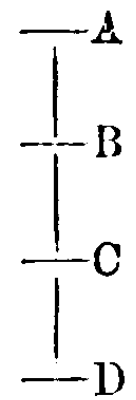


Fig. 19.

Lay the gun by the sights on A, the tange scale being raised to a certain height, s 2000 yards; note this height, and mark w chalk or a pencil any portions of the gun a carriage, so that the gun can be brought i the same position by making these marks co cide; now lower the tangent scale by 200 300 yards, and lay on B, again note the heig of the tangent scale and make marks as before; again lo

ıe tangent scale by 200 or 300 yards and lay on C, repeating ıe operations as above, and so on with D.

It will then be shown how, by making the chalk or pencil ıarks coincide, the gun can be given the elevation necessary) lay on A, B, C, or D without looking over the sights.

For example, suppose the marks that were put on when the ın was laid on A are made to coincide, if the tangent scale is ised to the height it was at when the sights were aligned on A, will be found that the sights are again laid on A, and this ay be similarly demonstrated with B, C, and D.

Sixth Lecture.—Causes Affecting the Accuracy of Shooting.

The forces and causes of deviation already mentioned will ıve been ascertained and their effects considered before a gun issued for service: they will not therefore come under the gnisance of the practical gunner. There are, however, other uses of deviation which must be observed and corrected to sure accurate shooting. These are—

a. Varying effect of the charge due to:—
- Incorrect weighing.
- Variation in the strength of the powder.
- State of the atmosphere, especially as regards moisture.
- Difference of space occupied by the cartridge in the bore.

b. Difference of level of trunnions.

c. Force and direction of wind.

d. Trail not being well supported.

a. The only way to correct variations in the strength of wder, which are sometimes very great, is carefully to mix the wder before the cartridges are made up. This is not a very ficult matter with small charges and the better practice that ll be obtained amply compensates for the time and trouble volved in the operation. With large charges it would not

be practicable to mix the powder, but care can be taken that a the powder belongs to the same lot and that the various barrel have had the same treatment as to storage. Extreme care i weighing out the charges cannot be too strictly enforced.

A long continuance of damp weather will cause the cartridge to absorb moisture, which will entail a reduction in muzz velocity and consequently in range. The contrary effect will tak place in dry weather, especially in hot climates.

If the shell is not rammed home exactly to the same sp each round, the shooting will be irregular. The greater the spac occupied by the cartridge the less will be the range. Ramm staves with M.L. guns are marked to show when the charge properly home with common shell.

b. For difference of level of trunnions or wheels, see page 5

c. Wind has considerable effect on the range and direction the projectile. According to its direction it may increase reduce the range, or drive the projectiles to right or left. gusty, and of great force, the shooting will be irregular, especial at long ranges or with low charges. If, however, the wind fairly constant in direction and force the necessary correctio can be made on the tangent or deflection scale. A little practi should enable an officer to obtain a very close approximation the proper correction.

d. Unless the trail rests on firm level ground, and is simila supported during successive rounds, the shooting will be ir gular.

Seventh Lecture.—Causes Affecting Velocity an Pressure.

For a given calibre and weight of projectile there are, sp ing generally, four ways in which the velocity and pressure be varied. These are :—

1. By varying the nature of the powder.
2. By modifying the gun.
3. By altering the weight of the charge.
4. By altering its gravimetric density.

1. *Effect of Varying the nature of the Powder.*

The nature of the powder exercises great influence on the muzzle velocity and pressure in the bore realised per pound of powder.

To obtain a high muzzle velocity a large charge is necessary, but to avoid unduly straining the gun a powder which burns slowly must be selected. As an instance of the behaviour of different powders, take the following results from the mean of several rounds from the 80-pr. R.M.L.

Charge.	Muzzle Velocity.	Maximum Pressure in tons per square inch.
10 lbs. R.L.G.^{2} ...	1300 f.s.	28
20 lbs. P.	1550 ,,	13·5

Here 10 lbs. R.L.G.^{2} gave 250 f.s. less velocity with over double the strain on the gun than that obtained by using 20 lbs. of P. In the first case the shell received a violent blow straining both and the gun very severely, in the latter it received a long slow push kept up well down the bore.

The important points are the maximum pressure and the rate at which the pressure changes, which again depend upon the point of ignition* and rate of combustion of the powder.

With the same gravimetric density these vary with :—

* This applies chiefly to small grain powders, such as R.L.G. powder. See Treatise on Ammunition, 1897, page 38.

1. The density and hardness of the powder.
2. The size and shape of the grain.
3. The amount of glazing.
4. The quantity of moisture.

1. The denser the powder the slower will it burn, the hard the powder is the slower will it ignite, thus retarding t ignition of the whole charge.

2. Generally speaking a charge composed of large grains w burn more slowly, and exert a lesser strain upon the gun th one composed of small grains; on the other hand the larg grains afford larger insterstices between them for the flam thereby facilitating the ignition of the charge. Thus a char may have a slow rate of "combustion," and yet a high rate ignition.

The shape of the Prism Powder with the hole in its centre adopted with the view of obtaining a uniform development gas which ensures uniform pressure; the prism burns both fr the outside and inside, the one surface getting smaller as t other gets larger, thus developing gas at a uniform rate and keeping up a sustained pressure down the whole length of t bore.

Cordite is made in strands which insures a large igniti surface.

3. The glazing of gunpowder has the effect of smoothing a hardening the surface of the grains, which tends to retard ignition of the powder, and thus make it slower in its action

4. The effect of moisture in powder reduces both the press and the velocity.

In an 8-inch R.M.L. gun firing a shot of 180 lbs. with a cha of 35 lbs., a powder with 0·7 per cent. of moisture gav muzzle velocity of 1545 f.s., and a maximum pressure of 2 tons, the same powder with 1·55 per cent. of moisture ga muzzle velocity of 1495 f.s., and a maximum pressure of 1 tons.

An increase of less than 1 per cent. of moisture thus decreased the muzzle velocity by 50 feet, and the pressure about 20 per cent.

The general effect of the increase of density, hardness, size of grain, glazing, and quantity of moisture in the manufacture of gunpowder, has been to produce slow burning powders, which, although with equal charges, give a less muzzle velocity than the quick-burning powders, have so lessened the pressure produced in the bore of guns, that larger charges, giving a greater muzzle velocity, can be used.

2. *Effect of Modifying the Gun.*

As regards the gun, the points which affect the muzzle velocity and pressure realised are :—

Length of bore.
Windage.
Rifling.
Position of vent.
Chamber.

Length of Bore.—The work done depends, in a measure, upon the length of the bore, but after a certain point is reached, the work done corresponding to each additional space passed over becomes less and less, and as the length of the bore increases, the energy absorbed in friction, &c., continually gets larger.

Hence lengthening the bore up to a certain point is advantageous, but there is in each particular case a limit of length which cannot profitably be exceeded.

By the introduction of slow burning powder, which gives less pressure in the bore, a long bore has become necessary, in order to obtain a high muzzle velocity, otherwise part of the charge would be wasted.

Windage.—Windage causes loss of pressure and a consequent loss of velocity.

Rifling.—The effect of rifling is generally to reduce the muzz velocity, a small proportion of the total work being absorbed giving rotation to the projectile, and to increase the pressure.

Position of Vent.—The uniform ignition of the charge depen in a measure on the position of the vent.

Chambering.—All the newer guns have the place where t cartridge rests of larger diameter than the bore. This is call chambering, and can be more easily developed in B.L. guns—gu designed for cordite are not chambered.

It enables the charge to be made up into a fairly compa form, and reduces the disadvantages of very long cartridges.

It is true that the increased diameter of the chamber is source of weakness, but this is of less consequence, as t maximum pressures may be kept tolerably low by using a slow burning powder.

3. *Effect of Altering the Weight of the Charge.*

An increase or decrease of the weight of the charge, t chamber or the space behind the projectile remaining the sam will raise or lower the muzzle velocity and the pressure in t bore.

4. *Effect of Altering the Air Spacing of the Charge of Powder.*

When the space per lb. of powder behind the projectile in loaded gun is increased the pressure and velocity of the pr jectile both fall off.

Eighth Lecture.—Methods of Checking Recoil.

The instructor will explain that a gun when fired will alwa recoil more or less (provided no means are adopted for checki the recoil), the amount of recoil depending chiefly on the weig of the gun and carriage, charge of powder, weight and resis ance to motion of the projectile, and that comparatively litt

r no recoil takes place when firing blank charges, owing to here being no such resistance to the escape of the powder gas s there is when the gun is loaded with a projectile.

Having pointed out the necessity for checking recoil, the structor will proceed to point out the various mechanical eans that have been adopted in the service to control it, ving examples of each method, or combination of methods. he various means may be divided into four heads :—

1. Raising a weight.
2. The friction of solids.
3. The resistance of liquids.
4. The resistance of air.

1. Most garrison and siege carriages recoil up platforms or ides sloping upwards to the rear, this materially assists to eck recoil. Again in Moncrieff (fig. 20) garrison carriages a unterweight is raised. Both these plans facilitate the running o of the gun after firing.

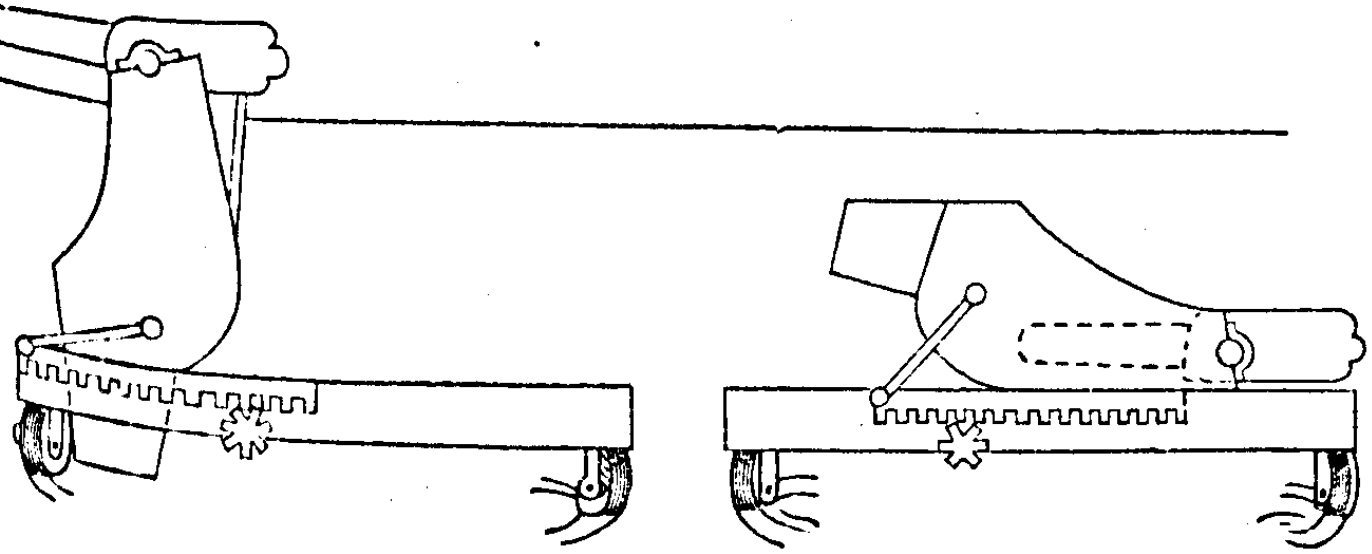


Fig. 20.

2. The friction of solids can be illustrated by friction between rriage and slide ; by use of check ropes with mountain guns

(fig. 21), which increases the friction between the ground
wheels by preventing the latter revolving; and also by Elsw

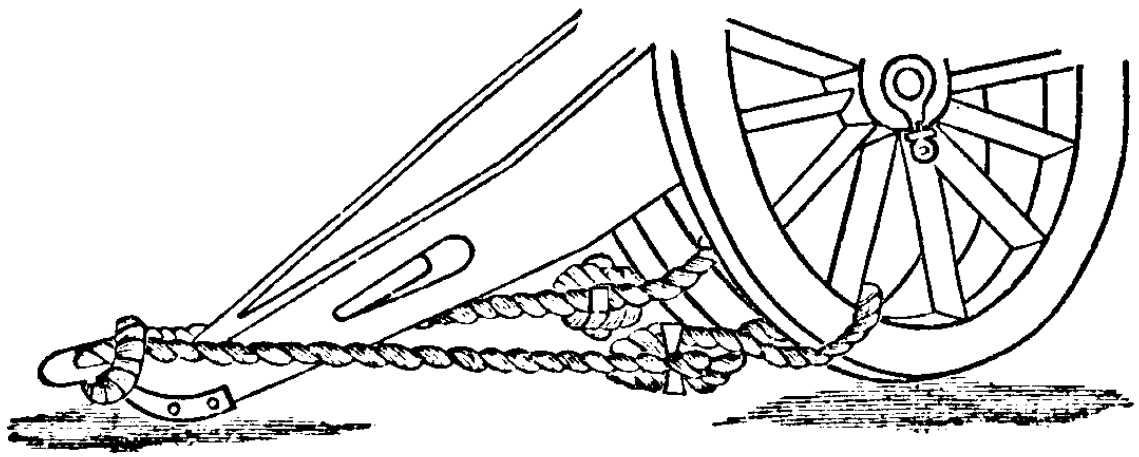


Fig. 21.

and other compressors, which consist of iron or steel plates
the carriage pressing against and between iron bars on
slide (fig. 22).

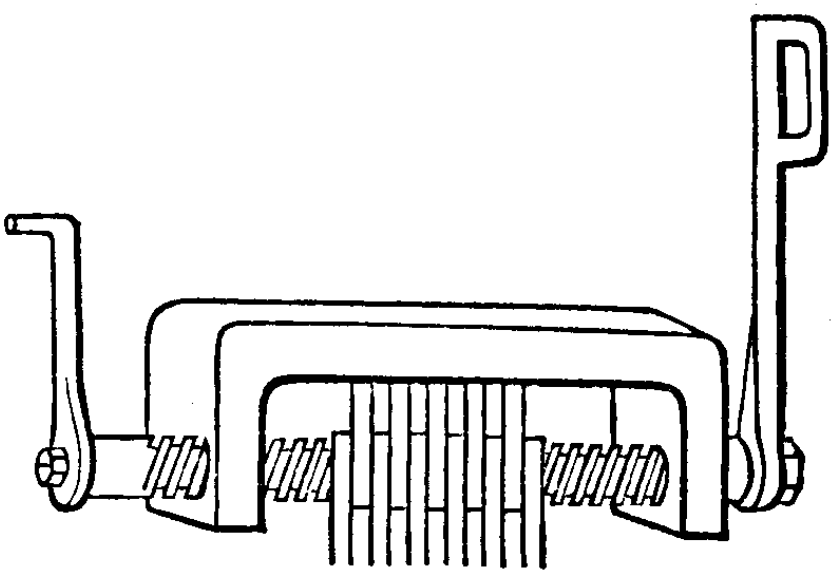


Fig. 22.

This latter plan possesses the serious disadvantage of being ncertain in its action; after long disuse the plates may become usty, and although for the first round the compressor may have hecked the recoil within its proper limits, owing to the rust eing rubbed off, the subsequent rounds may be too violent, and hus accidents occur, unless the compressor is readjusted after ach round for the first three or four rounds.

3. The hydraulic buffer is an example of the resistance of quids, in which the motion of the piston is resisted by liquid, hich can only escape to the other side of the head of the piston hrough small apertures, and the quicker the piston is moved he more resistance is offered by the liquid.

This plan is a decided improvement to the compressor, as the djustment is so simple, viz., to have the proper amount of oil n it.

4. This method is used in disappearing carriages, in which air is ompressed by the action of the gun in recoil, the resistance the ir offers to compression being the means of controlling the mount of recoil. This system has the same advantage as the Moncrieff counterweight, that of storing up the energy of recoil, hich is made use of for running the gun up into the firing osition.

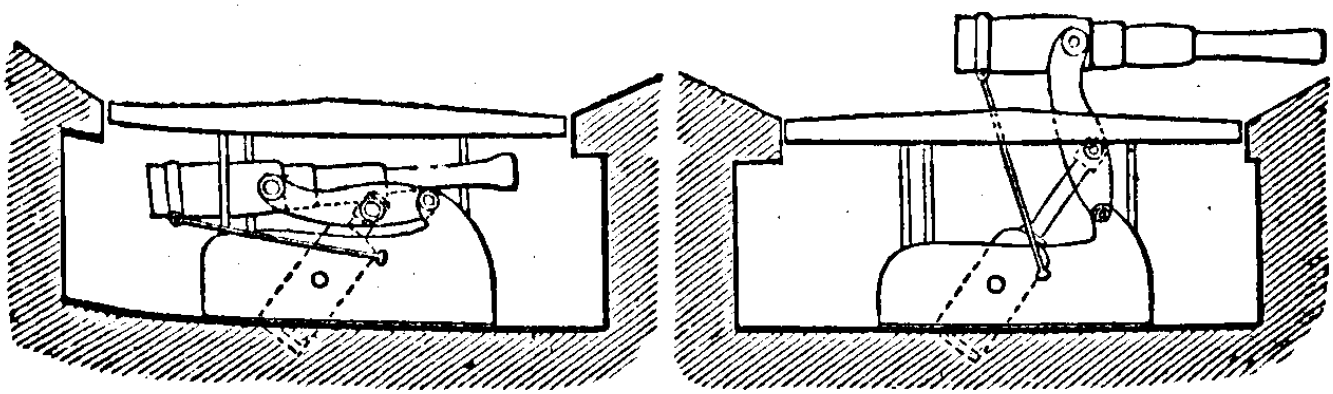


Fig. 23.

Ninth Lecture.—Quick Firing Guns.

Quick firing guns are so called on account of the facil allowed by their sighting, breech mechanisms and mounti for rapid and continuous fire. The distinction between t and other guns, which was at first very marked, is tending gradually disappear, as facilities for rapid fire with the la are improved in later manufacture.

The Q.F. guns in the service are the 3-pr., 6-pr., 12- 4·7-inch and 6-inch.

The essential point of difference at present between Q.F. all other guns in the land service is the metal cartridge c which is used with all of them; but this has been dispen with in the latest type of 6-inch Q.F. for the Navy, and retention for other natures will be considered in future ma facture.

The main points which conduce to rapid service of the are :—

1. Absence of necessity for sponging or scraping With powder charges this is provided for by the m cartridge case. With cordite charges sponging scraping out is not required.
2. Quick opening and closing of the breech. In the la patterns this is effected by one motion of a lever.
3. The power of the layer to keep his eye always to sight. This is allowed for by fixing the sights t cradle, which does not recoil with the gun.
4. Quick traversing and elevating. This is done placing the movement of the gun entirely under control of the layer, who directs it by the shoul piece, or by suitable elevating and traversing gear.
5. Absence of necessity for running up, the moun being constructed to return the gun automatical the firing position after discharge.

6. Simple firing arrangements. The action of loading also makes ready for firing, and the firing is performed by pulling a trigger.
7. Absence of necessity for setting the sights or estimating the range; automatic sights provide for this.

All these advantages are not invariably present with every pe of gun and mounting now in use.

For instance, with reference to—

2. Many 4·7-inch guns are without single motion breech mechanism.
3. The 3-pr. on travelling carriage, which is styled a Q.F. gun, has sights which recoil with the gun.
4. The 3-pr. on travelling carriage only allows the layer a very small arc of traverse, and requires a number at the handspike to assist him.
5. With the 3-pr. on travelling carriage the mounting does not remain always in the same position after firing, and consequently the gun is not returned to precisely the same position.
6. This is not the case at percussion firing with the 12-pr., 4·7-inch and 6-inch, but percussion firing is only used if electrical arrangements fail, which should not be allowed to occur.
7. Automatic sights are not generally provided at present, but supply will be made as opportunity occurs.

The 3-*pr. and* 6-*pr.* use what is called "fixed" ammunition, ., the cartridge case and projectile are permanently fixed gether and loaded simultaneously. Percussion firing only is nployed with these guns; the cartridge case has a cap containg detonating composition fixed in its base, which is exploded the blow of the firing pin on pulling the trigger.

The 12-*pr.*, 4·7-*inch and* 6-*inch* use "separate" ammunition, ., the cartridge case and projectile are not fixed together. hey are adapted for electric or percus ion firing.

At electric firing a primer screwed into the base of t cartridge, case is used, containing mealed powder which ignited by the electric current. This is effected by pulling trigger.

For percussion firing the primer has to be removed, and "adapter" substituted, into which, *after loading*, a vent seali tube is carefully placed; this is fired by pulling a lanyar which allows the striker to fall on the head of it.

Percussion firing is necessarily very much slower th electric, so that it is most important that the electric firi arrangements should be well attended to, and kept in go order.

The 6-inch Q.F. fires common shell, and a small proporti of amour-piercing shot. The remaining natures fire on common shell, which may be ordinary common or (except wi the 3-pr. and 6-pr.) armour-piercing common. The latter is stronger shell, but carries a smaller bursting charge.

Quick firing guns of the lighter natures (3, 6, and 12-pr.) a chiefly intended for the defence of harbours against raidi attacks by torpedo boats, &c., and may also be mounted for t defence of mine-fields.

The 4·7-inch and 6-inch are chiefly intended for attacking t unarmoured or lightly armoured parts of larger vessels in co junction with the other guns of the fixed armament, but th 4·7-inch is occasionally mounted for defence against raidi attacks.

Quick firing guns are divided into groups under Gun Gro Commanders. This officer (except in the case of guns mount for defence against raiding attack) is subject to the orders the Battery Commander as with other guns. With gu mounted for defence against raid he has independent comman

In either case automatic sights, if provided, would, for the sa of rapidity of fire, be used for ranges within their limits accuracy. Where automatic sights are not provided, or wh

range is too long for their use, range finders or position lers must be employed, except for those guns mounted for fence against raid, with which guns the range must be esti- ted by the Gun Group Commander, and corrections made om observations of fire.

(NOTE.—*The Instructor will also explain generally the provisions Part II, Sec. IX.—Manning and fighting Q.F. and machine ns for defence against raid—unless it is intended to do so in the th lecture.*)

TENTH LECTURE.—COAST DEFENCE.

NOTE.—*The following is intended as a syllabus of a lecture or tures on Coast Defence. In order to instruct efficiently, the turer must be well acquainted with the contents of Part II this volume. In instructing recruits or young soldiers, the bject should be very briefly and simply treated, and illustrated frequent reference to defences with which they are acquainted. more advanced instruction is required, the subject may be more lly treated, and divided into several lectures, following approxi- ately the arrangement of Part II.*

Define Coast Defences (Section I).

Define and explain the different subdivisions of the artillery mament (Section I).

Define Fire Control and Fire Direction (Section I).

Point out that Fire Control includes Organisation, *i.e.*, pre- minary arrangements as regards men and material in order to sure effective fire being brought to bear when and where quired. That efficient control and direction of fire are pendent on perfect fire discipline, which is ensured by each dividual man learning exactly what he has to do under all rcumstances, and doing it to the best of his ability, as well as efficient preliminary arrangements and training. Impress the squad that no duty, however unimportant it may seem, n be negligently performed without diminishing the fighting

power of the whole unit. Every officer and man, from the I downwards, has his own share in the work, and therefore s responsibility, greater or less according to his rank, in maintenance of fire discipline, without which no scheme defence, however carefully prepared and arranged for, can e be successful.

The chief points to be noted with regard to fire discipline are correct loading with the projectiles ordered, correct laying at proper objective, correct application of all corrections made the group, and the firing of the guns neither too soon or too la

Rapidity of loading and laying is essential; each officer a man must therefore know his duties thoroughly, and perfo them and them only. When using the D.R.F. the time of firi *i.e.*, the time from the moment when the range is passed fr the instrument to the moment when the gun is fired, must be nearly as possible constant for each round to obtain good effect. The B.C. must be able to rely implicitly on those un him to carry out his orders to the letter, and good fire discipl can alone ensure that such is the case.

Explain the three classes into which guns may be divi for tactical purposes, and the special application of e (Section II, ii).

Explain the Chain of Command from Fortress Commander Gun Captains in the case of each of the above three classes, a point out exceptions to the ordinary sequence which may oc locally (Section III, i).

Trace the System of Communications (Section III iii).

Explain that the duties included under the headings F Control and Fire Direction vary with the three classes of gu and describe the arrangements in each case. (Section III ii).

Explain generally the system of storage and supply ammunition (Section III vi).

Describe the uses and general disposition of electric lights obstructions. (Section III vii).

Explain briefly and generally the arrangements for the gulation of traffic in defended ports in war (Section III ix).

Describe briefly the methods adopted for identification of stile ships, and the objects of doing so. Explain the general les for the choice of projectiles and point of attack on ships, ving reasons for them (Section VII).

Explain the general rules given (i) for manning, (ii) for fighting Battery Command, distinguishing clearly between the instruc- nal method of manning (A) and the service method (B). ustrate by reference to defences with which the squad is quainted (Section VIII i and ii).

Explain the provisions with regard to the manning and hting of Q.F. guns for defence against raid. Give illustra- ns if possible (Section IX).

SECTION III.—LAYING ORDNANCE.

Explanation of Terms.

Before proceeding to instruct in laying, it will be necessa explain everything connected with the sights, the mann which they are fitted to the gun, and the reading of the scal elevation and deflection. The use of index plates and re range scales, traversing arc, clinometers, &c., and the meanin use of the most necessary parts of the range table shou clearly explained as the instruction proceeds.

The Tangent Sight.

The meaning and use of the different scales on each face tangent scale must be carefully explained to the gunner.

To adjust the Sight for Elevation and Deflection.

The hind sight is raised until the mark on it for the req number of yards or degrees is in line with the top of the s in which it slides, and then clamped.

For deflection the sliding leaf is moved to the right o until the arrow points to the required number of mi The deflection being given on that side to which the shot be thrown.

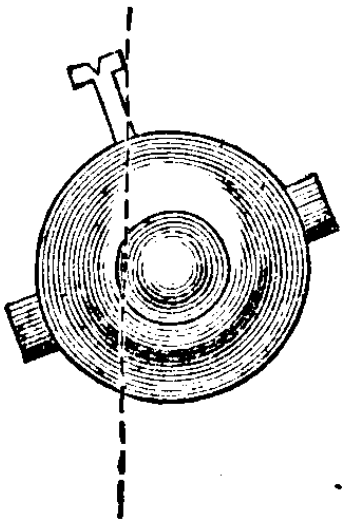
As a practical rule, each minute of deflection on the gives a difference of one inch in every hundred yards of r Thus, supposing at a range of 2400 yards a projectile has s 12 feet to the right, it will be necessary to move the defle leaf 6 minutes to the left, or give "6 minutes left deflectio correct the error, because 12 feet or 144 inches divided b (the number of hundreds of yards in the range) gives 6.

The above practical rule for deflection holds equally goo

ctions in elevation to raise or lower the point of impact on ical target. Thus if at a range of 1200 yards the point of ct is 6 feet too high, the necessary correction would be inutes less elevation," because 6 feet or 72 inches divided gives 6.

the trunnions of a gun are not level the projectile will t towards the side of the lowest trunnion; in reality, the f sight (apart from drift) will not be parallel to the axis of un, except when the tangent scale is at zero; for example, the right trunnion is the higher, the axis of the gun will rected to the left of the target on which the sights are ed, and vice versâ if the left trunnion is the higher.

e following figure illustrates the above.



Looking from breech.

e dotted line is a vertical through the fore-sight. When runnions are level a vertical line will cover both sights, or leviation of the tangent scale from it will only be due to permanent angle of drift. It will be also seen that a vertical will cover both sights when the tangent scale is at zero, ever may be the inclination of the trunnions.

e practical rule for correcting this error is as follows:—

No. of minutes difference of level × No. of Degrees of elevat

60

Minutes of Deflection to be given on the side of the h trunnion.

With gun carriages having a wheel track of 60 inch thereabouts, this rule may be thus stated: number of difference in level of wheels × number of degrees of elevat tangent scale = number of minutes deflection to be given side of highest wheel.

Various Methods of Laying.

Guns are laid by the following means:—

(*a.*) When the sights are aligned both for elevation and tion on the object. Case I.

(*b.*) When the sights are aligned for direction only o object, elevation being given by means of clinometer or plate, &c., &c. Case II.

(*c.*) When direction is given by the traversing arc on th floor, and elevation as in *b*. Case III.

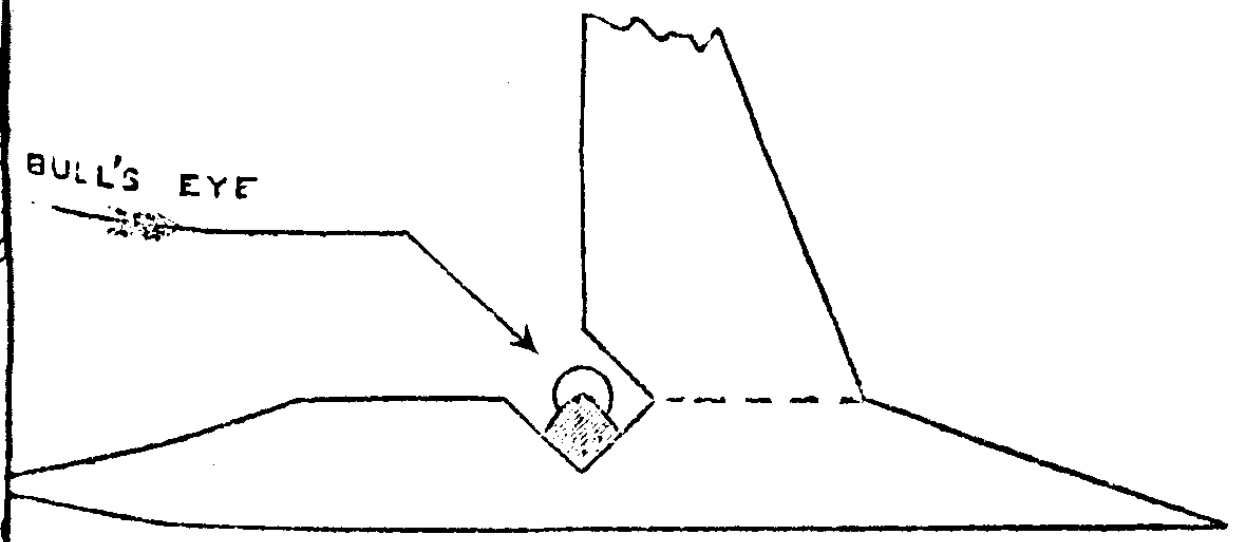
(*a.*) *When the gun is laid both for elevation and directi the sights.*

Laying by tangent scale.—To obtain uniform results in one method should be strictly adhered to. The service m of laying a gun is to direct it so that the centre of the line ing the two highest points of the notch in the hind-sigh apex of the fore-sight and the point aimed at are in line figure.

The scales having been adjusted at the required elevatio deflection, the gun layer proceeds to lay the gun.

* Note.—This means the number of degrees the tangent scale is raise

should put himself in an easy position, his feet being
l so that his body is well balanced, and if possible steady



elf by leaning on the gun with his arm, and bring his eye on a
with the top of the hind sight, and about one foot from it.
eneral rules to be observed.—1. See that the tangent and
ction scales are set and clamped at the elevation and deflec-
ordered, and that the tangent scale does not slip through
socket.

To avoid wearying the eye, get the gun laid approximately
elevation and direction before carefully looking over the
ts, then lay quickly.

Lay over the target and then depress* on to it, thereby
ding error due to the play of the elevating gear.

Choose a clearly defined part of the target to lay on, and
ays lay on the same point from round to round. All
ections and allowances should be made by using tangent or
ection scales and not by laying off the target.

The distance of the eye from the hind-sight should on no

*With disappearing mountings the last motions of the elevating gear should
at for elevation.

account be varied, but be the same from round to round, n than one foot.

During instruction in laying, the targets likely to be me on service should be selected, such as houses, encl batteries, &c., and on sea fronts, ships, boats, &c.

At this stage the Instructional Target should be made u It will be found most valuable in teaching men to lay correctly, as with it personal errors can be shown, bo elevation and direction, and the practical rule for corr errors can be proved.

Laying on natural objects.—After the gunner has atta thorough knowledge of the tangent scale, and can adj quickly to any named elevation and deflection, and ca accurately and rapidly at a target, he should be taught to natural objects, preferring first those objects which are stati and are more or less well defined, at medium ranges, and passing on to small or moving objects at short, medium, o ranges, or ships moving rapidly in all directions.*

To test accuracy at longer ranges, and when laying on stat natural objects, the following method may be used. The inst lays the gun with a certain elevation, and puts the tangent down. Then he directs the gunner to raise the tangent till the gun is correctly laid without altering the ele screw. The difference on the tangent scale will show the a of error.

When laying at moving objects, the instructor should te laying by looking over the other tangent sight.

(*b.*) *When the sights are used for direction only.*

Laying by straight edge sight from sighting step.—I case the tangent scale is raised to a convenient height

* The water line at the stern should be the point of aim with a target fro n the battery at such an angle that the bow water line is not well defined.

t socket, the gun layer stands on the sighting step and aligns edges of the sight blades on the object.

.C. officers and men should be frequently practised at laying h these sights, particular attention being paid to rapidly king up natural objects such as ships and boats, and when ving keeping the sights directed on them. During this prac- the layers can be tested by the instructor looking over the er tangent sight.

levation is given to the gun by index plates and readers, ltipliers, hydro-clinometers and elevation indicators.

(*c.*) *When direction is given by traversing arc.*

n this case the gun is laid by quadrant elevation, and for ection by the traversing arc on the gun floor.

INSTRUCTIONAL TARGET.

he target is made of half-inch deal, and is 4 feet square: it ainted half bright red and half bright green. On the top is d an iron rod, on which runs a ring. A leaden triangle of 6 hes side, painted white, and with a circular hole ·75 inch in meter in the centre, is suspended from the ring.

Instruction in laying for direction only.

tand the target so that the line down the centre is vertical; ect the recruit to lay on that line.

Instruction in laying for elevation only.

tand the target so that the centre line is horizontal; direct recruit to lay so that the point of the trunnion or fore-sight d the two highest points of the V of the tangent scale are on s line.

Instruction in laying for elevation and direction.

llow the triangle to hang in front of the target, and direct recruit to lay on one or other of its angles.

To teach the use of the deflection scale.

Set up the target with the centre line vertical, at a meas distance of 100 yards from the gun; direct the recruit t without deflection on the centre line. This done, let hin with a given number of minutes of deflection at the same p Show him, by letting him look over the sights, with deflection scale again at zero, that he has thus laid the gun same number of inches to the right or left of the centre.

At the distance of 50 yards the number of inches will be half of that of the minutes of deflection, and so on in propor for longer or shorter distances.

Where there is no target, or no room to place it at 100 y off, a target of reduced size can be painted on a wall or dr on a board at a measured distance in front of the gun, and same instruction carried out. For instance, if 20 yards 10 minutes on the deflection or elevation scale would gi inches on the target.

To test individual laying.

1. Lay the gun on one angle of the triangle—mark with c the position of the hole—remove the triangle. Let the re look over the sights, and give directions for the movemen the triangle until the angle on which the gun was previo laid appears to him to be in the line of sight. Mark with c the second position of the hole.

The distance between the two chalk marks will give personal error of the recruit.

2. Lay the gun on one angle of the triangle (or on any s object), with given elevation and deflection. Put down tangent-scale, but do not move the gun.

Let the recruit set the tangent-scale and deflection shifting each until the sights appear to him to be on the obj

The difference between the two readings of elevation and direction will give his personal error.

Laying by Night.

Laying at targets lit up by E.L.—Guns can be laid by night on targets lit up by the electric light, just in the same way as by day. When using the gun sights, whether for elevation and direction or direction only, it is generally necessary to throw the light of a lantern on to one* if not both of the sights (when this is done, chalking the fore-sight will make it stand out clearer when the light is thrown on to it); there is, however, some difficulty in keeping these lanterns alight, the shock of discharge of heavy guns often extinguishes them. Various experiments, both with candle, oil, and electric lamps, have been made, but no particular lamp for this service has yet been introduced into the service. The lamps themselves are, as a rule, held in position by one of the gun detachment.

Night sights of two patterns are provided for 12-pr. Q.F. guns. These are described in § 8754 List of Changes.

Laying on fixed objects.—When laying guns at fixed objects, such as at certain portions of a mine field, which may not be lit up by the electric light, the elevation for the range would be known, and would be given by index plate, clinometer, or hydrostatic inclinometer and the necessary direction being noted and marked on the traversing arc during the day, the gun would be laid for line at night by traversing until the reader came opposite the marked graduation. With guns not provided with such arcs the position of the trucks on the racer or floor of emplacement must be marked (white paint would be best) when the gun is laid in the correct direction by day; or similar arrangements, as described in Siege Artillery Drill, may be made.

* As a rule the fore-sight or the one further from the layer, if only one sight is illuminated.

General Remarks on Laying.

The relative advantages of laying for elevation by—

(1) Tangent scales.
(2) Clinometer.
(3) Hydro-clinometer.
(4) Index and yard scale plates.

are as follows:—

1. The advantage of this method is its simplicity, in tha combines in one operation the direction and the elevation of gun, and enables us to dispense with correction for the height the battery and the state of the tide. On the other hand, it most difficult to teach correctly, brings in personal error of g layer, and is less rapid than a system under which the laying range and the laying for direction are separate duties.

2. This method is not sufficiently quick, except for slow a deliberate fire, and, unless all other means fail, would never used when practising at moving objects. Its comparat accuracy for different elevations depends, to a great extent, the instrument being always placed exactly on the same pl on the breech for every round; any grit, or dirt, gett between the bottom of the clinometer and the plane surface the gun would affect the correctness of the elevation, it therefore, necessary always to make sure that this plane surf is clean. The clinometer has always to be removed bef firing, and lastly, as the graduations on the instrument are degrees, and not in yards, there is the drawback of having convert yards into degrees.

3. The hydro-clinometer has the advantage, as compared w (2), of being graduated in yards, of being permanently attached the gun, and of not needing any adjustment after it has once be set up. Elevation can be given rapidly and very accurately its means, the divisions on the scale for hundreds of yards bei as a rule, larger than on the tangent scale, or yard scale plates

4. Index plates afford perhaps the most rapid means of lay

guns for elevation, being certainly much quicker than (1) or (2), and as quick if not quicker than (3); the divisions on the yard scale plates are rather small (unless the gun is situated in a high site battery, as the higher the gun is above sea level, the larger are the divisions) and difficult to read. They possess the following distinct disadvantage, viz.—if there is any inequality in the level of the racers, they do not give the correct quadrant elevation, but this disadvantage tends to disappear as the height of the gun above sea level is increased.

For example, on a very low site if there is a difference of level in the racers of five minutes between trail extreme right and extreme left, this would mean with a 9 or 10-inch gun a difference of 50 yards at 1500 yards range; under similar conditions at a height of 250 feet above sea level the range would only be altered by 16 yards. In these cases although there would be a difference of five minutes in the elevation when the gun was traversed from extreme right to extreme left, the yard scale of index plate would read exactly the same, *i.e.*, 1500 yards in both positions. This error does not occur when laying for elevation either by tangent scale, clinometers, or hydro-clinometers.

Again, comparing laying by tangent sight with laying either by index plate, clinometer, or hydro-clinometer.

FIG. I.

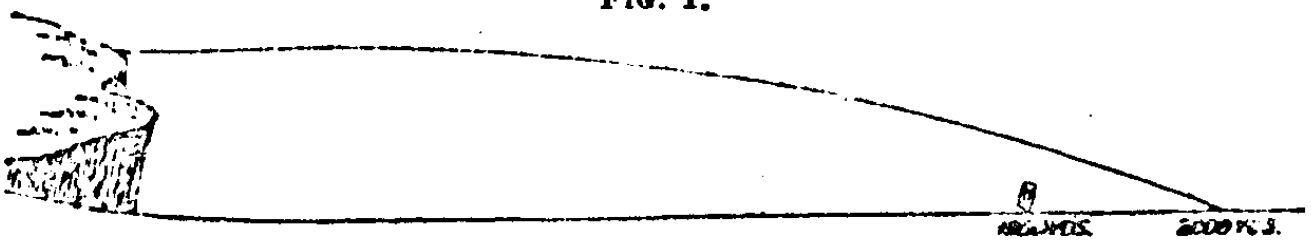
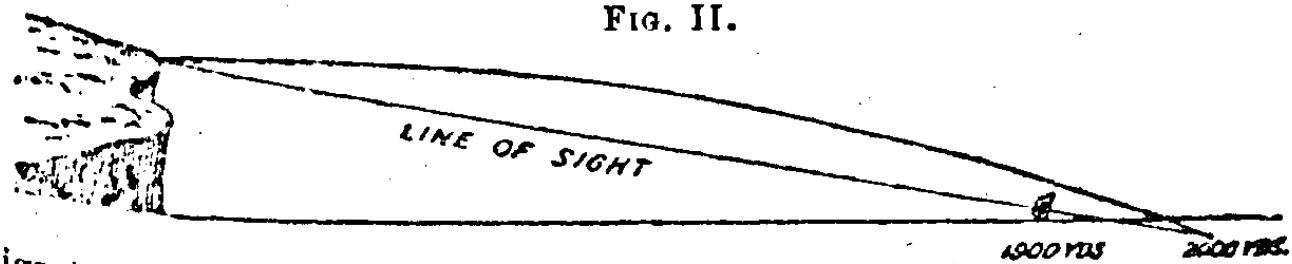


FIG. II.



Figs. to show advantage of laying a gun by tangent scale instead of by Index plate when firing from a height.

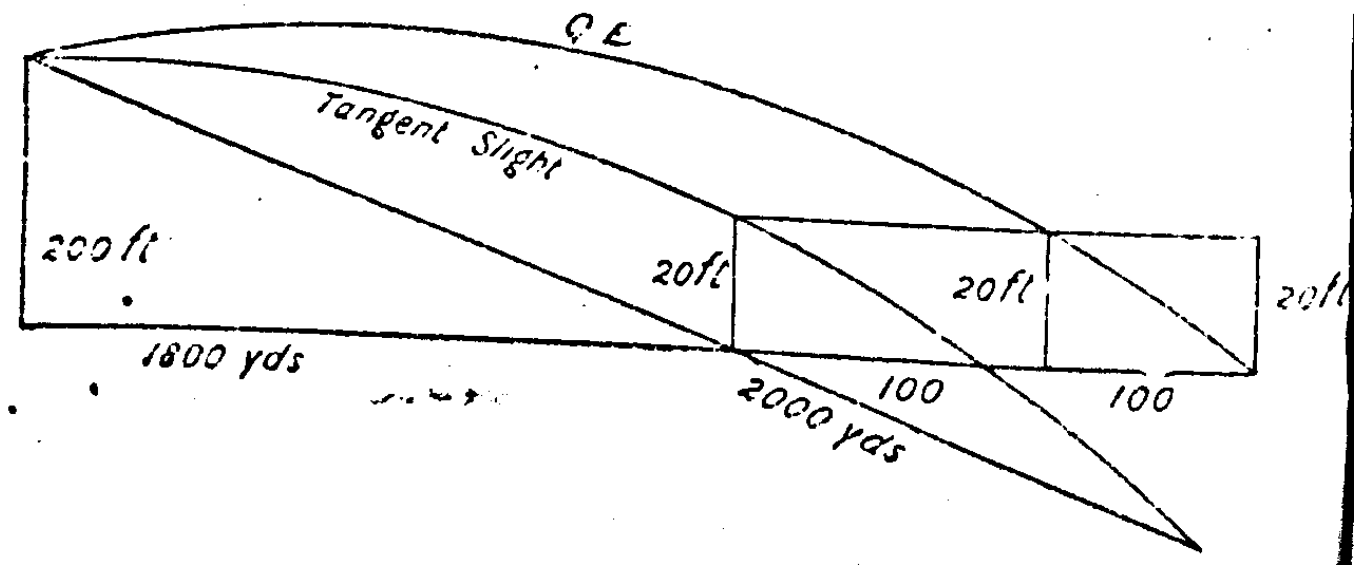
1. Any error due to the varying height of tide disappea when laying by tangent scale.

2. From a high site battery the admissible error in range greater when using the tangent sight than with either ind plate or clinometer, because the very act of bringing the li of sight on the target to a certain extent corrects an error range.

To explain this, suppose in figs. I. and II. that elevation f 2000 yards is given instead of 1900 yards, which is the tru range. In Fig. I. the gun is laid by quadrant elevation, and tl trajectory will strike the water at 2000 yards, or thereabout In Fig. II., though the tangent scale elevation is for 2000 yard the fact of bringing the line of sight on to the vessel correct this error to a considerable extent.

The amount of correction is the difference between the angle of depression to a target at 1900 and 2000 yards.

With a 6-inch B.L. gun on a battery 200 feet above sea leve range 2000 yards, the admissible error in range of a vessel 20 feet freeboard is 100 yards more when laid with tangent sca than when laid by quadrant elevation.



With a 9-inch gun 100 feet above a vessel which has be overestimated as at 1500 yards range, if the gun were laid

ndex plate or by clinometer she would be struck as near as 384 yards, but if laid by tangent scale she would be struck as near as 1324 yards, an additional admissible error of 60 yards.

This presumes the gun to have been laid on the water line, and that the yard scale was made out for a height of 100 feet above this water line.

This advantage decreases rapidly as the range increases and the height of the battery decreases. From a battery close to the sea level it entirely disappears.

It must, however, be remembered that personal error is likely to be greater when laying by tangent scale than when using quadrant elevation.

The relative advantages of laying for direction by—

(1) Gun sights.
(2) Traversing arc.

are as follows :—

(1) This is the most accurate method of laying guns for direction, and should be resorted to on all occasions when practicable, whether the guns are being worked by position finder or not. It has the disadvantage—that smoke or fog interferes and delays the laying of the gun by this means.

(2) Traversing arcs, on the other hand, quite overcome the difficulties of fog or smoke, so far as the gun itself is concerned.

This method of giving direction is also open to the objection that in using it, all the guns of the same group are firing in parallel lines of fire, and the error in direction of the guns on either flank of the gun of direction will be equal to their horizontal distances from that gun, unless convergence tables are used.

It is not therefore applicable when more than one gun of a group is being fired at a small object, unless it be stationary, and the previous round has been laid over the sights, and the position of the pointer noted, unless convergence of fire is

obtained by the use of a table similar to that described page 198.

Some confusion has arisen from the fact that traversing a are not always oriented alike, it is now ordered that in n works, or where new traversing arcs are being laid down, th shall be so graduated, that when the pointer is at zero the a of the gun will be pointing true north, if the gun be laid d east the pointer indicates 270°, or if south-west 135°.

SECTION IV.—AMMUNITION.

Space can be found in this Part for little more than the mere adings of the different articles of ammunition used by the rrison Artillery. Any officer who aspires to instruct his men ist know a great deal more of the subject than he will find re. The latest edition of the Treatise of Ammunition; gulations for Magazines, Ammunition Stores and Laboratories; d the Lists of Changes, will give all the information necessary, d they must be studied.

It is not intended that the instruction should be carried on the order given in this Part.

The officer should begin by explaining the ammunition of ne guns which the squad are likely to use at company practice, plaining each item forming the charge. He will then proceed show them how the nature of shell, common or shrapnel, &c., recognised, how they are plugged, how the gas check is ached, and the shell marked and stored. Next would low instructions in fuzing the shell. First the sort of fuze be used, and why others would not do. Then the boring setting of the fuze, lastly the uncapping or withdrawal of ety pin. After the detail of the ammunition for one gun has en thoroughly mastered, that for other guns in the district ould be taken in turn.

Separate instruction should next be given on the following nts:—

(a.) Filling, marking, and storing cartridges and shells, using tructional stores provided.

(b.) The action of those fuzes in use.

(c.) Their instant recognition by their appearance, either as gle fuzes or in cylinders, and their selection out of many others.

(*d.*) Securing lids of zinc cylinders and metal lined cases.

(*e.*) Every man is to be instructed in the regulations for ens safety during laboratory operations. *See* Magazine Regula and Army Forms G. 940 and 949, which are hung up in Laboratory. A limited number should be instructed in en ing filled shell and taking out fuzes.

Gunners should not have their memories burdened details of the ammunition of guns which are not in their Dis or which they have no opportunity of seeing or using.

NOMENCLATURE OF ARTILLERY MAGAZINE STORES, &c.

"*Magazine.*"—Building or buildings with passages le thereto, in which powder in bulk, and filled cartridges ma stored.

"*Shifting Lobby.*"—The chamber or portion of the ent passage devoted to putting on or taking off magazi laboratory clothing.

"*Ammunition Entrance.*"—The entrance to the magazi ammunition only.

"*Magazine Store.*"—A chamber within a magazine (if vided) in which the hides, wadmiltilts, and spare mag clothing may be kept.

"*Cartridge or Shell Store.*"—A chamber in which filled ridges or filled shell are stored respectively.

"*Powder*" or "*Shell Passage.*"—A passage along powder in cartridges or in bulk, or shell are transported.

"*Ammunition Passage.*"—A passage along which both na of ammunition are transported.

"*Lighting Passage.*"—A passage by which access is gained to e lamp recesses.

"*Cartridge*" *or* "*Shell Serving Room.*"—A chamber on the ne level as the gun into which the cartridge or shell lifts ad, and from which the service of cartridges or shell is con-cted.

"*Cartridge or Shell Recess.*"—A small receptacle for the storage a few cartridges or shell for the immediate service of a gun.

"*Receiving Hatch.*"—An opening in the door or wall of a rtridge or shell-filling room, through which empty shell or wder in bulk is passed.

"*Cartridge*" *or* "*Shell Issuer.*"—A hatch in a door, or opening a wall, through which cartridges or shell are passed.

"*Cartridge*" *or* "*Shell Lift.*"—The lift up which cartridges or ell are hoisted.

"*Artillery General Store.*"—A store for the reception of the are gun stores of all natures.

"*Artillery Store.*"—A store in a battery for the reception of e sights, elevating arcs, and other stores belonging to the guns d required for their immediate service.

"*Laboratory.*"—A building or buildings with passages leading ereto in which ammunition is examined, cartridges made up, d shells filled.

"*Inner Room of Laboratory.*"—A chamber in a laboratory which cartridges are made up and shells filled or examined.

SERVICE POWDERS.

The term "Service" is applied to powders fit for fi projectiles.

Nature.	Use.
MOULDED.	
Prism,[1] *black*	B.L. guns, 8-inch, Mark VII ; 6-inch, Marks and V ; R.M.L., 17·72-inch, 12·5-inch, 10·4-inch ; and primers for Prism[1] brown S.B.C. cartridges, and for E.X.E. cartrid except 6-inch B.L. It will probably superseded in gun charges by E.X.E., exc for 6-inch B.L., Mark V.
Prism[2]	R.M.L. guns, 17·72-inch and 12·5-inch.
Prism[1] *brown*	B.L. guns, 12-inch to 9·2-inch and 8-in Marks III, chasehooped, IV and VI, R.M.L., 16-inch.
S.B.C.	B.L. guns, 16·25-inch and 13·5-inch.
E.X.E.	B.L. guns, 6-inch, Marks III, IV, and R.M.L., 12·5-inch, Marks I and II ; 6-inch.
CUBICAL.	
P. or Pebble	R.M.L. guns, 12-inch, 35 tons to 80-pr.
S.P.	B.L., 6-inch, 80-pr. to 12-pr. (7 cwt.), 4·7-inch Q.F. guns. It may be used inst of P. powder when the latter is not availa
P.[2]	R.M.L., 12·5-inch, Mark I, S.S.
Q.F.[1]	3-pr. and 6-pr. Q.F.

Nature.	Use.
GRANULATED.	
L.G.	S.B. guns and mortars, the bursters for shrapnel shell having the bursting charge loose in the head, and as a substitute, in case of emergency, in P. mixture for F.G.
R.L.G....	R.M.L. guns, 9-pr. to 64-pr. (except 13-pr. and 15-pr.); R.B.L. guns 6-pr. to 40-pr.
R.L.G.^{2}	B.L., 12-pr., 10 oz charge for star shell; R.B.L., 6-pr. to 7-inch; R.M.L., 9-pr. and 15-pr.; R.M.L., howitzers, 8-inch, 6·6-inch, and 6·3-inch. In L.S. it may be used for any guns for which R.L.G.^{4} is employed, should the latter not be available.
R.L.G.^{3}	Made in India, for R.M.L. guns, 25-pr. to 80-pr., and S.B. guns.
R.L.G.^{4}	R.M.L. guns, 13-pr. to 64-pr. (except 15-pr.), and 2·5-inch; 6·3-inch howitzer, when existing stock of R.L.G.^{2} cartridges is used up.
M.G.^{1}	1-inch Nordenfelt gun.
F.G.	S.B. small arms, 7-pr. R.M.L. gun, and for bursting charge of shrapnel, shell having bursting charge in the base.
R.F.G....	Snider, S.A. ammunition, 7-pr. R.M.L. gun, and for bursting charges of shrapnel shell when F.G. is not available.
R.F.G^2....	Martini-Henry S.A. ammunition, and machine guns of small arm calibre; 4-inch R.M.L. howitzer; 7-pr. R.M.L. gun, and for filling shrapnel shell having the bursting charges in the base.

ISSUE.

Moulded powder is issued in cases, powder 100 lb., made wood lined with zinc.

Cubical and grained powders in barrels enclosed in waterproo bags holding 125 lbs. of P and P^2, 110 lbs. Q.F.^{1} R.L.G.^{2}, an R.L.G.^{4}, and 100 lbs. all other.

CORDITE.

Cordite is a compound of nitro-glycerine, gun-cotton, a mineral jelly. It is manufactured in long cords of a diamet suited to the gun for which it is required. The various sizes a distinguished by a fraction, the numerator of which gives t diameter in hundredths of an inch of the die through which t cordite is pressed, and the denominator the length of the stic or cords in inches; thus, $\frac{5}{11}$ means that the cordite is ·05 in in diameter and 11 inches long.

Cordite charges are made up like bundles of sticks. prevent "hang-fires" they are primed with F.G. powder.

DIRECTIONS FOR MAKING UP CARTRIDGES FOR RIFLED ORDNANCE.

Silk Cloth is used for all cartridges, except for those mention below.

Serge for S.B. cartridges for land service if silk cloth is n available, except for blank cartridges.

Serge cartridges for R.M.L. or R.B.L. guns, which may be store, will be used up according to orders issued from time time on the subject.

Shalloon will be used for the 7-pr. R.M.L. cartridge, 4 o 6 oz. and 8 oz.; 2·5-inch R.M.L. cartridge 6 oz.; 15-pr. R.M. 9 oz. cartridge; cordite cartridges under 3 lbs. (p. 50, Treati on Ammunition, 1897), and 6 and 3-pr. Q.F., saluting.

I. Filling.

Cartridges Filled with Loose Powder.

Care will be taken to see that cartridges are not made up in damp weather, (*see* para. 152 Magazine Regulations 1894, which should always be consulted before commencing laboratory operations) that they are properly dry before being filled, and the proper charge is carefully weighed out, and inserted by means of the "Funnel, copper, cartridge."

Cartridges will be choked by drawing together the mouth of the cartridge into several plaits with a magazine needle, threaded with three strands of worsted for serge cartridges, or with two strands of silk twist for silk cloth cartridges, up to 14 lb. inclusive; after drawing together the mouth of the cartridge, three turns will be taken round the plaits, and the choke thus formed will be further secured by passing the needle three times through it alternately above and below the turns, thereby stitching down the turns round the choke at two points equidistant from each other. Charges above 14 lb. up to 85 lb. inclusive, without beckets attached, require three strands of silk twist passed round the plaits, three times, and the needle passed through the choke four times, making three securing stitches. Charges from above 14 lb. and upwards, with beckets, will have the choke first formed, and temporarily secured by taking two turns round the choke, the becket drawn tightly in on both sides, then three turns will be taken round the choke, the needle passed through the choke and becket five times, making four securing stitches. The becket should form a loop about 3½ inches in length over the choke.

The cartridges will be made up to their proper lengths and diameters by means of the hoops, which should be drawn tight so as to make a firm cartridge.

cartridge is then reversed, and after the wood bottom is taken out, it is placed on the scales, and the necessary prisms removed from the top layer, or added to it, until the weight is correct,* an empty cartridge being placed in the scale with the weights to compensate for the one containing the powder. The superfluous choke is then cut off to within 1 inch of the top layer of prisms, a few vertical cuts are then made in this overlap, which is turned in until the edge is flush with the charge; the top is then placed on and secured at each side, and then oversewn round, with two strands of silk twist. The top and bottom of the cartridge have each a hole in the centre fitted with network, which is covered over with shalloon patches, stuck on with shellac to prevent the powder dust from falling into the package.

These cartridges, if necessary, may be made up, by careful manipulation, without using a zinc cylinder, by building up the prisms on a wooden bottom cut to the same shape as the cartridge.

Cartridges, Prism.[2]—The required number of prisms will be built up in layers on a wooden bottom the same shape as the cartridge, the empty cartridge drawn over the whole, and the remaining operations proceeded with the same as with Prism[1], with the exception of the zinc envelope which is not required for Prism.[2]

II. Marking and Gauging Filled Cartridges.

All cartridges when filled will have the nature and weight of powder which they contain marked on the side in *black* printers' ink, the letters being one inch long, and must be carefully weighed and gauged as to length and diameter. Paint must not be used, as it holds fire.

* In making up cartridges with Prism powder, the top layer should not contain less than 75 per cent. of the number of prisms in a complete layer, one or more complete vertical tiers of prisms being taken, if necessary to make up the requisite number in the top layer.

A record of the powder used with the maker's name, lot, and date of filling will be found marked on the package in which filled cartridges are despatched to stations.

All shalloon and silk cloth cordite cartridges will be stencilled with the lot number of the cordite, in addition to the information given on the package.

III. Issue of Filled Cartridges.

Cartridges for the 7-in. and 40-pr. R.B.L., 64-pr. and 80-pr. R.M.L., and 4-in. and 5-in. B.L. guns, R.M.L. howitzers, are issued in metal-lined cases.

These are of three sizes, whole, half, and quarter, and weigh 45 lbs., 30 lbs., and 18 lbs. respectively.

Cartridges for R.M.L. guns, 7-in. and upwards, and 6-in. B.L. and upwards, are packed in zinc cylinders, which may contain either whole, half, or quarter charge, according to size. They serve as cases to carry the cartridge from the magazine to the gun.

Securing Lids of Zinc Cylinders and Metal Lined Cases.

See Part II., Section V., Regulations for Magazines, 1894. Instructions are also printed on the inside of each lid.

Stacking Zinc Cylinders.

When cartridge cylinders containing cartridges are stored lying on their sides, the number of tiers in each stack will be limited as follows :—

Cylinders containing	over 100 lbs.,	not to exceed 3 in height
	60 to 100 lbs.,	„ 4 „
	less than 60 lbs.	„ 5 „

When stacked on their ends, which is always preferable storage room permits, thin battens of wood will be placed them to prevent the handles injuring the bottoms of t packed over them. These battens are not necessary for cylin with screwed lids having handles at the side. Stacking on t ends is preferable, because if stacked on their sides, unless points of support are under each end where the cylinders strongest, or along their length, they become so dented that cartridges are difficult to extract.

When so stacked the height of columns is not to exceed :

For quarter charges	....	....	5 cylinders.	
„ half „	....	....	4	„
„ full „	....	....	3	„

Brass and metal lined cases will be stacked on their sides height not exceeding 11 feet.

DRILL CARTRIDGES.*

Drill Cartridges B.L. and R.M.L. are a special manufact and are issued complete. They are of same shape and dimensio as the service cartridge they represent, and are brought up the required weight by means of a cast-iron core.

Those for R.B.L. guns are of wood covered with felt and leath The base of the cartridge is shod with copper, and they ha dummy lubricators with stalks to screw into sockets in cartridges.

MEANS OF FIRING ORDNANCE.

Except when firing by electricity, all R.M.L. radial ven guns and howitzers, and all R.B.L. guns are fired by means copper friction tubes ; the latest pattern is the solid drawn tu which is used for all natures, and supersedes the long, sho and special friction tubes, none of which have been man

* For Q.F. guns, see §§ 5856, 6509.

ctured since 1887, but there are still some of them in store ; ey will be used up as follows :—

Tube, friction, copper, long, for R.M.L. 7-inch and upwards.

" " " short " guns below 7-inch, and r R.B.L. guns.

Tube, friction, copper, special short, for R.M.L. 7-pr. and 5 inch guns.

The tube, friction, copper, solid drawn having been found o short for use with war rockets, the tube, friction, copper, S. short Mark II. will be retained in the service for use erewith.

When any of the above natures of ordnance are fired by ectricity the tube to be used is, Tube, electric, No. 10 (quill), xcept with guns on H.A. mountings, which are fired with tubes, nt-sealing, electric P. These tubes being of weak construc- on must be handled with care, when joined up, and lowered ently into the vent as far as the projection on its own head ill allow, as, should the head project and be unsupported, the p joint is liable to be broken off without igniting the mealed wder ; should a vent be too short to take the entire tube the wer joint may be removed. A turn should be taken with the uds round the lanyard guide or cascable to relieve the head om the strain caused by the weight of the wires, should it necessary to remove an unfired tube it must be done care- lly, as the upper quill containing the electric bridge easily comes detached ; should this happen, and any of the lower ints be pulled off and remain in the vent, either one or more of e lower joints must be removed from the next tube, to allow to enter to the full extent.

With axial-vented guns ; vent-sealing tubes are used.

The axial-vented R.M.L. guns are 10·4-inch, 12·5-inch Mark ., 16-inch, and 17·72-inch. These guns, except the the 10·4 ch, are fired with either a tube, vent-sealing, friction "V," or be, vent-sealing, electric "V."

The 10·4 inch gun is fired with the tube, vent-sealing, e
"P."

All B.L. guns 4-inch and upwards are axial-vented, a
fired with tubes, vent-sealing, percussion, or tubes, vent-se
electric "P."

Drill tubes of all the above natures are issued for use a
and for instruction in firing ordnance.

3-pr. and 6-pr. quick-firing guns are fired in similar m
to a rifle, a percussion cap being fixed in the base of the
ridge case. The 12-pr., 4·7-inch and 6-inch are fired electr
by means of an electric primer screwed into the base o
cartridge case; for percussion firing an adapter to take a
percussion tube is substituted for the electric primer a
lanyard is used with them.

Copper friction tubes are fired by pulling the lanyard,
hooking, into the friction bar of the tube; vent-sealing fri
tubes by pulling the lanyard, after hooking, into the draw
and percussion tubes, by pulling the lanyard, after hooking,
the firing bolt of the percussion lock, or, in the case of the
percussion lock fitted to B.L. 9·2, 10, and 12-inch guns, by pu
the lanyard, after hooking, to the loop of the trigger.

Electric tubes (except when using position finder) are fire
the battery, electric firing, 3 cell, Leclanché, or the battery
key, test and firing.

PROJECTILES.

Distinguishing Marks.

The following are the general rules for distinguishing m
on projectiles:—

(1) *Tips.*

Shot (except case).—To have white tips.
Common and palliser shell.—To have black tips.
Segment and ring shell.—To have blue tips.
Shrapnel shell.—To have red tips.

(2) *Bands.*

Steel projectiles.—To have white band round head.
Armour-piercing shell.—To have two white bands round head.
All filled shells.—To have red band round head.
Case shot with steel balls.—To have white band round body.
Practice, projectiles.—To have yellow band round body.

(3) *Bodies.*

Shells for high explosives to be yellow; all other projectiles be black.

(4) *Star.*

Star shells to have a star in red on a white disc, on the shoulder.

All filled shells will be marked with the date of filling, and at ations where means are available with the monogram, except hen filled by R.A. Filled common or double with bags, with e word "Bag," and with a red disc 1-inch diameter, if primers e used, and with "P" if filled with P and F.G. mixture. ells which have been emptied will be marked with "E" and onogram of station.
C.S. will be stamped on the base of cast steel and F.S. on the se of forged steel projectiles.
Palliser weighted with sand and armour-piercing shot eighted with sawdust and small shot, will have "W" in white head and also stamped on the base plug.
All projectiles 6-inch B.L. and upwards manufactured since ebruary 1891, are issued with the cannelures undercut for the ception of augmenting strips, and are stamped with the letter between the first and second cannelures.

STORAGE OF FILLED SHELLS IN CHARGE OF THE ROYAL ARTILLERY.

1. *When fitted for gas-checks.*

Filled shells will have the gas-checks, if attached by p fitted before being placed in the shell store. The automatic check is not attached to the shell.

In storing filled shell (9-inch R.M.L. and upwards), are to be placed on their bases, resting on the gas-check pl and prevented from falling over by two pieces of wood, 9" square placed one on each side of the nut. Filled shells of calibre and all shells at Nova Scotia will be piled.

The front row of all filled shells, 7-inch R.M.L. and upw should be so stowed that the transporting barrow can be veniently run under them. The front row will be placed 4" the 2nd row, and the shells the following distances, from ce to centre, viz. :—

11", 12", and 12·5"....	22"
10"	18"
9"	12"

The pieces of wood, or "battens," being placed so as to parallel to the axle of the barrow, in order that when the is tipped back the front batten may be removed to make ro for the tip of the barrow. When there is ample room in shell store the whole of the shell will be stowed as above, 4" from row to row.

2. *When not fitted for gas-checks.*

Filled shells for 7-inch R.M.L. and R.B.L. guns and upwa will be placed upright on their bases in the shell store.

Filled shell of less than 7-inch calibre will be piled.
B.L. filled shell 6-inch and upwards will be stored on their ases, whenever possible.
B.L. filled shell below 6-inch calibre will be piled, each layer ointing in the opposite direction to the one below to prevent injury to the driving bands.

COMMON SHELL.

Common shell are designed to contain the most powerful rsting charge possible, and are made either of cast iron, or of st or forged steel; the latter allows of a greater bursting arge as the walls of the shell can be made thinner; steel shell e also not so liable to break up on impact. Forged steel shell ing intended for armour-piercing, are made with small capacity r bursting charge.
They are used with all garrison guns and are lacquered inside th red lacquer. Bags are used for the bursting charges in all M.L. common shell 16 pr. and upwards, B.L. 4-inch and wards, and R.B.L. 40 pr. and 7-inch.
For weight of shells and bursting charges, see Part III, ction VII.
Common shell is used :—

To disable the *personnel* and destroy the *materiel* of the enemy.

Filling Common Shells.

All shells before filling should be carefully examined inside to e that they are clean and dry; in using the copper scraper for s purpose, care must be taken not to injure the lacquer.
All R.M.L. and B.L. common shells are to be filled with P. d F.G. powders. See § 7714.

The following are the proportions of P. and F.G. powders to be inserted at one time into the various natures of shells :—

Natures.	Proportions.
13·5 inch B.L. and above	about 8 lb. P. then 20 oz. F.G.
12·5-inch to 11-inch	„ 5 lb. P. „ 12 oz. F.G.
10·4-inch to 8-inch	„ 4 lb. P. „ 10 oz. F.G.
6-inch B.L.	„ 2 lb. P. „ 8 oz. F.G.
7-inch to 6·3-inch	„ 2 lb. P. „ 5 oz. F.G.
40-pr. R.B.L.	„ 1 lb. P. „ 4 oz. F.G.
5-inch and smaller natures, except 40-pr. R.B.L.	Fill with P. and then fill the interstices with F.G.

Filling Shells, Common, with Bag, through Fuze-hole.

Remove the plug from the fuze hole, place the filling-rod in the bag, insert it through the fuze hole, taking care not to force the end of the rod through the bottom of the bag; carefully push in the bag until the neck only is in the fuze hole, a portion being kept outside, as the whole bag must not be allowed to slip into the shell during the operation of filling, then withdraw the rod and insert by hand the proportion of P. powder as above for the nature of shell. Place the funnel in the fuze hole, pass the filling rod down through the funnel, and pour in the proportion of F.G. powder, moving the filling rod up and down to facilitate the passage of the powder through the funnel. Take out the funnel and rod, lift up the bag and jerk it, so as to "set" the powder well down to the bottom and to open the bag.

Repeat the process as above, each portion being lightly stirred and pressed with the filling rod.

When the shell is quite full, withdraw the funnel and filling-rod and tie the neck of the bag with twine close to the top of the fuze-hole. A piece of twine is attached to the neck of the bag for this purpose, it must be shifted to its proper position if necessary. Cut off the superfluous choke and push the neck of the bag well down, and to one side of the fuze-hole; insert

very shell two "Bags, primer, filled seven drams," or more there is room, then screw in the plug, taking care that he fuze-hole is clean and the plug lubricated.

Filling Shells, Common, with Bag, through the Base.

Place the shell upon its point which may be inserted in a block wood hollowed out for the purpose, or in any other convenient place.

After standing the shell upon its point pass the holder, shell, B.L." or "studless" of the size required over the base, and crew up the bolt, then hold the handles firmly while another man unscrews the base plug with the "Wrench, base plug." Now drop in three "Bags, primer, filled seven drams." The 17·72 inch shells take one "Bag, primer, filled 10 oz," and the 4·7 inch, being prepared for a base fuze, has one primer inserted after filling.

Insert the bag and fill the shell as when filling through the fuze hole, but no bags, primer, are to be inserted after filling except when a base fuze is used, as in the 4·7 inch shell.

With B.L. shells which take a lead disc, after screwing in the base plug, insert the projection on the lead disc in the recess in the plug and hammer it tightly into its place. There are two sizes of lead discs issued, the size taken by each shell being shown in para. 441 Mag. Reg. 1894. Their object is to prevent the flame from the charge of the gun getting past the threads of base plug and so causing premature bursts.

With B.L. shells fitted with an adapter in the base, the lead ring round it (if there is one fitted) must be cut out with a bronze chisel and hammer, and the adapter withdrawn as well as the plug before filling. After the bag is choked, the neck of will be passed through the adapter, which will be lubricated nd screwed home. After the plug is inserted a new lead ring ill be hammered in. The lead rings are of two sizes, and are ecified in para. 441 Mag. Regs. 1894.

SHRAPNEL SHELL.

These shells are made for all calibres of garrison guns, bu only issued to works whose armament comes under Class pp. 303 and 335, Part II., Sec. XII, Equipment Reg., 1896.

The body is of cast iron, cast or forged steel, with a cha inside the base into which fits a tin cup to contain the bur charge, over this is a wrought-iron disc with a hole in the ce threaded to receive a wrought iron pipe, the walls of the s are lined with brown paper and filled with sand shot excep 6-in. B.L., 40-pr., and 7-in. R.B.L., 64-pr., 80-pr., and 6 R.M.L. which have mixed metal balls, the interstices bet the balls filled in with resin; the head is made of Bessemer lined with wood, let into the head is a gun-metal socket lower part of which fits into the wrought-iron pipe; the in is tapped to receive the primer, the top threaded to the gauge.

The shrapnel shell is made to carry as many bulle possible, and is given a burster only sufficient to open the and release the bullets.

Shrapnel shells are used exclusively against the *perso* of the enemy when beyond the effective range of case shot; on land fronts, against troops in the open and sometime search them out behind cover; on sea fronts, against me boats, on or between decks, or in the rigging of ships.

Time fuzes are nearly always used with shrapnel a targets in the open.

With percussion fuzes, not only is the velocity of the reduced by the graze, but as it rises from the graze bursting, the balls are thrown upwards and are liable to over the heads of troops aimed at.

As, however, the flatter the trajectory the more effectiv percussion shell, it may be possible with the new high velo guns to use percussion shrapnel with considerable effect.

When firing with a view to penetration of very light structures, percussion fuzes must be used, with shrapnel. They will usually break up on encountering very small resistance, but the bursting charge being small and in the base, if not fuzed, it will not be ignited by the shock of impact, and observation of whether they are passing through or breaking up outside will be impossible.

At an experiment against a structure representing the section of an unarmoured portion of a ship, the iron sides of which consisted of one portion of two $\frac{1}{2}$-inch iron plates and another portion of two $\frac{3}{4}$-inch plates, a 9-inch R.M.L. shrapnel damaged six dummy men, dismounted the gun on the far side, and blew all the dummies at that gun to pieces.

It will penetrate about one-third of its calibre of wrought iron.

Its cone of dispersion is probably less than that of common shell.

One function of heavy time shrapnel is of some importance, viz., its action against the lighter torpedo boats, guard boats, &c. For heavy shrapnel a length of burst of 150 yards short will be best, and there is an ample margin of destructive effect on either side of this point.

Time shrapnel is the only projectile fired from heavy guns that will be of use against guns' crews in military tops, barbettes, &c. They cannot, however, be relied on for sufficient accuracy unless the pace of the ships is slow and the range moderate.

With time shrapnel the object to be attained is :—

1. Against an extended front to burst the shell so that its bullets cover effectively, that is without being too scattered, as much space laterally as possible consistent with their having sufficient velocity for penetration.

2. Against a deep formation to open the shell so that the depth as well as the breadth is covered by the balls.

Shrapnel shells depend for their effect on the striking velocity of the balls and splinters disengaged from the shell on bursting:

the higher the velocity the more effective the shell, because only is the angle of descent for a given range less, and the sp covered by the balls therefore greater, but the penetrative po of the balls is also increased.

When the shell opens, the bullets at first travel forward w the velocity the shell had at burst and they would move in original trajectory of the shell, were it not for :—

1. The disturbing effect of the bursting charge.
2. The centrifugal force imparted by the rotation of the sh
3. Loss of velocity greater than that which the shell in original condition would have experienced, due to the differe in form and weight of the fragments.

The trajectory of the centre line of the cone (especially the new B.L. guns) falls very little below what would have the trajectory of the shell had it not burst.

Hence the destructive effect of shrapnel may be said depend upon :--

1. Its velocity at burst.
2. The distance of burst.
3. The angle of descent.
4. With percussion shrapnel the angle of ascent after graze.

1. *Velocity at Burst.*

As on its velocity at burst depends the velocity of th balls, the higher the velocity of the shell the greater depth wi balls of the same weight and form cover with effective fire. heavy ball will retain its velocity longer than a light one.

The least velocity which a heavy shrapnel ball should have striking to be effective may be taken at from 350 to 400 ft. p second.

The remaining velocity at 4000 yards of a 64-pr. R.M. Mark III. Shrapnel shell is about 745 ft. per second, and th of the heavy R.M.L. and new type B.L. guns varies from 10 to 1300 ft. per second.

As far then as the penetrative power of the balls is concerned the shells will be effective beyond these ranges.

2. *The Distance of Burst.*

The distance at which a shrapnel should be burst in front of a target so as to obtain the greatest effect, is influenced by the following considerations :—

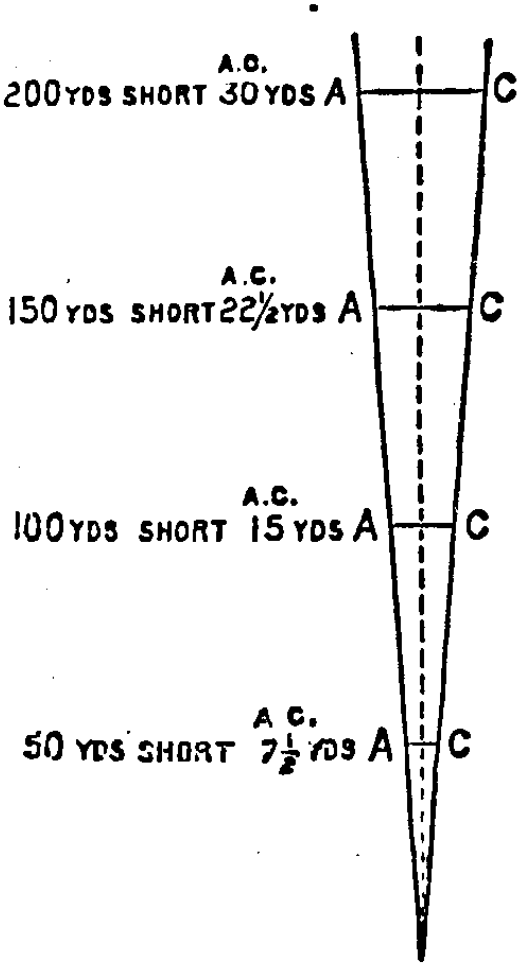
(*a*) That the balls when released proceed in a conical shower, the angle of the cone being from 8° to 16° increasing with the range.

(*b*) That the axis of the cone falls very little below what would have been the trajectory of the shell.

(*c*) That the diameter of the cone for medium ranges is from ·14 to ·15 of its length from point of burst.

(*d*) That the longer the range the greater becomes the angle of descent and the less the velocity of the shell.

(*e*) That the striking velocity of the bullets should not be less than 350 ft. per second.



Taking for example the angle of the cone of dispersion of a shrapnel to be 8° then (see fig.) if it burst 50 yards short of object, the spread of the bullets extends over about 7½ yards; at 100 yards short, 15 yards; at 150 yards short, 22½ yards; at 200 yards short, 30 yards.

It is therefore evident that the shell should be burst close to a target having great depth with very narrow front, further off against a target having breadth and depth, and still further off against one with an extended front but of no depth.

It should further be noted that as the range increases so does the cone of dispersion of the balls, because the velocity of the shell through the air decreases more rapidly than the velocity of rotation due to rifling.

The angles of the cone of dispersion at various ranges of the following guns are found to average from 8° to 13°.

Effective distances of burst when the object has breadth, and time fuzes are used, would be :—

Yards.	R.M.L. Yards.	B.L. Yards.
	Medium. Heavy.	Medium. Heavy.
Up to 1000	100 to 250	150 to 250
1000 to 2000	75 to 200	120 to 200
2000 to 3000	50 to 150	100 to 150
3000 to 4000	25 to 75	50 to 100

A considerable percentage of bullets must always strike between the gun and the object.

Table representing the front covered laterally by various cones at various lengths from the point of burst :—

Cone of dispersion.	20	40	60	80	100	120	140	160	180	Yards
	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	
8°	8·4	16·8	25·2	33·6	42·	50·4	58·8	67·2	75·6	
9°	9·3	18·6	27·9	37·2	46·5	55·8	65·1	74·4	83·7	
10°	10·5	21·0	31·5	42·0	52·5	63·0	73·5	84·0	94·5	
15°	15·0	30·0	45·0	60·0	75·0	90·0	105·0	120·0	135·0	

3. *The Angle of Descent.*

The angle of descent has considerable influence on the effect of shrapnel.

If it is great the lower part of the cone strikes at such an obtuse angle that there is little ricochet, and the upper part of the cone

covers but little space before grazing. Supposing the angle of descent to be 6°, the lower part of the cone with an 8° opening, would graze at 10°, and the velocity of the balls would be greatly reduced after ricochet. As the angle of descent increases considerably at very long ranges, the balls of the lower half of the cone would hardly ricochet at all.

4. *The Angle of Ascent.*

This will vary with the nature of the ground, with its slope and with the angle of descent. Even under favourable circumstances the angle of ascent is so great that all the bullets will generally pass over a 6-foot target if as far off as 25 yards from the graze. A quick or slow acting fuze also tells on the effect of a percussion shrapnel; the sooner it bursts after graze the better the effect.

FILLING SHRAPNEL SHELLS.

Remove the plug from the fuze-hole, and after seeing that the fuze-hole is clear of any dirt, and that interior of shell is dry, &c., insert the leather funnel and pour in the bursting-charge, which has been previously weighed out or measured. This must be done gradually, for if the whole of the powder is put in at once the tube will probably become choked. The shell should be tapped on the side with a wooden mallet, until the whole of the bursting-charge has passed down the tube, taking care that none of the powder is left at the bottom of the socket. Drop in the metal primer and, by means of the Shrapnel screwdriver, screw it tightly into the tube, and then screw in the plug.

SEGMENT SHELLS.

Made for R.B.L. guns only. They differ from common shell having a lining of cast-iron segments, are lacquered but do not use bags. They are shorter than common shell, and the metal coating extends somewhat farther over the base.

Filling 40-Pr. and 7-inch R.B.L. Segment Shell.

These shell are filled in a similar manner to the R.M.L. studded common, except that bags are not used ; after filling, a wad of papier mâché (termed G. S. wad) is driven into the fuze hole to prevent the powder getting into the screw threads ; it is not necessary to remove this wad before fixing the fuze.

STAR SHELL.

Will be found in the equipment of the "Armament for General Defence" in Garrison Artillery Service.

They are made for 8-in., 6·6-in., 6·3-in., and 4-in. howitzers, for 7-pr. and 2·5-in. R.M.L. guns, and for 12-pr. B.L. guns. For description, use, &c., see Siege Artillery Drill and handbooks of the ordnance mentioned.

PALLISER SHOT.

Are made for all B.L. guns 4-in. and upwards, and all R.M.L. guns 80-pr. and upwards.

They are ogival pointed projectiles, the head being made very dense, those of cast-iron being cast in an iron mould, called a chill, the body in sand, which makes it less brittle ; they are cast hollow and plugged. Projectiles, similar to the above were at one time issued as shell with bursting charges, but the bursting charge has been discontinued, and these shell are now filled with an equivalent weight of sand and treated as shot, see § 5033.

ARMOUR-PIERCING SHOT.

Are made for B.L. guns 5-in. to 16·25-in. ; they differ from Palliser shot in being made of forged steel, and having no lifting hole in the side.

CASE SHOT.*

Case shot is an iron cylinder full of balls, which vary in weight with the calibre. When fired it breaks up at once, and the balls are projected with a considerable spread.

Those for B.L. and R.B.L. have studs of soft metal, soldered round the base, to prevent them being rammed too far up the bore in loading.

The case for the 7-in. R.B.L. is used in the 7-in. R.M.L., that for the 8-in. gun serves for the 8-in. howitzer, and those for the 64-pr., 6·3-in. howitzer, and 80-pr. R.M.L. are identical. The 6·6-in. gun and howitzer also fire the same case shot.

The 32-pr. S.B.B.L. has a special case shot, and is the only projectile fired from that gun.

The case shot for R.M.L. guns, 7-in. to 12-in., 35 tons, are about one-third the weight of the other projectiles, and, in order to get sufficient recoil, two are loaded together.

For B.L. guns, and R.M.L. 12·5-in., and heavier natures, they are the same weight as the other projectiles.

Case shot from heavy guns would generally be used against boats or bodies of troops. With heavy R.M.L. case the limit of effective range is about 900 yards. B.L. case may be employed at longer ranges. The 9·2-in. B.L. case is effective at 1,100 yards.

SPECIAL CASE SHOT.

Shot, R.M.L., Case, special, is approved for 9-inch guns and upwards with chilled iron shot weight 3 lb. 9½ ozs., and has good penetrating effect against steel plates of torpedo boats at ranges up to 600 yards. Cordite charge has been approved for this projectile with 9-inch guns, § 8025.

* See § 7611.

DESCRIPTION OF FUZES.

Percussion Fuzes.

A percussion fuze is one that depends upon impact or graze for its action.

*Direct Action.** §

It acts equally well with high and low charges.

It is prepared by the removal of the metal cap or safety plug; this should not be done until the shell is in the bore of an M.L. gun, or is about to be entered into a B.L. gun.

The fuze acts on direct impact, and on graze only when the angle of descent is not less than 10°.

Great care must be taken to see that nothing shall press on the diaphragm in the head of the fuze after it has been uncapped.

Mark III. is the only pattern allowed to be used with guns loaded by hydraulic rammers. It differs from previous patterns in having a screw safety plug instead of the metal cap, thus enabling the fuze to be kept in filled shells covered by a wad.

Mark I.* or Mark II. fuzes only are to be used over land ranges.

Pettman, G.S.

Is made of gun-metal and threaded on the exterior to the G.S. gauge.

This fuze will not act on graze, neither will it act when fired with reduced charges.

It has no safety pin, and the only preparation necessary is to screw it into the fuze hole.

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* When practice is carried out over land ranges or sands where any blind shells are liable to be left exposed by the tide, R.L. fuzes are to be used with 80-pr., 6.6-inch and 64-pr. guns instead of direct action fuze.

§ 5488. Mark I. fuze obsolete.

§ 5572. Mark I. to be altered to Mark I.*

To face page 91.

FUZES USED WITH CERTAIN GUNS.

Nature of Fuze	Distinguishing No.	Paragraph in List of Changes in War Stores.	Material.	Nature of Ordnance with which used.
PERCUSSION.				
Direct-action, Marks I*, II, and III	3	I*5572 II5216 III5593 5788 6274 6740 7635	Metal...	R.M.L. 40-pr. and upwards. All rifled howitzers. B.L. 5-inch and upwards. R.B.L. 7-inch. *See* § 6740, *List of Changes*.
Pettman's G.S., Mark II	5	3200	,, ...	R.M.L. 12 (of 25 and 35 tons), 11, 10, 9, 8, and 7-inch, when firing full charges. To become obsolete as expended.
R.L., Marks II, II*, III, III*, and IV	7	II2621 II*5270 III5270 III*7175 IV7175 7635	,, ...	R.M.L. 7-pr. common, 9-pr. to 80-pr. R.B.L. 40-pr. *See* § 5270, *List of Changes;* 7-pr. common, 9-pr. to 25-pr. To be replaced, so soon as existing stock has become exhausted, by small percussion. For 25-pr. M.L. and 40-pr. R.B.L. common shell, the primer, R.L. percussion, Mark I, to be used.
Small, Marks III* and V	8	III*7230 IV7230 7635	,, ...	R.M.L. 15-pr. and 2·5-inch, and 7-pr. double shell. B.L. 12 to 30-pr. and 4-inch. This fuze will take the place of the R.L. percussion fuze when the stock of the latter is exhausted, except 40-pr. to 80-pr. R.M.L.
Base, Armstrong, Mark III	9	7008	,, ...	4·7-inch Q.F. (Cast-iron common shell.)
	10	6038 7229 7635	,, ...	Rifled howitzers, except 5-inch and 5·4-inch.
Base, large, Mark I ...	11	8099	,, ...	R.M.L. 9-inch and upwards. B.L. and Q.F. guns of 6-inch calibre and upwards, for use in cast-steel common shell having pointed heads.
Base, medium, Mark I	12	8100	,, ...	B.L. and Q.F. guns, 12-pr. to 5-inch calibre (excepting 4·7-inch cast-iron common shell), for use in cast-steel common shell having pointed heads, and Palliser, and armour-piercing shells.
Base, Hotchkiss, Marks II, II*, and III	...	II5944 7009 II*8229 III7490 8229	,, ...	3-pr. and 6-pr. Q.F. shell.

Nature of Fuze.	Distinguishing No.	Paragraph in List of Changes in War Stores.	Material.	Nature of Ordnance with which used.
TIME.				
Sensitive, middle, Mark I	24	5638 5982 7046 7231 7305	Metal...	R.M.L. 17·72-inch to 25-pr. B.L. 13·5-inch to 5-inch Q.F. 6-inch and 4·7-inch R.B.L. 7-inch and 40-pr. All howitzers. All star shell. To be replaced, when existing stock has become exhausted, by middle time and percussion fuze, Marks I* or II.
30-seconds M.L., Mark I	40	3458	Wood...	All ordnance with which 15-seconds M.L. is used, except 7-pr. shrapnel.
15-seconds M.L., Mark II	41	4045 4684 4685	,, ...	R.M.L. 17·72 to 10·4-inch, 7-inch, 64, 25, 16, 9, and 7-pr., also 80-pr., 8 and 9-inch, studded.
15-seconds M.L., special priming, Mark I	42	4686	,, ...	All R.M.L. star shell, and 7-pr. double shell.
15-seconds, with detonator, Marks II and III	43	4045 4496 4685 5132	,, ...	R.M.L. 10 and 6·6-inch, 40 and 13-pr., 80-pr., and 9-inch studless, also studded with gas-check. R.B.L. 7-inch, 40, 12, and 9-pr. shrapnel.
TIME AND PERCUSSION.				
Middle, Marks I* and II	54	...	Metal...	B.L. howitzers, 5-inch, 5·4-inch, and 6-inch, and for guns with which the middle sensitive time fuze is at present used, when existing stock of the latter has been expended.
Short, Marks II, II*, and III	55	5574 5982 7176 7305	,, ...	R.M.L. 13-pr. and 2·5-inch. B.L. 4-inch to 12 pr., and 12-pr. Q.F., until stock is expended. To be replaced by Mark IV.
	56	7716	,, ...	15-pr. and 12-pr. 6 cwt.

Until stock is expended.

R.L. II., III. and IV.

Is a short fuze, with one safety pin, which is removed before he shell is rammed home, it will act on graze or impact.

Small, Marks III. and IV.*

Is made of gun metal and is threaded throughout, except for length of ·3-inch at the lower end which is left plain and educed in diameter. It acts on graze or impact. The safety n should not be removed until the moment of loading.

Base, Armstrong (Mark III).

The fuze, which is of manganese bronze, is screwed into the ell by means of the key fuze and plug Armstrong. The d cap is then placed in the recess in the base, and pressed ne with a hollow drift; but on no account must the cap be ammered on or pressure be exerted on the centre of the head the fuze. It acts on graze or impact.

Base, Large, No. II.

Is made of manganese bronze. The body is screwed outside, d will fit either the large or small adapter in B.L. or R.M.L. mmon shell; it acts on impact or graze, and requires no setting.

Base, Medium.

In material, construction, and action it is similar to the fuze ercussion base, large, but is smaller, and screwed outside twelve reads per inch instead of nine.

Base, Hotchkiss (Marks II, II,* III).

The body of this fuze is of manganese bronze, screwed exter- lly with a left-handed screw; the base is formed with a ojection to take the key by which it is screwed into the shell. acts on impact or graze.

Time Fuzes.

The fuze composition, which consists of pit mealed powder pressed into a ring or grove which runs round close to the exterior of the fuze body, burns at the rate of one inch in two-and-a-half seconds, and owing to a metal stop can only burn from left to right.

Sensitive, middle.

Is made of gun metal. The lower part is tapped to the G.S. gauge, and contains F.G. powder. The upper part contains the time arrangement. The igniting composition is contained in a pellet, which is retained in position by the projections on two other pellets, which fit into a slot in the igniting pellet, and are kept up to their work by spiral springs. Opposite the detonator cap is a steel needle in the rim of the fuze, near the commencement of the composition ring. A safety pin passes through each retaining pellet.

The safety pins are withdrawn at the moment of loading. On discharge the centrifugal action causes the retaining pellets to fly out, releasing the igniting pellet, which flies out by centrifugal force against the needle, firing the detonator, which ignites the powder in the pellet and axial magazine, this latter lighting the quick-match in the composition ring.

The composition ring for the fuze is graduated from 0 to 30; and the divisions are subdivided into four, to increase accuracy in setting.

30-Seconds M.L.

In general construction this fuze resembles the 15-seconds M.L. fuze; it has however a slower burning composition and eight powder channels; its marking begins at 15 seconds, and runs up to 30 seconds. No more of this fuze will be made.

15-*Seconds M.L.*

This fuze has the composition channel in the centre, and is driven with a slow burning composition (7½ seconds per inch). There are six powder channels bored near to and parallel to the axis of the fuze, they are connected at the bottom by quick-match laid in a groove and pressed into the bottom of each channel. It is graduated to quarter seconds, the figures 2, 2·5, &c., are printed so that they may be read when the head of the fuze is towards the body of the person holding it, the figures are at one side of the side holes; and the side holes are accurately stamped and coloured yellow.

The fuze is lit by the flash of discharge igniting quick-match, which is wound round the head. This quick-match is protected by a copper band, which is torn off on placing the shell in the bore. This is called "uncapping" the fuze.

15-*Seconds M.L. Special priming.*

This fuze differs only from the above in having an additional priming of gun-cotton round the head of the fuze over the ordinary quick-match priming and fastened with tacks; a patch of waterproof paper is pressed down over the priming, and a band of thin copper and tape wrapped round the whole and secured by shellac varnish.

The head of this fuze is painted red, and the loose end or tip of the copper band white.

This fuze is used with star shell only.

15-*Seconds with detonator* (Mark III).

This fuze differs from the M.L. in being lit by a detonating arrangement in the head, held in safety by a pin; this is necessary in R.B.L. guns where there is no windage and also with R.M.L. guns 10-inch and under when using gas-checks, as they cannot be lit by the flash of discharge.

The safety pin should not be removed until the moment of loading.

Fuzes, Time and Percussion.

Middle.

Are made of gun-metal. The lower part is screwed to the gauge and contains the percussion arrangement; the upper part contains the time arrangement which consists of a composition ring, dome and cap; attached to the composition ring is the igniting arrangement. The ring is graduated from 0 to 30, and each graduation is divided into four so that the fuze can be set to $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ or whole graduations with accuracy. The fuze has two safety pins, the upper for the time and the lower for the percussion arrangement; both pins are withdrawn at the moment of loading so that if the time portion has been set too long the shell will burst on graze.

Short, Marks II. and III.*

Is similar in construction to the T and P, middle. The composition ring is graduated from 0 to 18.

PREPARING FUZES.

Direct-Action, Marks I. and II.*

These fuzes require no preparation, except the removal of the metal cap; they are screwed firmly into the fuze-hole. The cap is fastened on to the head of the fuze by two double bayonet joints, which enable the cap to be used either in fixing or unfixing the fuze. The cap can be removed by bringing the centre of the bayonet joints in line with the studs on the side of the head of the fuze.

With B.L. and R.B.L. guns the cap will not be removed until just before entering the shell into the breech.

With R.M.L. guns the cap will not be removed until after entering the shell into the muzzle.

Direct Action, Mark III.

These fuzes require no preparation, except the removal of the plug; it is screwed firmly into the fuze-hole. The plug fits inside the head of the fuze with a left-handed screw, and it is removed before loading.

Pettman, G.S.

The fuzes require no preparation; they are simply screwed firmly into the fuze-hole.

R.L.

These fuzes require no preparation, except the removal of the safety pin; they are screwed firmly into the fuze-hole; primers are to be used with these fuzes, § 8807 (No. 7). They will be screwed in before inserting the fuze. With R.B.L. guns the safety pin will not be withdrawn until just before entering the shell into the breech.

With muzzle-loading guns the safety pin will not be withdrawn until after entering the shell into the muzzle.

Small.

Remove the safety pin.

Base Armstrong, Base Large, Base Medium, Base Hotchkiss.

No preparation is necessary.

Fuze, Time, Sensitive, Middle.

The preparation of this fuze is identical with the T. and P. as regards time arrangement, but both safety pins must be withdrawn.

Fuzes, Time, Wood.

These fuzes are of two descriptions, one has a detonator and to be used when the fuze cannot be lit by the flash of

discharge, as in R.B.L. guns, or in some M.L. guns when gas-check effectually stops the flash. There is a safety which must be withdrawn on loading.

The other is the M.L. fuze, and is lit by the flash of discha igniting a quick match primer wound round the head. priming is exposed by uncapping the fuze on loading; this done by tearing off a copper band which protects the primin They are used with all R.M.L. guns, without gas-checks, and als for R.M.L. guns from 10·4-inch, upwards, with gas-checks.

These fuzes are prepared for any desired time of flight by boring through the side hole corresponding to the required time into the composition.

When using the hook-borer, place the fuze in the hook of the hook-borer in the proper position for boring the required hole enter the bit into the side hole accurately, the fuze being grip to the bottom of the hook by placing the first two fingers ro the fuze, and the thumb against the outside of the hook, a screw the bit home. When the boring is completed the fu should still have an even bearing in the curve of the hook.

Unscrew, and when the bit is quite clear, remove the fuz from the hook. The length of the bit is so regulated that, when placed in the handle, it will enter sufficiently far into the com position when screwed down to the shoulder. If the bit should become unserviceable, the handle must be detached from the hook and the tightening-screw unscrewed, the square hole in the hook being made for that purpose. Care must be taken, when substituting another bit, that it is properly placed in the handle and that the tightening-screw firmly presses upon it, for if any space be left between the handle and the head of the bit, the end will not enter a sufficient depth into the composition. The borer should be occasionally examined and cleaned. The opera tion of preparing the fuze and fixing it in the shell takes on an average, about 15 seconds; with a little practice these operations may be performed in a shorter time.

These fuzes should be screwed into the fuze-hole by hand. *They must never be struck with or against anything.*

Fuze, Time, and Percussion, Middle, and Short.

To Fix the Fuze.—Screw it in by hand, then tighten it by inserting the point on the hemispherical arm of the key in the small hole in the circumference of the body of the fuze.

To Prepare it as a Time Fuze.—Loosen the hexagonal cap on the top of the fuze by means of the key, and then turn the dome and collar of the fuze together until the required graduation on the collar coincides with the arrow-head on the body, and tighten the cap. This should be done *before the removal of the safety pins.*

Withdrawing Safety Pins.—If required to act as a time and percussion fuze, withdraw both safety pins at the moment of loading; if the percussion arrangement is not required to act, the lower safety pin should be left in; if the fuze is required to act as a *percussion one only*, the upper safety pin should *not* be removed, and the arrow-head should be set midway between the zero and the last graduation of the collar. If the fuze is not fired the safety pins must be replaced, or if this is impossible the fuze destroyed.

Wad, G.S., in Fuze Hole.

When fixing fuzes in shells having a wad in the fuze-hole it is not necessary to remove the wad, as the explosion of the fuze is sufficient to force it into the shell.

GAS-CHECKS.

Gas-checks were first introduced to prevent the bores of heavy guns being scored by the rush of gas along the bore, especially near the seat of the shot.

They are used with all R.M.L. studless projectiles (except case shot) and with studded common, and Palliser for 9-in. and upwards; the 40-pr. common and shrapnel and 12·5-in. studded shrapnel are also fired with gas-checks.

The first pattern, Mark I. (now obsolete, though perhaps to be met with at some out stations), were made with a smooth rim and were nutted tight on to the base. These acted well with the violent L.G. powders, but with the slower P. powder they did not expand into the grooves. Mark II. was therefore introduced with projections on the rim. It was also nutted on to the base, but allowed to revolve, so that the projections might not interfere with the loading.

It was soon discovered that rotation to the shell might be imparted by the gas-check, and thus obviate the inconvenience of studs. The present pattern automatic gas-check was thus introduced for studless shell. It is loaded separately, except with guns on H.A. mountings, being firmly attached to the base of the projectile on discharge, and as it takes the rifling of the gun it imparts rotation to the projectile.

The gas-checks for the 40-pr. R.M.L. and 8-in. howitzer of 46 cwt. have projections to fit into the grooves, and are fixed by means of a gun-metal plug, therefore the projections must be aligned with the studs on the projectile before nutting up.

The gas-check for the 6·3-in. howitzer consists of a saucer-shaped piece of copper with projections to fit into the grooves and perforated at the rim with a few holes. It has the concave surface to the rear, rotation being imparted to the shell by means of radial projections on the gas-check, which fit into corresponding grooves in the base. It is fixed by means of a hexagonal headed gun-metal plug.

There are, therefore, speaking generally gas-checks, for *studded* projectiles, which must be attached to projectiles before loading, and automatic gas-checks for *studless* projectiles, which attach themselves on discharge.

FIXING GAS-CHECKS.

Projectiles fitted with plug and nut.

Unscrew the nut and remove it, then apply the "Wrench base plug" to the gas-check plug, and screw it well up in the direction of the arrow,* to ensure its being well home.

If, when unscrewing the nut, there is any tendency for the plug to unscrew also, the "Wrench, base plug," should be at once applied to the head of the plug and turned in the direction of the arrow, at the same time as the nut is being turned in the opposite direction.

Place the gas-check on the base of the projectile, with the concave or unpainted side next the base, then screw the nut on to the end of the plug with the "Spanner, gas-check nut." With Mark II.,† gas-check, plug and nut, the nut will be screwed down to the shoulder on the plug.

Projectiles fitted with plug with hexagonal head.

Unscrew the plug and remove it.

Place the gas-check on the base of the projectile with the concave or unpainted side next the base (the saucer-shaped gas-checks for 6·3-inch howitzer with the concave surface to the rear), insert the plug and screw it well home with the spanner until it ends against the gas-check.

With gas-checks having projections for studded projectiles, see that the projections are in the line of the studs before screwing the plug home; with the 6·3-inch howitzer shells see that the radial projections on the gas-checks fit into the corresponding grooves in the base before screwing the plug home.

* The heads of the gas-check plugs, and the wrought-iron nuts, will each be stamped with an arrow to show the direction in which to turn, either when screwing in the gas-check plug, or when screwing on the wrought-iron nut. All base plugs and gas-check nuts have left handed threads to prevent them unscrewing during flight.

† Mark I. is obsolete.

Projectiles fitted for "Gas-checks, automatic."

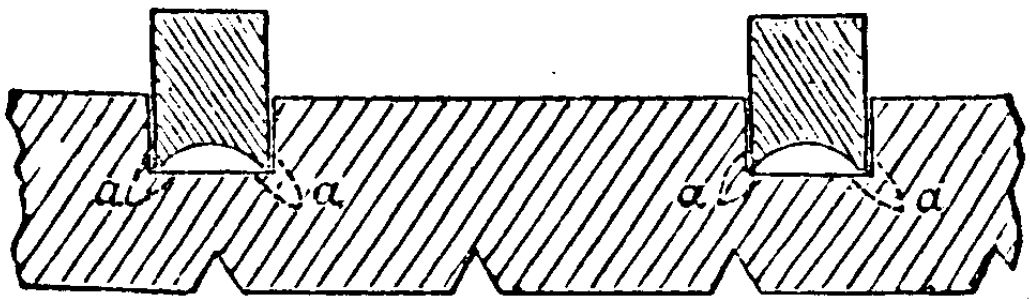
These gas-checks become fixed to the projectile when gun is fired. They are loaded separately, except with guns H.A. mountings, when they are nicked on before loading.

AUGMENTING STRIPS.

Augmenting strips are strips of pure copper of rectangular section, and grooved on one side.

They are intended for use with B.L. projectiles in cases when the rifling of the gun has, owing to firing, become so worn that the gun ceases to properly rotate its projectiles. Their length varies with the calibres, being marked for the nature of gun with which they are intended to be used.

Scale, twice full size.



They are fixed by means of a special steel chisel (§ 5887), which will be supplied for the purpose, and a hammer, V-shaped grooves are cut in the bottom angles of the upper cannelure, as shown by the dotted lines, *a a*, in the sketch, except with projectiles marked U on driving band, the augmenting strip is then placed in the cannelure, grooved side downwards, and hammered round the shell until the two ends meet.

When the gun is further worn and one strip is found to be insufficient, two may be used; the second being secured in the lower cannelure.

B.L. guns which are so worn that augmenting strips are necessary will be marked as follows: A white ring 3 inches

external diameter and $\frac{1}{4}$ inch thick will be painted on the breech when one augmenting strip is required. A second concentric ring will be painted inside the first if two augmenting strips are used. The rings will be painted on the upper left hand surface of the breech: position "left of up."

WEDGE WADS.

Wedge wads.—Two sizes of wedge wads are issued. They both consist of two wooden wedges connected by a piece of cane; the larger is for use with 9-inch guns and upwards, the other for 64-pr., 80-pr., and 7-inch guns.

Their use is to prevent the projectile from shifting when running the gun up.

They are employed with all R.M.L. guns mounted on sliding or Moncrieff carriages, and 64-pr. R.M.L. when mounted on garrison standing and rear chock carriages.

TIN CUPS.

To prevent, as far as possible, the escape of gas on discharge in R.B.L. guns, tin cups are issued as under:—

For the 7-inch and 40-pr. side closing } With service, practice, and exercise ammunition.

" 40-pr. With practice ammunition.

Each cup may be used until it loses its shape.

They are placed against the cartridge with the edge to the front. An extractor is provided, by which to withdraw them after firing.

PRIMERS.

Shrapnel Shell.—Are used for all shrapnel shell having their bursting charge in the base, to convey the flash from the fuze to the bursting charge, and consist of a gun-metal cylinder filled

with powder, tapped at the top to screw into the pipe of the shell. They are dropped into the shell, and, by means of a screwdriver, screwed tightly in.

Vent Piece.—Are used with the 7-in. and 40-pr. R.B. (except side-closing) and consist of a cylinder of leather pape driven like a tube, with three strips of red worsted attached t the exterior. To prime, the primer is pressed into the vent worsted end first—Dummy primers are issued for drill purposes.

Vent B.L.—Is made of brown paper filled with fine grain powder, and is intended for use with 9·2-in. B.L. guns and upwards when missfires occur with vent sealing tubes (without ball) Marks I and II.

Cartridge Q.F. Electric.—Is made of manganese bronze of form and dimensions to screw into the cartridge, the end being screwed to take the igniter for cordite charges. Filled cartridges are issued with primers in. Spare primers are packed 10 in a tin cylinder.

Projectiles that may be fired with full charges.

All B.L. projectiles.

All R.M.L. studless, except 17·72-in. iron common shell and case shot. The R.M.L. studded projectiles 7-inch and upwards that may be fired with full charges are:—All Palliser shot, the 12·5-in., 9-in. (Mark VI), and 7-in. common; the 12·5-in. shrapnel and all studded common (except 12 in. 35 ton) which have *not* been altered to take gas checks.

All other R.M.L. shells, 7 in. and upwards, will be fired with reduced charges.

Ammunition for Q.F. Guns.

The ammunition for 3-pr. or 6-pr. Q.F. guns, differs from that for other guns in being what is called fixed ammunition, that is the charge, projectile and means of ignition are all contained

in one metal case as with small-arm ammunition. This arrangement is, however, limited by considerations of weight, of difficulties of attachment of shell to cartridge case, and, for convenience in loading, with the 12 pr. the 4·7-in. and the 6-in. the projectile is not contained in the case.

The Q.F. guns at present in the service are the 3-pr. (Hotchkiss and Nordenfelt), the 6-pr. (Hotchkiss and Nordenfelt), the 12-pr., the 4·7-in., and the 6-in.

For the 3-*pr. and* 6-*pr.* there are for each nature cartridges containing iron shells and steel shells. Both natures are issued with the shells filled and fuzed.

Earlier patterns of iron shell were issued filled with salt and plugged. They are marked with a yellow band.

The percussion cap in the above cartridges is protected by a brass clip fitting over the base. This clip is removed when the cartridges are brought up to the gun.

Cartridges are interchangeable with the Hotchkiss and Nordenfelt Q.F. guns.

The fuze used with the 3-pr. and 6-pr. projectiles is the Hotchkiss base percussion fuze.

Ammunition for Q.F. guns, 12-*pr. and upwards,* differs from the above in having the charge and projectile separate from each other. These guns can be fired either electrically or with a percussion striker, and the base of the cartridge case is fitted to receive either an electric primer or an adapter containing a vent sealing percussion tube.

The projectiles for the 4·7-in. are armour-piercing shell, iron common shell (for practice until existing stock is used up), and steel common shell.

The projectiles for the 6-in. Q.F. are armour piercing shot and shell and common shell.

The common shell are filled through the base with P. and F.G. mixture contained in a bag; one "Bag, primer filled drams" being used. A lead cap fits over the head of plug or

fuze when screwed home to seal the recess between the metal of the shell and the fuze or plug. This cap is pressed home by means of a hand lever press supplied for the purpose. *It is not to be hammered and the hollow drift supplied must be placed on the cap to prevent any pressure coming on the centre of the head of the fuze.*

When plugs are used instead of fuzes the cap will be stamped with the letter P, with fuzes the cap is not marked.

The fuze used is the "Base Percussion Armstrong," for future use Base Medium Mark I.

The charge for 12-pr. Q.F. is 1 lb. 10 oz. cordite, size II. The projectiles are armour-piercing shell, and cast steel common shell; shrapnel shell (12-pr. B.L.) and case shot (12-pr. B.L.) may be used. The fuzes used are the Hotchkiss base percussion and Time and Percussion, short, Mark III; for future use Base Medium Mark I and Time and Percussion Mark IV.

Cordite Cartridges have been introduced for Q.F. guns. The charges are of cordite of the sizes suitable for the different guns. Igniters for 3 and 6-pr. Q.F. are contained in shalloon bags and attached to the base of the charges. In the heavier natures the igniter is contained in a varnished paper cylinder, which is attached to the primer. A later pattern is being introduced to supersede the above; it is attached to the charge, not to the primer, and is contained in a short cordite cylinder

Saluting Cartridges have been introduced for Q.F. guns.

Cartridges for 3-pr. and 6-pr. Q.F. guns must not be stored in the same place as gunpowder, whether in bulk, made up into cartridges, or in shells, nor in the same magazine as any kind of explosive.

As these cartridges contain their own means of ignition great care should be taken in handling the boxes and cases containing them.

Cartridges for the higher natures of Q.F. guns will be treated as regards storage in the same way as ordinary gun cartridges.

NOTE.—Instances having occurred where Q.F. guns have been fired with cracked cartridges, which is a source of danger, all ammunition for these guns should be carefully examined before loading. *Cartridges which show any signs of splits or cracks are not to be fired.*

EMPTY Q.F. CARTRIDGES.

Empty cartridges will always be cleaned as soon as possible after firing. The fired cases should be immersed and well washed in clean fresh water, which should, if the cartridges have been fired with cordite, contain ½ oz. of soda to the gallon. They should then be rubbed inside and out with a mop, formed by a piece of rag tied to the end of a stick, rinsed in clean water and wiped perfectly dry. Soda may be used with cartridges which have been fired with powder, but it is not essential in this case. When perfectly dry they will then be repacked in the boxes in which they were supplied, and returned to store, the clips being replaced on those cartridges which take them.

Fired cartridges are not on any account to be repacked in boxes containing unfired ones.

An R is stamped upon every refilled Q.F. cartridge case, which signifies "rectified," and a puncture mark made for each time of refilling.

DISPOSAL OF Q.F. CARTRIDGES WHICH MISS-FIRE.

Q.F. cartridges which miss fire at percussion firing, will, if the cap or tube has been struck, be destroyed as soon as possible by being thrown into deep water, except at Shoeburyness, where they will be returned to Woolwich.*

* Authority 57 | Straits Settlements | 3009.

SECTION V.—SIGHTS, &c.

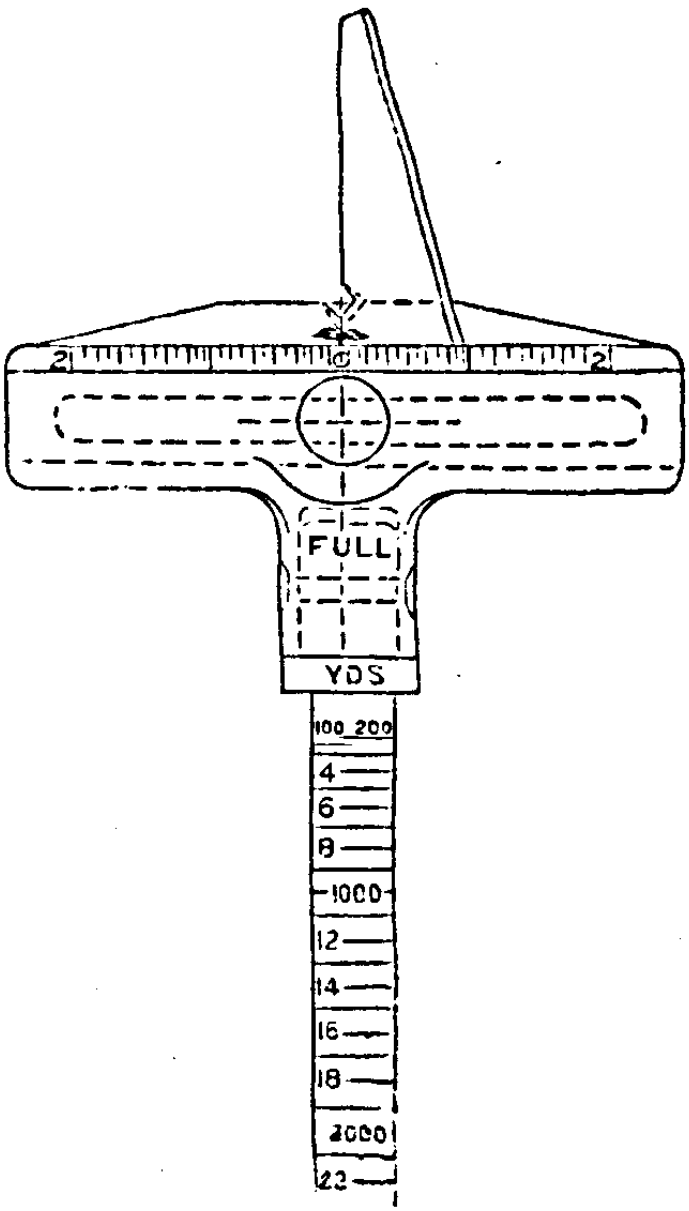
Sights for R.M.L. Guns.

R.M.L. guns are (generally speaking) provided with the following sights :—

(*a.*) Fore sights.
(*b.*) Tangent sights.

(*a.*) All *fore sights* of R.M.L. guns on garrison mountings up to the 12·5-inch are of the "drop pattern." They are provided with a small steel acorn point and a sighting blade, to facilitate laying. The sights are "left" and "right" respectively, and are so stamped, the vertical edge of the sighting blade being turned inwards in each case when the sight is in position in the gun.

(*b.*) *Tangent sights* are bars of steel, rectangular in section with bronze crossheads furnished with deflection leaves. They are made "left" and "right" respectively, and are so stamped. The vertical edge of the sighting blade is turned inwards in each case when the sight is in position in the gun, so as to correspond with the sighting blade of the foresight mentioned above. They are graduated in yards and degrees on the front faces, and fitted with range strips graduated in yards on the rear faces.



TANGENT SCALE FOR 10″ R.M L. GUN.*

* The apparent paradox of more elevation being required for 100 yards than fo
200 yards is due to the fact of the line of sight being so much above the axis of th
gun owing to the great thickness of metal of the gun.

Sights for B.L. Guns.

B.L. guns mounted on garrison mountings are provided with (generally) two foresights and two tangent sights.

The foresights are of the pattern described for R.M.L. guns. The tangent sights are steel bars triangular in section (except that of the 6-in., Mark II., which is rectangular). On the front face is a degree scale, and a rack which gears with the elevation in the automatic clamp. The rear face is fitted with a range strip graduated in yards for a full charge, and stamped with the corresponding M.V. The crosshead is fitted with a deflection leaf, worked by a screw capable of giving 2° deflection right and left. This leaf has a sight blade similar to those for R.M.L. guns.

Sights for R.B.L. Guns.

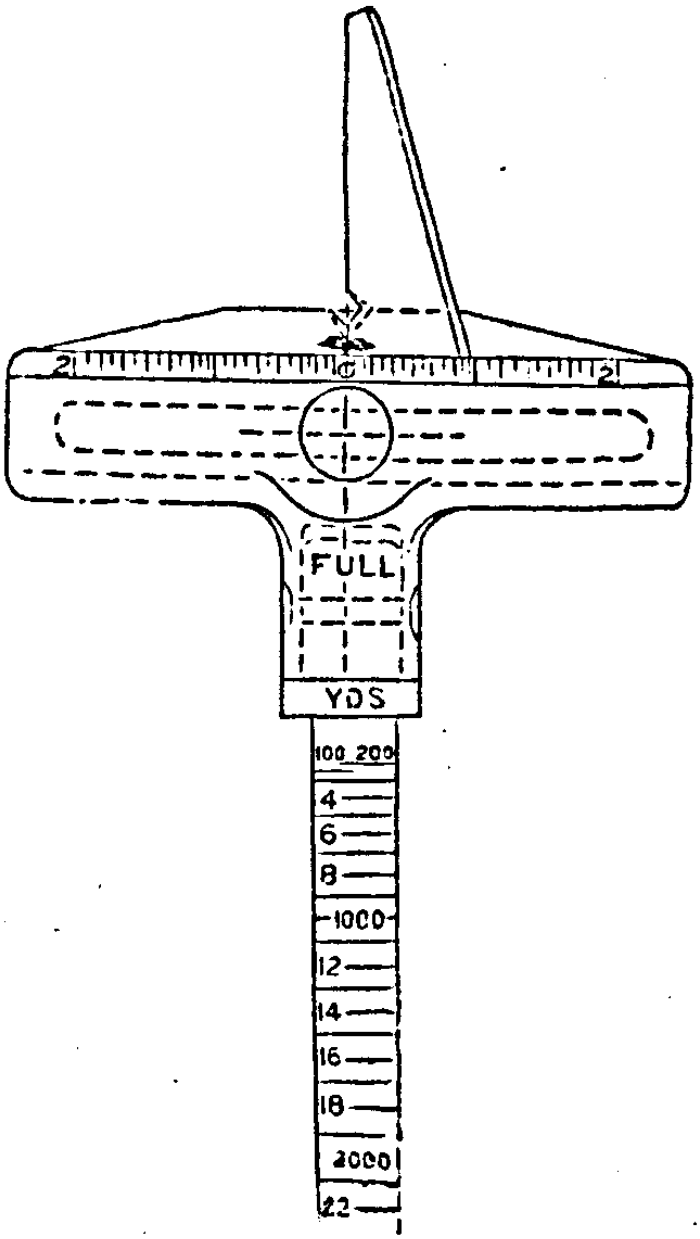
All R.B.L. guns are sighted on both sides, having two foresights, and two tangent sights.

The foresights for these guns are of the "hogback" pattern, and are either screwed into the gun, or attached on the drop pattern (bayonet joint) principle, similar to the foresights for other guns. Screw foresights are supplied to the 7-in. of 12 cwt., and a few 7-in. of 82 cwt.

The tangent sights are, generally speaking, steel bars, rectangular in section, but for the 7-in. of 72 cwt., and for a few 7-in. of 82 cwt., the bar is hexagonal in shape, and made of gunmetal. On those sights of the 7-in. R.B.L., which are rectangular in section, range strips, similar to those on R.M.L. tangent sights, have been fitted, but as on the bronze hexagonal sights this cannot be conveniently carried out, yard scales are engraved on the surfaces of the bars in place of these strips.

Sights for Q.F. and Machine Guns.

These are of various patterns, particulars of which will be found in the handbooks of the respective guns.



TANGENT SCALE FOR 10" R.M.L. GUN.*

* The apparent paradox of more elevation being required for 100 yards than 200 yards is due to the fact of the line of sight being so much above the axis of the gun owing to the great thickness of metal of the gun.

Sights for B.L. Guns.

B.L. guns mounted on garrison mountings are provided with (generally) two foresights and two tangent sights.

The foresights are of the pattern described for R.M.L. guns. The tangent sights are steel bars triangular in section (except that of the 6-in., Mark II., which is rectangular). On the front face is a degree scale, and a rack which gears with the pinion in the automatic clamp. The rear face is fitted with a range strip graduated in yards for a full charge, and stamped with the corresponding M.V. The crosshead is fitted with a deflection leaf, worked by a screw capable of giving 2° deflection right and left. This leaf has a sight blade similar to those for R.M.L. guns.

Sights for R.B.L. Guns.

All R.B.L. guns are sighted on both sides, having two foresights, and two tangent sights.

The foresights for these guns are of the "hogback" pattern, and are either screwed into the gun, or attached on the drop pattern (bayonet joint) principle, similar to the foresights for other guns. Screw foresights are supplied to the 7-in. of 72 cwt., and a few 7-in. of 82 cwt.

The tangent sights are, generally speaking, steel bars, rectangular in section, but for the 7-in. of 72 cwt., and for a few 7-in. of 82 cwt., the bar is hexagonal in shape, and made of gunmetal. On those sights of the 7-in. R.B.L., which are rectangular in section, range strips, similar to those on R.M.L. tangent sights, have been fitted, but as on the bronze hexagonal bars this cannot be conveniently carried out, yard scales are engraved on the surfaces of the bars in place of these strips.

Sights for Q.F. and Machine Guns.

These are of various patterns, particulars of which will be found in the handbooks of the respective guns.

AUTOMATIC SIGHTS.

Designs of these sights have been approved for the various Q.F. guns in the Land Service, also for 9·2-in. B.L. Mark I on barbette mountings. They are suitable for sea fronts only.

For description and sketch, see Appendix I.

Special Sights.

For the description of special sights, such as centre sights reflecting and chase sights, the handbooks of the various guns which are fitted for them must be consulted.

Sighting Blades.

All 6-inch B.L. guns and upwards, and R.M.L. guns 9-inch to 12·5-inch when mounted on sea fronts have their foresights and tangent sights furnished with vertical sighting blades with straight edge inwards, of a height corresponding to a mean length of 1000 yards on the yard scale (see figure on page 109). They are for use in conjunction with the hydroclinometer, index plate, multiplier or any similar means of giving elevation when firing at a moving target. When using the sighting blades the tangent sight should be clamped about 1000 yards less than the estimated range if the target is approaching, and at the estimated range if receding, and by this means the gun can be laid for line at any time during the period the range alters 1000 yards without any necessity for shifting the tangent sight.

Removable Range Strips.

The tangent scales of all B.L. guns and of all R.M.L. guns 9-inch and upwards, and 7-inch, 80-pr., 64-pr. of 64 and 71-cwt

nd R.B.L. 7-inch* are to have all scales removed, excepting the gree scale, and to be fitted with a removable range strip, aduated in yards for a full charge on the rear face.

Index Plates and Readers

Index plates and readers are fitted to all R.M.L. guns 9-inch 12-inch of 25 tons, and B.L. 8-inch Mark VII., 9·2-inch ark IV., and 12-inch; with the 12-inch of 35 tons and 3-inch R.M.L. the elevating arc is graduated. They are aduated for 10° of elevation and 6° of depression.

9-inch R.M.L. to 12-inch of 25 tons (except 10·4-inch) and inch B.L. Mark VII., 9·2-inch, Mark IV., and 12-inch have a ard scale fixed to the index plate. It is graduated for the full harge and due correction made for height of the axis of the gun bove mean tide level.

In the case of disappearing mountings the elevating arcs are raduated in degrees and fitted with yard scales.

Elevation Indicator.

Generally fitted to B.L. mountings. It consists of a cir- lar disc keyed to a small pinion shaft which is actuated by toothed piece fixed to the elevating arc; a reader with zero ark is provided. Degrees, and also yards of range corrected height above mean tide are marked circumferentially.

Hydro-Clinometer.

The instrument consists of a glass tube, partially filled with a

*With bronze sight bars hexagonal section this cannot be conveniently carried they will have the yard scale engraved on the rear face.

red or green coloured fluid, and encased in an oblong iron box which is rigidly attached to the right trunnion. The front of the box is filled in with mahogany, which is cut away so as to expose a portion of the tube. A range scale in yards, corrected for height above mean tide level, is marked on a plate fixed above the tube, and the elevation is indicated by the coincidence of the upper portion of the end of the column of liquid with any particular graduation. The plate is also marked with the muzzle velocity, charge, and weight of projectile.

To test the adjustment of a hydro-clinometer.—On the scale of every hydro-clinometer is marked, independently of the yards scale, an arrow head which has lettered against it either the word "level," or a number of degrees such as 1°, 2°, &c.

Set a large Watkin clinometer to this angle (having previously made sure of its proper adjustment), and place it on the clinometer plane of the gun. Elevate or depress until the bubble of the Watkin clinometer is in the centre of its run. The upper portion of the end of the liquid in the hydro-clinometer should then be exactly opposite the arrow head. If it is not the fixing screws must be slackened, the hydro-clinometer adjusted until the liquid comes to the right position. The screws are then tightened again, and the hydro-clinometer again tested to ensure that it has not moved during the screwing up.

Multipliers.

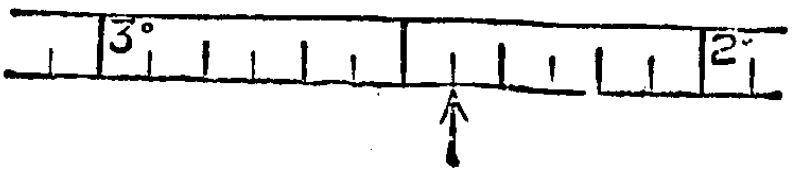
Multipliers are designed with the object of facilitating the reading of small variations of quadrant elevation by the elevating numbers of the gun. The present service multiplier consists of a cast-iron box fixed to the carriage. In the rear or one side of the case, is an aperture, having across it a reader, behind which is a tape graduated with a range scale and rolled on a drum. The internal mechanism is so arranged that every alteration made in the elevation of the gun causes about three times that movement on the tape.

Watkin's Clinometer.

To read the Angles marked on the Drum.—The brass drum is marked in degrees, commencing at 0° on the top, to 45° at the bottom. Each degree is subdivided into 12 parts, each small division, therefore, represents angles of 5 minutes.

The scale is read from right to left, thus—

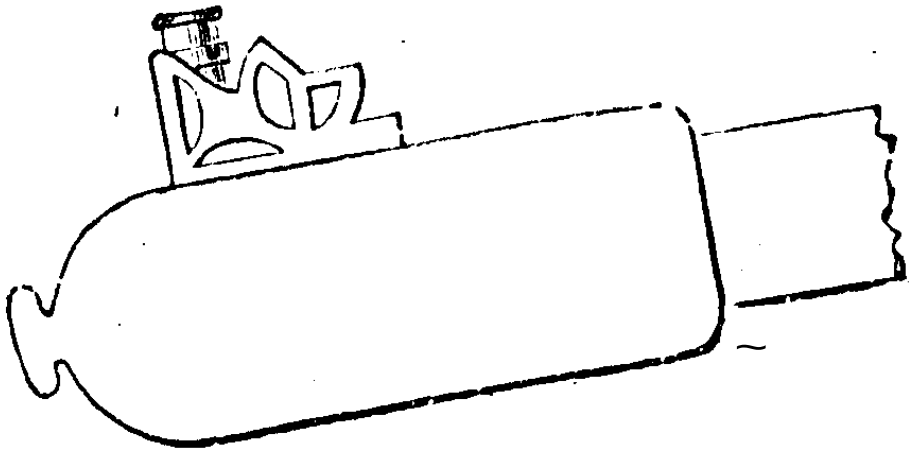
Fig. IV.



The reading opposite the arrow would indicate an angle of 2° 25′.

To lay a Gun to any Angle up to 45°.—Unscrew the drum until the ↑ points to the elevation required, place the clinometer, thus—

Fig. V.

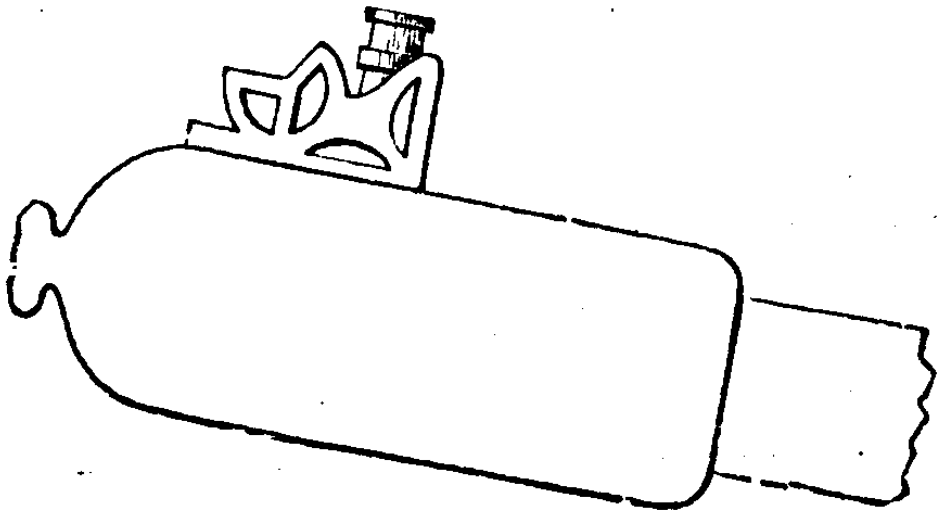


the plane surface cut on the breech, and elevate the piece til the bubble of the spirit-level is in the centre of the tube.

To lay for Angles of Depression.—Proceed as above but

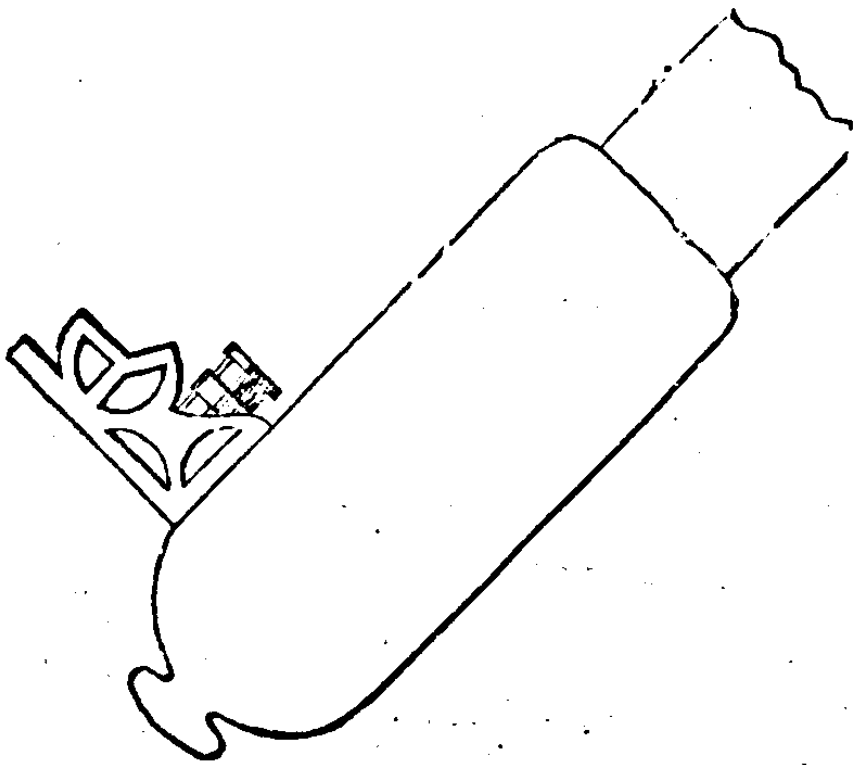
reverse the direction of the instrument, placing it thus on the breech of the gun—

Fig. VI.



To lay for Angles of Elevation greater than 45°.—Subtract the angle of elevation required from 90°, unscrew the drum to this reading; thus, for 60°, unscrew the drum to 30°, and place the instrument on the breech of the gun, thus—

Fig. VII.



Preservation and Adjustment of the Instrument.—In order to preserve the Clinometer in efficient working order, it is necessary to keep the working parts free from grit and dust as far as possible. As excess of oil is apt to cause the adhesion of grit, only sufficient is to be applied to make the screw work smoothly, and to keep the steel parts from rusting.

On no account should the instrument be taken to pieces, as it requires special tools to put it together again.

Instruments are issued in correct adjustment, and with due care will remain correct for many years.

To ascertain if the instrument is in adjustment—

(*a*) Carefully clean the plane surface cut on a gun for use with the Clinometer.

(*b*) Turn the drum to zero.

(*c*) Place the instrument on the plain surface and elevate or depress the gun till the bubble is in the centre of its run.

(*d*) Turn the Clinometer end for end.

(*e*) Should the bubble not return to the centre, the instrument is out of adjustment.

(*f*) As the amount of the error will generally be small it is advisable to add or subtract the error, as the case may be, rather than correct the adjustment.

(*g*) To ascertain the error after complying with (*d*), turn the drum until the bubble is again in the centre of its run; *one half* the reading on the drum is the index error.

(*h*) If the reading falls on the *black* markings on the drum, *add half* the amount when setting the Clinometer for any required *elevation*.

(*i*) If the reading falls on the *red* markings on the drum, *subtract half* for any required *elevation*.

If it is required to adjust the Clinometer to have *no* index

error, set the drum to *half* the ascertained index error, and bring the bubble to the centre of its run by manipulating the capstan-headed nuts (using a tempered steel wire just fitting the holes in the nuts). Then placing the drum at zero, elevate or depress the gun till the bubble is in the centre.

Reversing the instrument end for end should not alter the central position of the bubble; should it do so, proceed as before until there is no change.

SECTION VI.*—CARE OF ARMAMENT AND STORES.

ORDNANCE, CARRIAGES, SLIDES, &c., GENERALLY.

1. Tools for the repair of ordnance, as also for wrought-iron garrison carriages and slides, are allowed to all stations as detailed in equipment regulations. They will be in the charge of the accountant of the sub-district in which they are kept, and will be maintained in serviceable condition, and be available for use by armament artificers when required, for carrying out the repairs, &c.

2. All ordnance, carriages, slides, and stores connected therewith, forming the armament of fortresses, and projectiles exposed to the weather, will be cleaned and painted biennially; but should it be found on inspection that when mounted on the sea faces of works they are in a bad state from exposure to the spray of the sea, or when in casemates from the damp and dripping, they will be cleaned and painted every year, and oftener if considered necessary by the Officer Commanding Royal Artillery; on this point, considered as a question of expense, a sound discretion will be exercised.

3. Before the periodical painting of ordnance, carriages, and slides, the Officer in immediate charge of the guns will apply for the services of the Armament Artificers to examine and thoroughly overhaul the gun mountings. This examination will be carried out under the Inspector of Ordnance Machinery when there is one in the district.

* Detailed information, further than what is contained in this Section 6, will be found in the equipment and magazine regulations.

4. All spare parts held on charge by the R.A. should be fitted to the ordnance, carriages, &c., for which they are intended, that no delay may occur when they are required for use. Officers, N.C. officers, and men should be frequently practised in fitting spare parts.

Care and Preservation of Ordnance and their Fittings.

I.—General Instructions.

5. All ordnance, whether breech-loading, muzzle-loading, or quick-firing, will be kept in good preservation, the exterior being protected from the effects of the atmosphere by a sufficient coating of paint, and the bore by being lacquered when not in constant use, or by being well cleaned and oiled during practice.

6. Before the working parties commence work, the ordnance will be dismounted and placed on skidding, in such a position as to admit of the exterior and interior of the piece being thoroughly well cleaned.

7. In cases where, from the nature or position of the work, it may not be deemed advisable to dismount the pieces, they will be raised out of their trunnion holes to a sufficient height to admit of all parts of the gun being thoroughly scraped and cleaned.

8. Dismounting, placing on skidding, raising out of trunnion holes, and mounting ordnance in charge of the Royal Artillery, form part of the duties of Artillery soldiers, for which working pay is not allowed, and should, when practicable, be performed independently of the working parties.

9. Ordnance will be scraped on the exterior (the scrapers or old swords supplied for the purpose being previously sharpened) until the old paint and all rust which may appear beneath it are entirely removed; the sight notches and all marks will be completely cleaned out and rendered distinct, and the ordnance will afterwards be wiped over with a piece of old canvas or cloth.

10. The radial copper vents will be cleaned with the vent-scrapers.

11. The exterior of the piece will be painted with two coats of paint; the second coat will not be applied until the first coat has thoroughly set, and as, in the process of mounting the ordnance, the paint gets much rubbed, the second coat should be given, when possible, after the piece has been mounted.

12. Guns and mountings will, where necessary, be painted in colour to harmonise with the surroundings of the work (which will be similarly painted), with the view to lessening their visibility.

13. The paint to be used will be in accordance with the description approved for the several stations and works. For proportions for each piece, necessary tools for painting, and working pay allowed for scraping, cleaning, and painting, see Equipment Regulations.

14. The bores of all ordnance, when not in use, will be lacquered;* but when in frequent use they will be kept clean and slightly oiled instead. At the close of each day's practice they will accordingly be washed out and placed under metal and as soon as dry will be oiled with a greasy sponge (a sponge cloth tied over a piasaba brush), and the muzzles closed with tompeons or caps. When the practice for the year is over, the bores will be lacquered,* the vents plugged, and the bright parts about the breech of B.L. and R.B.L. guns dealt with as directed in paragraph 283, Equipment Regulations, and the breech screws, ventpieces and all other fittings, as directed in paragraph 284. The lacquer can be removed in a few minutes by brushing the bore with hot potash solution.

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*The lacquer consists of—

Lead {	black	24 lb. 8 oz.
	red	6 ,, 12 ,,
Lamp black		12 ,,
Oil, linseed, raw		9 gallons.

15. It is the duty of the Royal Artillery to keep in perfect order the bores of all ordnance in their charge, and working p is not granted for this service.

16. In the case of ordnance having gas escape channels, t latter will always be kept clear, the outer ends being merel stopped with plugs of greased tow when the guns are not in use

2. *Preservation of Sights.*

17. When mounted in exposed positions, or in batteries accessible to the public unguarded by sentinels, all the sights (except screw pattern fore-sights of R.B.L. guns) will be removed from the ordnance and kept in store, the sight recesses in the guns being filled with a plug of greased tow to keep out the rain and dirt. These plugs can be readily removed when it is required to fit the sights to the ordnance. Particular attention will be paid to the prevention of rust or grit accumulating in the sight recesses.

18. The set-screw for clamping the centre hind-sight, not being removable from the socket, will be tested to see that it works freely.

19. The sights themselves will be kept clean, free from grit and oiled; the sliding leaf, as well as the collars of the fore-sights, should have free play.

20. The exposed portions of the sights of rifled ordnance are bronzed if made of gunmetal, and blued if of steel, in order to preserve them from corrosion, and on no account will these parts be cleaned or burnished in such a manner as to remove the bronzing or blueing. The screw pattern fore-sights of 7-in. R.B.L. guns will be kept painted. In the case of sights for S.B. ordnance, the fore-sight, is kept painted as well as the block which is used with the hind-sight on guns and carronades. The tangent scale sights are kept clean and oiled, and should on no account be polished.

3. *Preservation of Fittings.*

21. The breech-screw and bright parts of B.L. and the mechanism of quick-firing guns in store, or mounted where seldom used, will be coated with the grease detailed for that purpose in the table at pages 534 and 535, Equipment Regulations.

22. When R.B.L. guns are not in use, the vent-piece, breech-block, and all the fittings, except the breech-screw and elevating plates, will be removed and laid up in store. In the case of B.L. guns all fittings excepting the bronze frame will be removed.

23. The muzzles of guns and howitzers—as also the breech end of the bores of R.B.L. guns—will be stopped with tampeons, and those of mortars when in use (mortars not in use do not require caps, as they can be laid horizontally with the coins removed) covered with caps to keep out moisture; and vent plugs will be used with mounted R.B.L. and R.M.L. ordnance.

24. Ordnance, whether mounted or lying on skidding, will be depressed to prevent rain or moisture lodging inside.

25. Elevating plates will be removed for transport, and the holes in the gun filled with preserving screws.

26. All garrison ordnance are furnished with lanyard guides to overcome the tendency of the tubes to be partially pulled out at the vent. When the guns are not in use the lanyard guide will be removed, and the hole filled up with a preserving screw.

27. Guns fitted for land service have the friction tube pin holes filled by preserving screws, which should be occasionally removed and oiled to prevent their becoming fixed by rust.

28. All fixing screws should be occasionally removed and oiled.

4. *Examination of Ordnance.*

29. All ordnance will as far as possible be examined after the

following number of rounds. Practice should be discontin
until such examination takes place.

	Natures.	Number of rou with projectile
B.L.	16·25-inch, and 13·5-inch	
	12-inch to 8-inch	5
	6-inch to 4-inch	15
	15 and 12-pr.....	
Q.F.	6-inch, 4·7-inch, and 4-inch	10
	12-pr. and under	15
R.B.L.	7-inch	10
	40-pr. and under	15
R.M.L.	35 tons and upwards	
	12-inch, 25 tons to 9-inch	
	8-inch howitzer, 7-inch, 6·6-inch (gun and howitzer), 80-pr., 64-pr., and 13-pr.	10
	6·3-inch howitzer, 40 pr. and under except 13-pr.	15
S.B.	Firing 10 lb. charges and upwards	10
	„ charges under 10 lb.	20

30. *B.L. Guns.* Lined guns and 8-in. Mark VI., 9·2-in. Marks VI and VII, 10-in., Marks III and IV, 12-in. Mark VII, 13·5-in. Marks III and IV, will be examined after firing double the number of rounds shown against their respective calibres in the above table.

R.M.L. Guns. Rifled guns, such as those in R.N.R. Batteries which fire one-third elongated projectiles, and two-thirds smooth bore shot with special charges, may fire double the number of rounds in each series.

Instructions for the Care of the De Bange Pad Obturator.

31. If a pad becomes very hard, soak it in a hot mixture of olive oil and tallow.

The protecting discs should be carefully examined, and if om continued firing, the tin be fused, or the steel rings eroded broken and thus liable to cut the canvas of the pad, they ould be replaced by new discs.

Obturating pads and discs are issued expanded and unexanded. The pads have the words "expanded" or "unexuded" painted on the canvas.

The expanded pads and discs are always to be used on the t occasion with a full charge, and any spare pads or discs hich are supplied unexpanded should be used with full charges the first practice after receipt.

Care should be taken that blank charges are not used unless olutely unavoidable for the first round, even with an exded pad and discs, and the first time any pad is used in a n (even if expanded) should be with a shotted round.

Should a pad get too soft from rapid firing, remove it and ace it in cold water.

Care and Preservation of Carriages and Slides.

1. *General Instructions.*

32. Iron and steel carriages and slides, of every description nire special care to preserve them from the effects of the ther, and to keep them in working order; otherwise they be deteriorated by rust, and the working parts become so oded as to induce irregularity in action, and be difficult work.

33. Detailed instructions with reference to buffers and gear of L. 12-inch and 12·5-inch, high angle and disappearing ntings, will be found in the handbooks.

In batteries accessible to the public, where no permanent ction is possible, or in works where mountings are not freuently used, all detachable fittings and movable parts of the ting and other gear will be removed and placed in store,

where the bright parts of the ironwork will be well coated with Field's grease No. 3, to preserve them from rust. These parts will be thoroughly cleaned and placed in position at least once three months, to see that they are in proper working order. All other gear should be worked once a week, to ensure their being in a working condition.

35. If the paint is rubbed off any part of the mounting, the place should be patched over as soon as possible to prevent rust.

36. A thorough cleaning and lubricating of all standing working parts must take place once a month. In this cleaning all clotted grease must be removed where visible, by scraping, and the parts wiped with an oily rag. Where mountings are much exposed and liable to accumulate dust or sand, they should not be left with much grease or oil upon them, but only sufficient to prevent rust, for which a very slight film will suffice.

37. Whenever fresh lubricant is applied the old should first be wiped or scraped off, and the parts well worked to distribute the fresh lubricant.

38. The gear hidden under the slide can be examined as to condition by a man lying on his back while the slide is traversed above him.

39. It has been found, especially in exposed positions, that hard glassy cake of oil and sand, &c., will sometimes form between the carriage and slide, which is likely to escape observation, being of a semi-transparent nature, and which induces violent recoils from the very slippery surface it presents. Such a skin has to be hammered off; its formation is best guarded against by leaving as little oil on the sliding surfaces as possible when not in use.

40. When not in use, the position of the carriage and slide will be frequently changed to prevent impressions on the rollers, trucks and racers, and to keep the sliding faces clean.

41. Before firing, or drill, care should be taken that all nuts and screws are properly tightened up; that all working parts

re in proper gear; and that all friction cones and brakes are curately adjusted, and are not jammed. Particular attention hould be paid to the clip plates, the bolts of which tend to tretch and throw undue strain on the guide plates.

42. If a nut or screw be removed it should be slightly oiled efore being replaced, and a few turns given to it by hand efore using the spanner, to prevent damage by the threads ossing. A burr on the threads of a screw will prevent it being ewed home; the burr can be easily removed by means of a e.

43. A hammer should never be used to tighten up screws or nuts. djusting any gear not to indent or damage the component arts by rough usage. A hammer should never be used unless ith a piece of wood or brass to transmit the blow.

44. Rollers and trucks will be removed, and the axles properly eaned and greased before replacing. The front trucks are emoved by running the carriage back and lifting the front of e slide by hydraulic jacks, sufficiently high to take the weight the trucks; care will be taken to block up the slide before moving the axles. For the rear trucks, run the carriage up, ace the jacks under the rear block plate, and proceed as for e front trucks. Particular care must be observed when placing conical trucks that they are in the correct position, :—with the smallest diameter towards the pivot.

45. The truck brackets of wood slides must be adjusted so at the trucks are in the right position with reference to the rve of racer. *i.e.*, with the axles truly radial, otherwise the nges will bite the racer and cause stiffness in traversing.

46. The racers, especially at the sides, should be scraped and aned to render traversing easy. Care must be taken that the ots of mountings do not cause the truck flanges to bear inst the racers. Where an error in position of the pivot or ot plates appears to exist, it should be at once reported.

47. The clamping arrangements or friction cones of elevating

gear, brake drums, and the discs of friction clutches, will be cleaned and slightly oiled to prevent seizing.

48. Differential brake gear will be regulated by the adjusting screws, until the tension of the brake bands is just sufficient to retain the carriage on recoil, and prevent it running out until the bands are slackened by the levers.

49. Jamming levers and friction cones of elevating gear will be tightened up by means of the adjusting nuts, so as to allow a slight slip in the gear on firing.

50. The plates and bars of the compressor and preventor gears will on no account be greased or oiled, but should be kept free from rust by scraping, as compression adjusted with a scale of rust between the plates may lead to a violent recoil after the first round.

51. The adjusting lever should be set up after each round, for the first three or four rounds, so that the removal of any scale or rust on the bars will not vary the recoil.

52. In replacing the preventor gear particular care must be taken to place the lever in its correct position to ensure proper working. For this purpose a note must be taken of the number on the toothed collar to which the arrow on the lever points when the lever is removed.

53. Compressor gear is regulated by raising or lowering the adjusting lever until, by the exertion of one man, the compressor lever can be just forced beneath its catch.

54. Iron pointed levers and their sockets must never be oiled or greased, but simply cleaned to prevent rust.

55. In lubricating, the lubricating holes will be cleaned out with a wire and filled with oil, care being taken to replace the small screws, the heads of which must be kept bright so as to be readily seen. One list for each nature ofmounting,—showing positions of oil holes, and how access is obtained to them, is to be hung up in a safe and convenient place in each work, and none must be neglected. These lists can be obtained on applica

to the U.S. of State for War, the nature of the mounting ing specified. After filling the oil holes the parts should be orked backwards and forwards until the oil shows on the afting, fresh applications of oil being made if necessary.

56. Carriages with rollers permanently in action should have he roller axles removed, cleaned, and lubricated. The axles can e taken out one by one.

57. The teeth of all pinions and toothed wheels should be eased.

58. G. S. jacks should, when not in use, be placed in the Frame, store, hydraulic jack," and frequently released and mped up to maintain a moderate pressure on the leather ckings; on release, the jack should descend to its lowest int.

59. The cylinders of hydraulic buffers should be emptied and eaned out every 12 months; the fluid drawn off may then be ltered and used again if not too thick. The buffers should be refully examined before firing or drill, to see that the cylin- s contain the requisite quantity of fluid marked on the scription plate; that there is no leakage at the glands, and t the piston rods are properly connected.

60. If a buffer leaks at the gland, and tightening up the ker does not stop the leak, the packing will be renewed. terials for packing are detailed in Appendix VII of Equip- nt Regulations. The buffer will not be removed, but will be filled and periodically examined (*see* Equipment Regulations).

61. Any drippings of oil from the buffer, collected in the drip or attached to the carriage or slide, should on no account be l on any part of the machinery of the mountings or on any the gun fittings.

62. R.M.L. carriages and slides will be dismounted and the le of the gear removed by armament artificers at the odical painting and all parts cleaned, keys adjusted, bolts nuts tightened, lubricating holes thoroughly cleaned, the

trunnion holes greased, and all parts properly lubricated, and any slight defect made good before reassembling the parts.

63. B.L. mountings will require the same overhaul, but the period may be extended.

64. Whenever any parts are found broken, defective, or deficient, which cannot be renewed by the artificers, fresh parts should be demanded at once. Any damage occurring at drill or practice, should be at once reported with a view to its being made good without delay.

65. In all correspondence and reports relating to carriages and slides, their exact natures, marks, and register numbers should be quoted.

66. The Inspector of Ordnance Machinery reports quarterly on his district. In districts where no inspectors of ordnance machinery are appointed, arrangements will be made to detail an inspector from another district to make periodical inspections of the gun mountings. The reports on these inspections will be addressed to the officer commanding Royal Artillery of the district concerned, for transmission to the Adjutant-General.

67. When examining mountings in permanent works particular attention is to be paid to the accuracy of level of the racers—especially on sea fronts. It is necessary that there should be no alteration in elevation, as the slide is traversed from side to side. To ascertain whether this condition holds good, a spirit level should be placed

(1) lengthways on the slide, and
(2) crosswise on the slide,

and the slide traversed from extreme right to extreme left and *vice versâ*; the bubble should remain stationary throughout, and the mounting bear on all its rollers continually.

68. The adjustment of the degree scales of index plates, graduated arcs, or elevation indicators, should also be checked. These should read at zero on the degree scale when the axis

gun is horizontal. The horizontal position of the gun can obtained by a spirit level resting on a straight edge in the bore on the quadrant plane prepared on the breech of the gun.

69. A copy of General Instructions, for care and preservation carriages and slides (Army Form G. 907) attached to a board will be hung up in each fort or battery where there are iron carriages.

Scraping and Painting.

70. Previous to being scraped and painted all carriages and slides will be examined, and, if necessary, repaired.

71. Wrought-iron carriages and slides require a great deal of scraping and cleaning, especially if mounted in open works. Before proceeding to paint them they must be stripped of all their loose parts, and all the old unsound paint, rust, and corroded oil or grease must be thoroughly removed.

72. The implements to be used in scraping are old swords, triangular steel scrapers, and scrapers made from old files.

73. Scraping consists in going lightly over the surface with the scrapers, removing all blisters and loose paint, and forming a smooth surface for the new coat of paint. Care will be taken not to break into the old coat where it is found to be sound.

74. In repainting carriages and slides care will be taken not to paint any bearings or gearing parts: for instance, soles of racks, teeth of pinions and wheels, the upper surfaces of the slide on which the carriage slides, the sliding surfaces of the carriage, &c. The carriages and slides will be thoroughly dry when painted.

75. Racers, racks, soles of trucks, and pivots, will not be painted, but will be rubbed occasionally with an oiled wiper, to prevent rust. Pivot blocks will be painted at the same time as the slides.

76. The first coat or patching will be laid on lightly in those places which have been laid bare in the repairs or by scraping,

The stopping will be done after the first coat of paint has become set, as in the case of wood carriages.

77. The second coat will be given after the stopping has been completed. It will be applied lightly and carefully finished off.

78. In hot climates the top surface of the shields of disappearing mountings will be painted white to keep the pit cool.

79. The time and working pay allowed for scraping, cleaning, and painting, and the quantity of paint required for painting and marking wrought-iron carriages and slides is laid down in Equipment Regulations.

Instructions for the Erection, Working, and Preservation of High Angle and Disappearing Mountings.

These are fully explained and described in the handbooks of each gun and mounting.

Instructions for Filling, &c., and Adjusting Hydraulic Buffers.

80. In all cases where guns are mounted on carriages and slides fitted for hydraulic buffers, the buffer will invariably be kept on the slide filled with the proper quantity of oil; and the piston-rod kept connected to the carriage; but in cases where guns are found to be especially hard to run back, and such guns as are likely to be much used at drill, the Officer Commanding Royal Artillery may order the piston rods of such guns to be disconnected, provided such instructions be given as will ensure proper precautions being taken to prevent the gun taking charge in running up. When works, however, are under repair, or persons other than the Artillerymen actually in charge have access to places where guns having hydraulic buffers are mounted, the Officer Commanding Royal Artillery will use his discretion in having the buffers temporarily emptied, but they must be refilled as soon as possible.

81. *To connect the buffer.*—Move the carriage to the rear sufficiently to enable a man to get at the bracket on the under side; remove the connecting nut from the piston rod, and draw the latter forward until its end projects through the hole in the bracket, keeping it central in the hole; screw on the connecting nut, and when quite tight take half a turn back to allow a slight play of the bracket between the two nuts.

Before connecting it to the carriage, the rod should be pushed in and out to see that it works freely, and that the packing gland is not too tight.

82. To fill the cylinder, run the carriage up to the stops, take out the screw plug, and rest the gallon measure in the hole; turn off the cock and fill the measure with mineral oil (or in cold climates with the service liquid described in para. 451A, Equipment Regulations) to the gallon mark, then turn the cock and allow the oil to flow into the cylinder; repeat the operation until the quantity required is run in. The quantity of oil used with 7-inch R.B.L., and 64-pr. R.M.L. (5 feet 6 inches parapet) iron slides, is 5 gallons, giving a depth at filling hole of 4 ins., with 7-in. R.B.L., and of 2⅜-ins. with 64-pr. R.M.L.; with the buffers of 7-inch 7-ton, 9-inch, 10-inch, 11-inch, and 12-inch 25-ton guns is 12 gallons, which, with the carriage run up, will give a depth at the filling hole of about 4⅝ inches of oil, except 9 in. and 10 in. R.M.L. on 7 foot parapet mountings; this depth may be easily tested by a slip of wood. On other buffers a brass plate is attached giving directions for filling. The oil is withdrawn by means of the front cock, air being let into the cylinder at the same time by the removal of the rear plug.

When firing reduced charges, a certain amount of oil is to be drawn from the buffers, *vide* R.A. R.O. 65 of 1893 and p. 16, Part II, Vol. II. Care should be taken to replace the oil at once, on the conclusion of the practice.

Before firing cordite charges the recoil valves of the recoil

cylinder or buffers must be set to suit the cordite charge, or the recoil control arrangements otherwise modified in accordance with regulations.

For the regulations for 6-inch Disappearing, *vide* L.C.W. 890

Rope Mantlets.

1. When rope mantlets have been fitted to shields, and have been found complete and in good working order, on the joint inspection of the Officer Commanding Royal Artillery and Commanding Royal Engineer, they will be taken on charge by the Officer Commanding Royal Artillery, who will be responsible that they are kept in a safe condition and at all times ready and fit for use; he will therefore make requisitions in the usual manner upon the Royal Engineer Department to carry out any repairs, and also for the necessary application of a solution of chloride of calcium. The above also applies in the case of the rope mantlet doors issued for use in powder magazines and cartridge stores to certain stations at home and abroad.

2. Rope mantlets, according to pattern required, will be provided and fitted for all guns actually mounted behind iron protection. In the case of open batteries, however, in which mantlets, when hung, would be fully exposed to the weather, and therefore liable to rapid deterioration, they will be kept in store in time of peace, and will be hung only when required for drill or practice, or for actual service in time of war.

3. For instructions for the care and preservation of rope mantlets, see paras. 661 to 669 Equipment Regulations.

Instructions for the Care and Preservation of Optical Instruments.

1. It is essential, when circumstances will permit, that optical

instruments should be kept in a warm, dry, clean store or box, or they will rapidly deteriorate. They should not be put away wet or damp, but be first carefully dried with a chamois leather. The lenses should be dried with a soft chamois leather or piece of silk, which must be carefully kept free of grit or dirt and must be used for no other purpose.

SECTION VII.—INSTRUCTIONS FOR THE MANAGEMENT AND PRESERVATION OF ELECTRIC FIRING APPARATUS.

2. *The Menotti test battery* consists of an outer vessel, which is of ebonite, at the bottom of which is a copper cup ½-in. deep and 3½-in. in diameter, containing 2 oz. of crystal of sulphate of copper, with a "fearnought" diaphragm on top. Above this is 3 inches of fine sawdust that has been moistened with clean fresh water and laid in loosely. On top of this layer of sawdust is another diaphragm and then a slab of zinc ½-inch thick, 3½-in. in diameter, and weighing 2 lb. The upper portion of the zinc and its connection with the insulated wire are carefully insulated.

As this cell is only used for testing purposes, a low resistance (about 20 ohms) astatic galvanometer is permanently attached to the ebonite disc which forms the core of the cell; together with a key which closes the circuit through the wires or tube under test. The whole is fitted into a leather case.

The batteries are supplied with the sulphate of copper, fearnought diaphragms and sawdust in place, but dry and consequently inactive. They are prepared for service by taking out the sawdust, soaking it in clean fresh water, or better still in a solution of sulphate of zinc, then squeezing it out to a certain extent and replacing it; the advantage of this method being that the cell will be ready for use at once. If the water were merely poured on to the sawdust some hours, or even days, will elapse before the cell is ready for use. If the sulphate of copper is spilt among the sawdust care should be taken to remove all

the spilt crystals or to use fresh sawdust, for if the sulphate of copper is allowed to come into contact with the zinc it will at once deposit copper on the latter.

3. *Test.*—After being rendered active the battery should be tested by joining a short wire between the positive pole of the battery and the free terminal of the galvanometer, then placing the instrument so that the needle points to zero and pressing the key, a deflection of between 80° and 85° should be shown. This is called "testing the battery on short circuit."

A magnet is supplied for the purpose of steadying the needle when there is motion or reducing the deflection when it is too great; when not required for use it is kept in a pocket in the strap of the leather containing case.

After the test battery has been in action six months the sawdust is to be changed and the copper cup recharged with sulphate of copper. Any copper sulphate crystals found can be used over again. At the same time the connections of the insulated wires with the zinc and the copper cup should be carefully examined and the incrustation cleaned from the zinc so as to leave a clean surface on the under side at any rate.

Should the battery show indications of loss of power, and these measures fail to restore it, a new battery must be rendered active.

4. *The *Battery and key, test and firing.*—This key and battery is designed to serve two purposes.

1. To test the tube and circuit when the gun is made ready to fire.

2. To fire the tube.

To enable this to be done an indicator is fitted within the firing key itself, which is so arranged that when the button is turned to the right the current passes through the indicator and

*When "battery and key test and firing" is issued, the Leclanché and Onotti batteries are not required.

the rest of the gun circuit, and if this is complete a visible and audible signal is given. If it is then required to fire, the button is pressed in, which action cuts the indicator out and allows the full current to flow through the circuit firing the tube.

Besides this the apparatus may be used in place of the Menotti cell and galvanometer for testing tubes, and firing wires.

The Leclanché cells, of which there are two in the battery box, are issued with the sal-ammoniac in them, and all that is required to make them ready for use is to fill the cells two-thirds full with water and to see that this is added from time to time to make up for evaporation.

When the battery fails to fire a tube, fresh sal-ammoniac (about 4-oz. to each cell) should be added; the old solution being thrown away.

The apparatus is suitable for firing any low tension fuze or tube through a short length of wire, about 50 yards of No. 16 copper wire (·065 inch diameter).

5. *Precautions to be observed.*—The turning of the knob should be done just before it is required to fire, and it may either be held turned or not as desired until the gun is fired by pressing it in. An arrow is cut on the handle of the key in such a position that when the arrow is up the handle is safe.

The following rules will detect the particular cause of failures to fire with electric tubes :—

1. If the indicator works properly, and yet when the knob is pressed in the tube does not fire, the fault is a short circuit between the firing leads or in the tube itself.
2. If the indicator works feebly only, some bad joint in the circuit will be the probable cause.
3. If it does not move at all, the circuit is broken at some point in the wires or in the tube itself.
4. If the indicator works when the knob is turned and the gun does not fire when it is pressed, and then when the knob

is turned again the indicator does not work, this shows that the tube has fired without igniting the charge.

To eliminate faulty tubes it is as well to test them before use out of the gun. This should be done under precaution, so that in case of a tube being accidentally fired no damage would ensue. The firing leads may also be tested, and the apparatus may be considered to be in good order, if on joining the terminals with a short bit of wire, and turning the knob, the indicator works well. If it should only work feebly the battery should be examined, as in this case it will not give sufficient current to fire with certainty.

The 3-cell Leclanché firing Battery may be found still in some places, and the preparation is almost identical with the Battery and Key, test and firing.

SECTION VIII.—INSTRUCTIONS FOR THE VENTILATION OF MAGAZINES.

1. The dryness of any building depends greatly upon its proper ventilation, and as gunpowder possesses in a high degree the property of absorbing moisture, great attention should be paid to the following rules :—

2. A common thermometer will be placed inside every magazine; it should be, if possible, so placed that a reading may be taken without opening the inner doors.

3. At every station where there are magazines, and in every Artillery Sub-District, there will be provided one or more sets of common and wet and dry bulb thermometers or hygrometers according to the extent and distribution of the magazines. Commanding Officers concerned should demand as many as may be necessary to meet the requirements of each district or station.

4. The wet and dry bulb thermometers will be permanently placed in the open air. They should be protected as far as possible from rain and wind, and not exposed to the direct rays of the sun.

5. Care must be taken to keep the wet bulb well supplied with water, and to see that its muslin covering and strands of wick are always wet.

6. The scale attached to the dry bulb will show the temperature of the external air, while that of the wet bulb will read more or less below the other accordingly as the air is dry or damp.

7. With a view to the magazines being open as long as possible on favourable days, the wet and dry bulb thermometers should be observed twice a day, morning and afternoon, and the reading

corded on Army Form G 944. A record will also be kept on rmy Form G 945 of the readings of the thermometer inside the agazine. Copies of these forms, attached to boards, will be ung up in each magazine and signed weekly by the officer in harge of the sub-district.

8. The actual times at which the wet and dry bulb thermo- eters are to be read, and the details of the arrangements for ening the various magazines, must depend more or less on local nditions. It will be necessary for the Officer Commanding issue his orders to meet the circumstances of the case.

9. Generally speaking, the conditions are favourable for ntilating a magazine when the temperature of the inside is igher than that of the outside air, but when the latter is very y, as may frequently be the case in summer in England, the agazine may be ventilated with advantage when its tempera- re is below that of the outside air.

10. Two tables (Army Forms G 880 and G 881) are provided the guidance of those in charge of magazines. Copies of ese tables will be attached to boards hung up in each maga- e. A detailed description of these tables and of the method applying them to determine when atmospheric conditions are vourable for ventilating a magazine will be found in "Regula- ns for Magazines, &c."

11. Great care must be taken that the magazine is securely sed as soon as the favourable conditions cease, or when that int is approached.

12. Subject to the conditions being favourable magazines uld be opened as often and for as long a time as possible, d every means should be adopted to secure a thorough culation of air, but care must be taken to provide for their ng immediately closed, in case a sudden change of temperature ders it necessary to do so.

13. It must be borne in mind that conditions favourable for tilation may not last long, especially when the temperature

inside the magazine is above that outside, as the former will soon fall when the doors are opened. Under these circumstances about five minutes should be long enough for ventilating a small magazine; but when the temperature inside is below that outside the magazine, and other conditions are not filled, there is no limit to the time during which ventilation may be continued, provided the outside conditions remain favourable.

14. The following are instructions for examining the condition in regard to moisture of the air in magazines:—

(*a.*) Place about 12 of the small crystals of nitrate of soda (provided for the purpose, and kept in a well-stoppered bottle) upon a piece of sheet glass, separating the crystals from each other, place this in the magazine upon any suitable support; and examine its condition after the lapse of 24 hours. If the crystals have become liquid at the expiration of that period, the magazine is in a decidedly damp condition. If they have not liquefied, but if a piece of dry blotting-paper when pressed upon them is stained, the magazine is somewhat damp. Before using the crystals of nitrate, place them upon blotting-paper; if they do not stain it they can be at once used, but should the paper be moistened by them, press them between folds of blotting-paper until they no longer produce a stain; they are now ready for use.

(*b.*) In entering the magazine for the purpose of placing the nitrate of soda, and afterwards examining it, the doors should be only so far opened as to admit the person, and quickly closed. It is best to take the bottle of nitrate of soda and the glass plate into the magazine, and to arrange the nitrate upon the plate when there.

CTION IX.—INSTRUCTIONS AS TO LIGHTING AND LAMPS.

1. On no account will any but the authorized lamps be used the purpose of lighting magazines, ammunition stores, laboraes, and their passages.

2. Such lamps will be lighted only when absolutely neces

3. A magazine copper lantern will be used for the inspection the ammunition stores and underground passages, and on no count will the passage lamps be used for the purpose.

4. One or more men, as may be required, will be specially tailed as "lampmen" for each work, to attend to all the lightg arrangements and stores connected therewith.

5. As all lamps, required for lighting magazines and carges stores can be placed in position without entering the lean" portions of the building, the lamp men will on no count pass beyond the barriers.

6. When it is impossible to clean the glass of the lamp ess from the passage, such glass will be cleaned by one of the gazine men from the inside. This may in some cases necesate unscrewing and removing the frame; if so, care must taken that it is properly replaced. This operation will be cted in the presence of the officer or other person in rge.

7. Chimneys should not be used with the lamps if the dles burn regularly without them, but only if from want of or too much draught, the candles show a tendency to smoke gutter, when the chimneys will be likely to improve the ning. No detailed instructions can be given regarding their which must be regulated by local circumstances.

8. Lamp barrows and trays are provided for the carriage of the lamps to and from the lamp room; care must be taken that they are always used, and that the lamps are not placed on the ground or floor, as the glasses are thus likely to be broken.

9. All lamps, when not in use, will be kept in the lamp room.

10. Copies of instructions on lighting, printed on Army Form G 877, can be obtained on demand and will be hung up in every lamp room. Should special instructions be required in any particular work or magazine, for the guidance of the lampmen in the management of any peculiar lamp recesses, they will be added in manuscript.

11. *Lamps on Gun Floors.*—The following lights are used on gun floors:—

Fighting lanterns or lamps.
Tracing lamps.

A *fighting lamp* is on the pattern of a small carriage lamp and has a clutch at the back to hang on to a loop, and burns a candle. Two of these are provided for every emplacement 7-inch R.M.L. and upwards, one for each side. They are intended to give light for the service of the gun at night. § 8381 introduces a new pattern of fighting lamp which consumes oil.

A *tracing lamp* is a small hand lantern attached to a loop in the wall, generally on the right side of the gun, and having a handle at the top so that it can be easily removed. It burns colza oil. Its special object is to be a movable light for general purposes at the gun, such as reading the training or elevating arcs, &c.

These lamps should always be in their proper position on the gun floor, trimmed and ready for lighting.

APPENDIX I.

AUTOMATIC SIGHTS.

The sketch shows a 12-pr. Q.F. sight, which may be taken as typical.

The sights for the various natures being the same in principle though differing in detail.

General Description.

The sights consist of the following parts :—

1. A sight bar A, carrying sights which can be illuminated, if necessary, at night, and a telescope for use at long ranges or indistinct objects. Deflection is given by the small hand wheels which traverse the sight bar horizontally about the pivot Z. No deflection need be given for drift, as the sight is set at a compensating angle.

2. A radius bar B, to which the sight bar A is pivoted at Z. It carries the deflection gear. B is pivoted at Y to a bracket D which is attached to the cradle of the mounting by eccentric bolts H H. Their eccentricity enables the final fine adjustment to be given to the sight on its first fitting to the mounting, and which should not afterwards be disturbed, future adjustments that may be found necessary being given by the eccentric screw Q, which is provided for the purpose. The bracket D carries also the gear by which the sight is moved when used as telescope and drum sight, and also the range drum R.

3. A bent lever E is also carried on the pivot Y. One end of E carries a roller, engaging a cam C attached to the carriage. The other end is forked to receive a latch F, worked by a lever G.

The latch F connects the lever E to the radius bar B, and when the latch engages the fork, the sight is controlled by the cam C, and works automatically. When the latch is disengaged the sight can be used as an ordinary tangent sight.

4. A spring P, in compression, keeps the roller at the end of the lever E in contact with the driving surface of the cam C.

5. One of the studs fixing the cam C to the carriage is eccentric, and can be turned by the lever K to give the correction necessary for height of tide, the proper position of the lever K for different heights of tide being shown on the arc V. When the rise and fall of tide is very small compared to the height of the battery, the lever K is omitted, but the eccentric stud is retained as a means of adjusting the cam.

6. A screw S, which will be found in the sketch above the latch F, is provided to give the correction for the error of the day. Its head is graduated in yards short and yards over. By its means the relative positions of the radius bar B and the lever E can be altered to the extent necessary to compensate for any error observed in the shooting.

7. For use at night, both the fore and tangent sights can be illuminated, the foresight presenting a point of light at the top of the acorn, and the tangent sight a luminous V. To effect this incandescent electric lamps are carried in the sight blocks. The current should be turned off when not required, so as not to exhaust the battery.

The Principle of the Sight.

The sight combines a depression range finder with a bar and drum sight. Suppose the elevating gear be worked so that t

adius bar B is depressed from a horizontal position until the hts bear upon the water-line of an object, the drum R will be rned by the rack T, which is attached to the radius bar B, to an tent depending upon the angle of depression, which in its turn epends on the range. If then the drum R be correctly graduated, we have a complete range finder.

It now remains to secure that the elevation corresponding to range be given to the gun.

This is effected by connecting the radius bar B by means of latch F to the lever E, whose other end works in the cam C the carriage. The sight can then be moved only by raising lowering the breech of the gun, and the cam C is so shaped at the angle between the axis of the gun and the line of sight always equal to the proper angle of elevation for the range. om this it will be seen that the cam must be cut to suit the ight of the gun above the sea, and each cam will thus be special the site for which it is made.

Method of Use.

As an automatic sight :—

The sight being in adjustment, and the latch F engaged in the k of the lever E, set the tide lever K to the proper height of , and the error of the day screw S to zero. Give the imated deflection. Align the sights on the water-line of the ect by working the elevating and traversing gear of the gun. o correct errors in shooting, turn the error of the day screw o the graduation corresponding to the number of yards short over observed, and make the usual correction for direction on deflection scale.

As a bar and drum sight :—

he sights are only suitable for automatic use when firing at water-line of objects. Should it be desired to utilize the

automatic sight as a range finder, to fire at the upper works tops of a ship, the water-line should first be laid on (and if it the first round of the day's practice, ranged on as in 1). latch F should then be thrown out of gear by the lever G, and the sights aligned on the desired point by working the elevating and if necessary the traversing gear of the gun. If the ship be moving it will be necessary to throw the latch F in again from time to time, and to lay on the water-line again n order to re-set the sights to the altered range.

It will be seen from what has been said about the principle of the sight, that its accuracy as a range finder falls off rapidly at long ranges, especially if the site of the battery be low, as in that case the angle of depression on which the action of the sight depends varies but slightly with the range at long ranges.

For these longer ranges the latch F should be thrown out of its fork by the lever G, which at the same time throws into gear the hand wheel J, which works the rack T and range drum R. By means of this hand wheel J, the range drum R may be set to any required range as given by P.F. or D.R.F., and the gun can then be laid as with ordinary tangent sights.

Adjustments.

In the first place the mounting must traverse truly in a horizontal plane. This may be tested by placing a large clinometer on the gun and traversing the mounting round. The bubble should not move.

Means will be provided for correcting the level of mountings fitted with automatic sights. The mounting being levelled, the following tests may be applied :—

1. Mechanical test :—

Turn the error of the day screw S and the tide lever K to zero, and throw the latch F into its fork. Place a large

clinometer on the gun, and lay it at the prescribed angle. Then place the clinometer on the upper surface of the radius bar B, and over the portion where the directions are inscribed, and see that its reading is the corresponding angle. The angles referred to will be found engraved on the upper surface of the radius bar B. If the reading is not correct, slack the clamping nut and turn the eccentric Q until the correct reading is obtained. None of the other eccentric studs should be used for this purpose.

Finally, see that the range shown on the range drum of the sight (when set as above) is the prescribed range laid down by the directions inscribed on the upper surface of the radius bar. If not, slack the set screws on the outer circumference of the range drum and turn the scale till it reads the prescribed range.

(2) Optical test :—

The telescope being focussed on a distant point, should be rotated in its supports. If this shifts the intersection of the cross wires or pointer from the object, the usual collimation adjustment should be applied. *Vide* Handbook for D.R.F.

The ordinary sights on the bar may be compared with the telescope by laying on a distant object, and should be in agreement. As it is possible that individual layers may vary, thus introducing a personal error between gun sights and telescope, vertical adjustment is given to the foresight to enable sights and telescope to be adjusted to each other to suit the gun layer.

As manufactured, the gun sights and telescope are in adjustment with the foresight screwed down home, and this should be regarded as the normal position of the foresight, correction being made only to suit the individual gun layer should time permit of the gun being carefully laid on to a distant target.

If such correction has been made, and the layer should be disabled, the foresight should preferably be screwed home failing time to make a test.

Care and Preservation.

When not in use, the sight bar A with all its fittings attached should be removed and placed in a dry store. Its removal can be effected by slackening a screw which will be found under the pivot Z, and disconnecting the leads for the night sights.

As the efficiency of the sight depends upon the accuracy of the cam C, special care should be taken that this suffers no damage. It should ~~on no account~~ be polished, and should be kept free from grit.

All parts should be kept lightly smeared with ~~anti-corrosive grease~~ when not in use, ~~but care should be taken that the holes at the tip of the foresight and the glass V of the hind sight are kept clear, and do not become~~ plugged with grease or dirt.

The lamp holders and lamps must be kept clean and clear of grease, as also the holes into which they fit. There must be electric contact between lamp holders and sight bar, and if this is dirty the lamps will not burn well.

In throwing the latch F into gear, care should be taken that it is opposite the jaws in the bar E, in order to avoid injury to the parts.

Instructions regarding Laying.

An automatic sight is one which, being properly adjusted and connected with the gun (or cradle) and mounting, is dependent in such a way on the movement of the gun that by elevating and traversing the latter till the sights are aligned on any spot on the sea level, the gun is necessarily so laid that its projectile should strike that spot.

The principle is dependent on the solution of the triangle formed by the sea level as the base, the height of the gun above sea level as the perpendicular, and the line from sights to water line of target as the third side.

The angle of depression of the line of sight varies with (and in fact indicates) the range of the target. The angle of quadrant elevation of the gun also varies with the range, therefore the quadrant elevation of the gun varies with the angle of depression of the line of sight, and the amount of elevation given to the gun can be made automatically dependent on the amount of depression given to the sights.

It follows that the sight can be used as a range-finder, and this, with combined automatic and tangent sights, may be useful if it is desired to fire at ships' tops, &c. The gun must be first laid automatically at the water line of the ship. This will indicate the range to the ship on the drum of the sights, and will set them at the proper angle of elevation. The automatic gear being then disconnected, the gun can be laid on the top in the ordinary way, the sights retaining the elevation which has been automatically given to them.

The pattern of automatic sight adopted for the 12-pr. Q.F. gun requires a height of not less than 20 feet. With a height of 25 feet it is accurate up to 1,200 yards, and with greater heights to longer ranges.

The sights, so far as the mechanism is concerned, can be made perfectly accurate, and this accuracy is capable of being tested without firing, but the results obtainable do not depend only on the accuracy of the sight; they are limited by what can reasonably be expected from a layer.

Inaccuracy on the part of a layer is of much more importance in the case of an automatic sight than in that of a tangent sight laid *at a known range*. For example, with a 12-pr. Q.F. gun, mounted 25 feet above the sea, an error of one minute in the adjustment of the automatic sight bar would cause an error of range of only 25 yards at 800 yards, but the effect of the same error would be 52 yards at 1,200 yards range, and 200 yards at 4,000 yards range, while a corresponding error in the setting of the tangent bar would be about 20 yards in all three cases.

The reason for this is that, in the latter case, the a
motion of the line of sight is precisely the same as that
axis of the gun, while in automatic laying any variation
angle of depression of the sights (or range finding angle) ne
tates a greater variation (the amount of increase dependin
the range) in the quadrant elevation of the gun, so that ex
in the case of short ranges, or very lofty sites, the axis of
gun moves through a far greater angle than the line of si
For example, under the conditions above quoted (12-pr. Q.F.
at a height of 25 feet), it is found that an error of one minu
either in the sight or made by the gun layer, at a range of 2
yards, causes an error of 22 minutes in the elevation of the

PART II.

Coast Defence.

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PART II.—COAST DEFENCE.

SECTION I.—DEFINITIONS.

Coast Defences.—The means provided to prevent damage to material or occupation of territory by an enemy's maritime forces.

These means comprise the artillery armament, the works in which it is placed, submarine mines, the Brennan torpedo, obstructions by sea, and electric lights.

The artillery armament is divided into *fixed armament* and *armament for general defence.*

Fixed Armament.—That which is mounted in fixed positions in forts or batteries.

The fixed armament is divided into *primary armament* and *secondary armament.*

Primary armament includes R.M.L. guns of 9 inches and upwards, B.L. guns of 6 inches and upwards, and 4·7-inch and 6-inch Q.F. guns.

Secondary armament includes guns of lower calibre than the above.

Armament for general defence consists of those guns, howitzers, quick-firing guns, and machine guns which are so mounted as to be capable of being moved and brought into action in various positions. Of this armament such portion as can be readily moved and carry its supply of ammunition in limbers and wagons is termed the *light armament for general defence.*

Submarine Mine.—A charge of explosive moored below the surface of the water, and designed to be fired when in contact with or approached by a hostile vessel.

Minefield.—An area of water provided or intended to be provided in war with submarine mines.

Brennan Torpedo.—A metal case containing a charge of explosive capable of being moved below the water under control from the shore, and designed to fire on striking a hostile vessel.

Obstruction by Sea.—Impediments to navigation, either permanent, such as breakwaters, or temporary, such as booms.

Electric Light.—The beam illuminating any portion of the defended area, together with the material and appliances for creating it.

Electric lights may be either *fixed beams* or *search lights.*

Fixed Beams.—Electric lights intended to bear always over the same area.

Search Lights.—Electric lights intended to be traversed so as to illuminate different areas.

Electric lights may occasionally be adapted for use either as fixed beams or search lights.

Electric Light Area.—The area of land or water effectively illuminated by an electric light.

Coast Fortress.—An area of land and sea provided at certain important points, or along tactically selected lines, with works of defence, and with an artillery armament, partly fixed, partly movable.

Fortress Commander.—The officer in chief command of a coast fortress.

Section.—A sub-division of a coast fortress for purposes of organisation and fighting.

Section Commander.—The officer in command of a section of a coast fortress.

The above definitions refer to coast defence generally, the following to the artillery part of it only.

Section I.—Definitions.

Fire Command.—A sub-division of a fortress section purposes of organisation and fighting, under the command a *fire commander.*

Fire Commander (*F.C.*).—The officer entrusted with *fire contro* and in command of a fire command of a fortress.

Battery Command.—A sub-division of a fire command con sisting of such a number of gun groups, together with the range finding or position finding installations, and all men and stores necessary for fighting them, as may be efficiently commanded by one man.

Battery Commander (*B.C.*).—The officer in command of a battery command, and entrusted with its fire direction and fire discipline.

Battery Sub-Commander (*B.S.C.*).—An officer occasionally appointed to represent the battery commander at the group and performing such duties as the battery commander may depute to him.

Gun Group.—A group of adjacent guns of the same nature placed under the command of an officer or N.C.O.

Gun Group Commander (*G.G.C.*).—An officer or N.C.O. in command of a gun group, and responsible under the battery commander for its fire discipline.

Gun Captain (*G.C.*).—The N.C.O. commanding a single gun, complete with its detachment and stores.

Range Group.—A group of position finding instruments together with their operators, intended to be supervised by one man.

Range Group Commander (*R.G.C.*).—The officer or N.C.O. entrusted with the supervision of a range group.

Ammunition Detail.—The officer, N.C.O.'s, and men employed in the supply of ammunition for a battery command or battery commands.

Ammunition Officer (*A.O.*).—The officer or N.C.O. commanding an ammunition detail.

Tactical Unit.—A specific detail of personnel with the material to be used by it in action, definitely organized for fighting. A gun group, irrespective of the number of guns, is the smallest tactical unit.

Manning Detail.—This term referring to any unit, means the personnel belonging to it.

Manning Parade.—The place appointed for the assembly of the details of a battery commander's command.

Manning Table.—A printed form, A.F.A. 2008, on which to enter particulars of manning details.

Fire Area.—The extent of water, or land and water, covered effectively by the fire of any specified unit.

Target.—The object at which a gun or guns are aimed or fired, or intended to be aimed or to be fired.

Displacement.—The distance from the centre of a group to the range finding or position finding instrument working for that group.

Group Difference.—The difference measured in yards between the range to a target at any given moment from the centre of a gun group, and that from the range instrument.

Command Post.—The building, cell, or position selected to be occupied by the commander of any unit during action.

Depression Range Finding Station (D.R.F. Station).—A place appointed and prepared for working a D.R.F. instrument in action.

Fire Control.—The general conduct of any system of artillery defence by the officer in superior command, both previous to and during action.

Fire Direction.—The conduct during action of the artillery fire in accordance with the orders given previously or at the time by the officer holding fire control.

SECTION II.—CONDITIONS AFFECTING ATTACK AND DEFENCE.

The functions of coast defences in war are mainly dependent on the naval strength in relation to its adversaries of the power to which they belong. Since the maintenance of sea supremacy has been authoritatively adopted in our case as the basis of the system of Imperial defence against attack from the sea, the circumstances attending the use of coast defences in the British Empire are peculiar to it, and cannot be judged entirely from the standpoint of other nations.

But as command of the sea, to be effectively established, must first be fought for by our Navy, except in the case of an enemy of clearly acknowledged inferiority by sea, there will probably be times at, and just previous to the commencement of hostilities, when the command will be "doubtful," that is neither side will acknowledge inferiority, but neither will be in a position of "assured" command. It may even happen that in particular regions or for short times our fleet will be locally or temporarily in a state of inferiority. And after engagements have been fought there may still occur periods when neither side will be in a position to assert a decided superiority. Ultimately one side or the other will establish command, and it is on the assumption that our Navy will be strong enough to effect this, that the whole scale and organisation of our coast defence is based. In order that command may be "assured," the fleet holding it must be able to keep the enemy's fleet shut up by blockade in his own ports, and this will be the aim of our ships. It is impossible, however, to prevent with certainty small expeditions or single vessels, especially torpedo boats or torpedo

boat destroyers, from occasionally breaking through the blockade.

Our coast defences are designed to meet all the above contingencies, and it is necessary to bear them in mind in order to appreciate the equipment, organisation, and training best suited to make coast defence effective.

Subsection I.

The Attack.—The attacks which coast defences may be called upon to resist are divisible into the following four classes :—

(*a.*) Deliberate attack.
(*b.*) Bombardment.
(*c.*) Forcing a passage.
(*d.*) Raid.

(*a.*) Deliberate attack is such attack as has for its ultimate object the reduction of the fortress. In the great majority of cases the object could only be gained by the action of military forces landed outside the sphere of the coast defences and covered by a fleet. If land attack is undertaken in conjunction with naval attack, the range of attack from the enemy's base is diminished by difficulties of transport and supply. As assured command of the sea is a necessity for the naval attack, whether in concert with land attack or apart from it, such an operation could not be undertaken until some considerable time after the commencement of hostilities. Taking into account all the disabilities under which ships labour when engaged with fortifications, it is evident that unless the latter are very weak and disorganised, a strong fleet heavily armed, and perhaps including vessels specially constructed for bombardment, is a necessity to the assailant. The tactics employed by the attackers would probably include some of the offensive measures referred to under the remaining headings.

(*b.*) Bombardment may be either persistent, that is carried on with the intention of persisting in it till the desired effect is

obtained, or desultory, that is, undertaken in the hope of doing in a short time some damage to the port or shipping guarded by the defences, or producing moral effect which may cause inconvenience or injury to the defenders. Persistent bombardment, where defences are moderately well placed and equipped would entail a strong force and a large expenditure of ammunition, and require considerable time. It could therefore only occur under the conditions that admit of, and with the objects that call for deliberate attack, of which it might form a part.

Desultory bombardment by single ships, or very small squadrons, is perhaps just possible in any state of sea power, but the advantages to be gained, unless defences are very inefficient, appear so doubtful that its use is improbable. Comparatively few rounds are carried by ships for their heavier guns.

(*c.*) Forcing a passage. That is an attempt to run past within range of defended points with a view to operations in interior waters not commanded by coast defences. This is possible in any state of sea power, except where the defenders hold assured command, but where open waters do not exist inside the defences, could only be attempted under the same conditions as are required for deliberate attack. Interior waters of any extent are of very infrequent occurrence in the British Empire.

Where the attack is made (if vessels of any size are to pass, and unless the channel is exceptionally easy) it will be by day, possibly immediately after a night reconnaissance by small craft, which, if the passage is mined or obstructed, may be sent in to clear it. This latter operation will partake of the character of raid. The ships will steam past at their highest speed, and endeavour to avoid all conflict with the defences, probably only using their guns, if at all, to pour in as rapid a fire as possible in the hope of causing losses to personnel which may impede the service of the shore guns.

(*d.*) Raid, that is a sudden attempt to penetrate the defences,

ith a view to the destruction of shipping in the harbour or der construction, docks, coal, or stores.

Torpedo boats, and torpedo boat destroyers, are the most itable craft for such an undertaking. They are very speedy, nd can therefore reach their objective in a very short time fter leaving the base, and more easily elude detection and ttack both on the voyage and after reaching their destination. By reason of their light draught they are not confined to the linary channels on approaching a port, and their small size nd low freeboard further aid them in eluding observation, and ake them a difficult target. The damage they are capable of flicting is out of all proportion to the inconvenience which the s of even several of them might occasion, and on this account ey will not be deterred by difficulties of navigation. Night, thick weather, or both, offer the best facilities for the attack, uring which every endeavour will be made to escape detection. urprise and dash are the essence of such an attack. Feint tacks will perhaps be made with a view to wearing out the gilance of the defence. The strength of the attacking flotilla ll probably vary according to the importance of the object to gained; in some cases it may be expected to reach three visions or eighteen boats. It is improbable that any definite rmation will be adopted in attack when once the boats come der fire.

Not only can this form of attack be adopted in any state of power, but as it requires little or no preparation on the part the assailant, it is to be expected at ports within range of the emy's bases not later than immediately after the outbreak of stilities, and perhaps even before they have formally com-nced. Prompt action of this kind offers the best chance of ccess, since the defender is less likely to have completed all se arrangements for resisting attack, such as the placing of tructions, which cannot be finally effected in time of peace.

Torpedo boat depôts have been established on foreign coasts

within striking distance of several of our home ports. The nearer a port to the enemy's bases, the more liable it is to form of attack. But no ports however distant are safe from for if out of range of sea-going boats, they are still liable attack by smaller types carried by battleships and cruisers.

It is possible that Raid might take the form of landing small parties with a view to destruction on shore, but if this is done outside the range of the sea defences, it must be met by the military precautions usual on land, while if landing takes place inside this area, opposition to it would assume precisely the same form as that to torpedo boat attack. There is no probability that large vessels will ever be used for purposes of raid where the defence is not utterly disorganised, with these exceptions:—

(i.) Where the attacker has reason to believe that the channel is obstructed to such an extent that the boats will have physical difficulties in effecting an entrance, it is possible that under favourable circumstances an old or specially constructed vessel of larger size may be sent in with them for the purpose of making a breach in the obstructions.

(ii.) The use of gunboats as a convoy to raiding torpedo boats at night is contemplated abroad. The gunboats would however remain outside the lighted area and probably direct their fire on the projectors of the lights in the hope of disabling them, or of drawing the fire of the guns intended to act against the torpedo boats.

In the event of countermining or the clearance of obstructions being attempted with a view to an attack of the nature of (*a*) or (*c*), such operations would be very similar in character to raid. Countermining attack would take place by night, and would be made by fast launches carrying charges of explosive to be dropped at intervals along the channel it is desired to clear, and afterwards fired simultaneously from each launch by electricity. Other methods of rendering mines inactive, such as "creeping" or "sweeping" are too slow to be adopted under fire.

Subsection II.—*The Defence.*

Of the means of defence comprised under the term "coast defences" as defined in Section I., the artillery armament and the works in which it is placed alone are under artillery control. Of the other means, submarine mines, Brennan torpedo, permanent obstructions, and electric light, are controlled by the Royal Engineers, temporary obstructions by the Royal Navy.

The guns forming the artillery armament are divisible for tactical purposes into three classes, each having a more or less distinct application, and method of fire control and direction, viz.:—

(*a.*) Direct fire guns.
(*b.*) High-angle fire guns.
(*c.*) Quick-firing guns.

(*a.*) The direct fire guns of the heavier natures are intended to encounter ships armoured or unarmoured, anchored or under way, at all ranges within their effective area. The construction of their mountings and sights, and their systems of loading and laying do not however enable them to fire with much effect at very quick targets, or by night. Their use is therefore practically confined to action against vessels larger than torpedo boat destroyers, except that where narrow channels exist, and a sufficient number of quick-firing guns is not available, a proportion of them may be furnished with special case shot for use against torpedo boats and torpedo boat destroyers.

The lighter natures belonging to the armament for general defence, including machine guns on parapet or field carriages, are chiefly applicable to the defence of land fronts or the resistance of attempts at landing, but might also be used as auxiliary to the primary armament.

(*b.*) High-angle fire guns are intended for preventing, by deck attack, bombardment from ranges at which the ships' side armour is beyond the penetration of the direct fire guns. They are designed to deal with vessels at anchor, or moving slowly.

(c.) The heavier quick-firing guns are chiefly intended for the attack of the unarmoured or lightly armoured parts of ships. Quick-firing guns of the lighter natures are provided primarily for dealing with very quick unarmoured targets, such as torpedo boats and destroyers, or countermining craft, but their fire against the unarmoured parts of ships at short or medium ranges is likely to prove very effective. A proportion of machine guns on cone mountings is sometimes mounted with the lighter Q.F. guns for use under the same conditions.

The works, in which the artillery armament is placed, are designed to give cover for the guns, their detachments, ammunition supply, range finding emplacements, communications, &c., and sometimes accommodation for troops.

Submarine mines are intended to deny certain waters to an enemy's ships, or to close channels against them. Those in the service are of two descriptions, viz., "Electro-Contact" and "Electro Observation." The former may be so arranged that when struck by a ship they give a signal on shore, and can then be fired electrically by an operator, or they may be arranged to fire automatically when struck. The latter are fired electrically by an observer on shore, who is provided with a means of determining when a vessel is within effective distance of one of them. The charges which submarine mines contain vary, as also does the depth at which they are moored below the surface. Submarine mines are of little use against torpedo boats, owing to the depths at which they are generally moored, and to the spaces between them, which are large compared to the beam of such small craft. The Navy use "boat mines" to aid their personal protection against torpedo boats; these however do not enter into the general scheme of Coast defences at present, though the adoption of a similar mine for the above purpose by the Royal Engineers has been under consideration. They contain comparatively small charges, are moored at or near the surface, fairly close together, and connected by cables, which

en stretched by a boat trying to run through, fire the mines chanically.

The Brennan torpedo is intended for the defence of narrow annels. Very few installations exist, and these are not likely be added to at present.

Obstructions by sea are chiefly applicable to torpedo boat tack, but breakwaters are of course efficient against the largest sels. Booms are generally composed of steel hawsers or of mbination of baulks and hawsers stretched across narrow annels, they are secured on either shore to anchorages, and metimes receive intermediate support from piles or moored lks. They are useless against ships, and have often been mounted by even torpedo boats. Unless defended by gun , boats can demolish them at their leisure.

Electric lights are provided to illuminate channels with a view the detection and destruction of raiding craft, and to light mine fields and their approaches, so as to admit of attempts render the mines inactive being prevented by gun fire.

Subsection III.—*Summary.*

The general considerations which have been put forward in is section are combined and summarised in the attached table.

Section II.—Conditions affecting Attack and Defence.

Nature of Attack.	Probable Object.	State of Sea Power.	Class of Vessels likely to be used.
(a) Deliberate Attack.	Reduction of the fortress with a view to invasion.	Assured command necessary to the attacker.	All existing classes. Perhaps specially constructed vessels.
(b) Bombardment.	Destruction, or to produce moral effect.	Barely possible in any state.	Battleships, cruisers, and gunboats.
(c) Forcing a Passage.	To operate in interior waters.	Possible in any state except when defender holds assured command.	Any vessels, but probably fast ones.
(d) Raid.	Damage to shipping, docks, and stores.	Probable in any state, particularly when doubtful.	Torpedo boats and torpedo boat destroyers, perhaps accompanied by a larger vessel for breaking through obstructions.

"Means of Defence" placed in brackets

Section II.—Conditions affecting Attack and Defence.

Probable Time.	Means of Defence applicable.	General Remarks
Day, but may be continued by night.	All guns which can bear (mines, Brennan torpedo, and obstructions).	Includes persistent bombardment. "Means of Defence" refers to naval attack only. Purely naval attack unlikely except against very inefficient defences. If in conjunction with land attack objective must be fairly close to enemy's base. Cannot occur at beginning of hostilities.
Day or night ...	High-angle fire guns, heavy direct fire guns.	Refers to desultory bombardment only. An unlikely form of attack by our adversaries.
Day	Direct fire and Q.F. guns (mines, Brennan torpedo, and obstructions).	Applicable to very few of our coast defences.
Night. In thick weather by day or night.	Quick-firing guns, machine guns, and heavy guns firing special case (obstructions and perhaps boat mines).	Applicable to all defended ports in proportion to their importance and nearness to enemy's bases. May occur before, almost certain immediately after, declaration of war, where convenient bases exist.

are not under artillery control.

SECTION III.—ORGANISATION FOR DEFENCE.

The complete scheme of defence for a coast fortress is prepa in peace time under the direction of the G.O.C. the Distri acting in concert with the Naval authorities. The detail scheme for the artillery defence is a matter for the person supervision and arrangement of the C.R.A., subject to th G.O.C.'s approval. For this purpose he must be acquainted wit those intentions and provisions of the general scheme whic have a bearing on the artillery defence.

With regard to the intentions of the general scheme, it most important in the first place to realise the strategical and tactical conditions which are peculiar to the fortress in question and which affect the probabilities of attack, and the strength and nature of it, and consequently determine the dispositions for defence which are likely to be most suitable.

With regard to the provisions of the general scheme, the positions and uses of obstructions, electric lights, mine fields, &c., if already settled, must be known to the C.R.A.; but it is much better for the sake of mutual support that such measures should be arranged concurrently with the artillery details by agreement between the officers responsible for them, subject to the sanction of the G.O.C.

Such extracts from the scheme of artillery defence as affect particular officers—F.C.s, B.C.s, &c.—together with information as to the extent and manner in which they are required to co-operate with the measures of defence not under artillery control, will be embodied in the form of handy manuals called "Fighting Books," and distributed to the officers concerned. They will be strictly confidential, be numbered and registered, given into the personal charge of the officers, and returned by them on leaving the command.

The intention of this Section is to lay down such general principles for artillery organisation, fire control, and fire direc-

ion as may serve as a guide for the preparation locally during eace time of a detailed scheme for the artillery defence of a coast fortress. It is impossible to lay down hard and fast rules which will include and be applicable to all cases. The spirit of these instructions must however be followed unless very good reasons exist locally to the contrary.

SUBSECTION I.—*The chain of Command and delimitation of units.*

Every fortress will be under the command of a Fortress ommander, and divided into Sections, each under a Section ommander, who will be responsible generally for his Section the defence. A section will include the portion of the arrison allotted for its defence, and the Fire Commands within s area. Its boundaries must be so traced as to include entire ire Commands. The Fortress Commander and Section Com- ander may be officers of any arm of the service.

Each section will, for artillery purposes, be divided into Fire mmands, of which the size will be governed by the character the land and water areas to be defended, and by the number forts and batteries which it may be possible for one officer to rect in action.

The guns of a fire command must never be partly in one ction and partly in another. All personnel and matériel will llow the guns; *i.e.*, where officers, men, or instruments are ated in action in a different Fire Command from their guns, ey will still belong to the Fire Command in which their guns e included.

The Fire Command will be the highest unit of executive illery command, and will be under an Artillery Officer styled ire Commander, who will be subject to the immediate orders and in communication with, the Section Commander.

The G.O.C., R.A., or officer commanding R.A., will be employed the staff of the Fortress Commander. In some few cases the

paucity of officers may render it necessary for the O.C.R.A. act as a Section or Fire Commander, but such cases must exceptional and exceptionally treated.

The general chain of command and the communications w run from the Fortress Commander through Section Commande to Fire Commanders, with which latter officers the chain artillery command will commence. The chain of artillery com mand will run from the Fire Commander through the Batter Commanders to the Gun Group Commanders.

The following are exceptional cases of command, and should be dealt with as directed below :—

High-angle batteries.—The water covered by a high-ang battery or batteries will be divided into areas, each of which will have a position-finding cell, and instrument under a Fire commander. The senior officer in a battery will be termed Battery Commander.

The cell (or cells, if there is more than one water area) will be connected by telephone with the Fortress Commander (or Section Commander, as may be necessary), and also with the high-angle battery or batteries firing over the water area in question.

The Fortress Commander (or Section Commander) will control the fire of the high-angle battery, or batteries, to the extent of deciding on the water area over which fire is to be directed; the actual target will invariably be selectedby the Fire Commander.

When high-angle batteries are employed for firing over a land area, the fire will be conducted as laid down in siege artillery drill.

Quick-firing guns.—In action 12-prs. and under will not be included in any chain of command, but will open fire on the sole initiative of the Gun Group Commander.

For purposes of intelligence, groups of quick-firing guns will be connected by telephone with the post of the Fire Commander in whose command they may be situated, unless information can be more readily given from some other post, such as a sig

alling station, Fortress Commander's post, or Section Commander's post. It is to be distinctly understood that no attempt is to be made to use this line of communication for the purpose of controlling the fire in action. The fire control of quick-firing guns is never, in action, to be taken out of the hands of the executive officer on the spot, who alone is responsible for opening fire and selecting targets.

Electric lights.—Artillery fire at night will be assisted by ed beams only. Search lights may sometimes be employed r the purpose of discovering the movements of an enemy's ips; but only under very exceptional circumstances for llowing and fighting them by artillery fire.

The electric lights are under the Section Commander, through e officer in charge of submarine mining defences.

[The above instructions as to the general chain of command in ortress, and its connection with the artillery chain of com- nd, are from a circular of the Adjutant General $\frac{\text{Genl. No. 5}}{342}$ September, 1898.]

The extent of a battery command will be decided by local nditions in each particular case, and should not exceed that ich can be efficiently commanded by one officer. It will be essary to consider the positions of the groups forming the ttery command, and of the means of range finding provided; system of ammunition supply, facilities for internal com- nication, and the area over which the guns bear. The groups ming a battery command must, as far as possible, bear over same area, so as to admit of efficient fire direction by the tery Commander.

nder the Battery Commander will be the Gun Group Com-

manders, the Range Group Commander (if the appointmen
one is considered necessary locally), and Ammunition Offi
These may be officers or selected N.C.O.'s, as available local
Where D.R.F. is used the D.R.F. operators are also direc
under the B.C.

In the case of Q.F. guns, 12-pr. and under, each G.G.C. w
be immediately responsible to the Fire Commander in who
command his guns are situated, but in action will have entire
independent command as stated above.

The division of guns into groups will be governed by t
following principles :—The group of whatever size should be
complete unit, composed of guns of the same nature, similarl
mounted. at the same height above sea level, and commandi
the same water. The distance of the several guns from
range finding instruments should differ as little as possib
Their position should admit of salvo fire at all trainings. The
frontage should be limited to the extent which allows o
thorough command by the G.G.C., and the possibility of th
accurate ranging of salvoes. The source of ammunition suppl
should not be common with that of any other group. A grou
should never consist of one gun when it is possible to avoi
such an arrangement.

In many works great difficulty will be experienced in following
the above principles, and it will be necessary to make the bes
arrangement that circumstances permit.

Each gun group will be distinguished by a letter, and each
gun by its number in the group. Groups will be lettered from
right to left of a work, and guns numbered from right to left o
a group.

The following letters only will be used in lettering groups
and will be assigned to groups from right to left in the followin
sequence :—A. B. F. H. I. L. M. O. Q. R. S. W. X. Z.

In the event of the existence in one work of more tha
fourteen groups, the first and eighth, second and ninth letter

nd so on, will be respectively combined as a group designation, hus, "A O group," "B Q group," &c.

The letter and gun number will be painted on the breech of each gun in white on a black ground, or black in a white ground, and also upon the expense stores, &c., which supply the group, thus $\frac{A}{1}$, $\frac{BQ}{3}$.

The appointment of Range Group Commanders will only be ecessary where there are a large number of P.F. instruments. hese will then be divided into range groups in such a way as o admit of their being efficiently supervised by the Range Group ommander, who may have to be mounted if instruments in a roup are widely separated. If possible all the instruments in a ange group should serve only one battery command, and all the nstruments of a battery command should belong to the same ange group. This, where it can be done, will obviate the neces- ity for a R.G.C. being responsible to more than one B.C., or r a B.C. having to communicate with more than one R.G.C.

The ammunition details should, if possible, be distinct and mplete for the service of each battery command, so that each mmunition officer should be responsible to only one B.C., and ch B.C. have to communicate with only one A.O.

Under the G.G C.'s are the Gun Captains.

Under the R.G.C. are the P.F. operators.

When a Battery Commander's unit is, owing to special cir- mstances, of such a character that it cannot be allotted to any e commander, the Battery Commander must be prepared to scharge the duties of Fire Commander in addition to his own, d will be in direct communication with the Section Com- ander.

In some casemated works it may be necessary to appoint Battery Sub-Commander, whose duties will be determined ally.

When gun groups are so far detached that they cannot be

conveniently included in any Battery Commander's unit, Group Commanders must be prepared to execute the duties Battery Commander, and will be in direct communication w the Fire Commander.

There is however an intermediate case when it might be co venient for a B.C. to depute the fighting of a certain group his command to the G.G.C., keeping at the same time a gener supervision. In this case, if the command is being fought b D.R.F. a second instrument would be required.

Similarly, the Gun Captain must be prepared to perform the duties of Gun Group Commander.

The guns forming the fixed armament should be so mounted as to admit of concentration of fire upon the most important portions of the areas which they are intended to defend, and also, if possible, to afford mutual protection.

High angle fire guns are mounted in batteries sometimes containing several groups. They are best placed in advance of the localities they are intended to defend from bombardment, so that hostile ships will not be able to attack these at even extreme ranges without coming well within the fire area of the guns. They should command anchorages and roadsteads from which bombardment can be most easily carried out, and should be concealed as far as possible from view from the sea.

It will be of advantage if quick-firing guns of the heavier natures (6-inch and 4·7-inch), in addition to conforming to the general rules of siting for the fixed armament, can be so placed as to command at least a part of the more narrow waters, where illuminated, with a view to their aid in dealing with raiding attacks by night should a larger vessel than torpedo boats or destroyers be employed by the enemy.

The main duty of the lighter quick-firing guns, viz., dealing with raiding attacks by night, demands for them a site which will compel the attacking boats to come under their fire at short ranges, and through water which can be thoroughly illuminated.

Their arc of fire and the view from them should be as extensive as possible, and for this reason casemates are unsuitable to them. With a view to the protection of temporary obstructions, some of them at least should be so placed as to be able to fire on any craft attempting to destroy these. Such a position also affords them the opportunity of attacking with great effect boats temporarily delayed or disabled by encountering the obstructions. They should be grouped in numbers not too great to allow of efficient command by the G.G.C., and groups should be far enough apart to prevent confusion of orders in action. As it is absolutely necessary to be able to man these guns at very short notice, accommodation for the manning details should be provided in close proximity to them.

In the case of all the guns of the fixed armament, high sites conduce very greatly to accuracy, and as they permit automatic sighting at long ranges, they also increase the rate of fire. But with the lighter quick-firing guns other considerations intervene, such as the necessity for short ranges and the absence of dead water. Their height, however, should be sufficiently great to permit the use of automatic sights at decisive ranges.

The positions which can be occupied most advantageously, from a tactical point of view, by the guns of the armament for general defence should be carefully studied, and the proposed disposition of them and their organisation for fighting should be worked out and recorded. They should be assigned to fire commands and stored so as to be readily removable to the selected positions. The weight behind the teams in the case of guns told off to the light armament for general defence should not exceed 50 cwt.

Subsection II.—*Fire Control and Fire Direction.*

The sole test of a perfect artillery organisation is the power exhibited by the defenders of any unit, whether section, battery command, or group, to direct upon an indicated target at the

shortest possible notice a rapid, accurate, and effective fire, to maintain that fire until its object is secured.

The arrangements for and procedure in carrying out fire control and fire direction, on the adequacy of which this power greatly depends, vary to some extent according to the tactical use of the guns to which they refer. They may therefore be conveniently treated under the tactical headings by which the guns have been classed in Section II.

(*a*) *Direct Fire Guns.*

In the case of the direct fire guns of the primary armament (except those provided with special case shot for defence against raid, *when so used*), the Fire Commander is charged with fire control; this includes:—

On assuming command.—(1) The settlement, if not already settled, of the general lines on which action is to be taken under the different conditions of attack, and as far as possible of the details, such as projectiles to be used, and ensuring the entry in Fort Record Books of all permanent orders relating to the above.

Before, and during action.—(2) If possible, identification of the class of vessels attacking, and communication of this information to B.C.'s.

(3) Selection of the target or targets to be engaged by each Battery Command, and indication of these to B.C.'s both at the commencement of, and during action.

(4) Ordering the commencement, or cessation of fire.

The Battery Commander is charged with fire direction, which includes:—

(1) Acting on and transmitting to his groups and R.F. observers the orders of the F.C. as to the target to be engaged and the commencement and cessation of fire, and seeing that they are carried out.

(2) Ensuring that projectiles are used suitable to the class of vessels engaged.

(3) Maintaining an effective fire for as long as the F.C. requires it to be kept up.

In the case of the direct fire guns belonging to the armament for general defence, and of those heavy guns provided with special case shot which are intended to aid in resisting raid, the numbers in which they exist, and the conditions under which they are likely to be used vary so considerably as to make it inexpedient to lay down even general principles for their fire control and fire direction. Such principles must however be determined locally in formulating schemes of defence, and details elaborated as far as possible with due regard to the tactical requirements of each case.

(*b*) *High Angle Fire Guns.*

The system of fire control and fire direction are the same as for the direct fire guns of the primary armament, except that identification of ships becomes of less value, and the necessity of choice of projectile and indication of target by B.C.'s to G.C.'s does not occur.

(*c*) *Quick-Firing Guns.*

6-inch and 4·7-inch Guns when not used for defence against raid.

Fire control and fire direction of these guns will, under the above circumstances, be conducted on the same lines as laid down under (*a*) for the direct fire guns of the primary armament, with the exception that when they are used with automatic sights the G.G.C. will become responsible to the B.C. for that portion of the fire direction (3) which refers to the maintenance of an effective fire.

6-inch and 4·7-inch Guns when used for defence against raid (as in the case of a larger vessel accompanying torpedo boats and destroyers), and other Q.F. guns at all times.

In this case fire control includes only general dispositions

previous to action; fire direction includes all those functions which are necessary for absolutely independent execution command during action.

Fire control will be exercised by the F.C., who, on assuming command, will settle (if this is not already done) the general lines on which action is to be taken, and as far as possible the details, and ensure the entry in Fort Record books, or elsewhere if more convenient, of all permanent orders relating to the above.

Fire direction will be vested in the G.G.C., and will consist in—

(*a*) Carrying out the general instructions given previous to action by the F.C. or permanently settled by the scheme of defence.

(*b*) Selecting targets and indicating them to his G.C.'s ("rapid fire" is used).

(*c*) Determining the class of projectile to be employed.

(*d*) Ordering the commencement and cessation of fire.

(*e*) Maintaining an effective fire from the earliest possible moment, and for as long as possible.

Where machine guns are mounted with the lighter Q.F. guns for defence against Raid, their fire control and fire direction will conform in all respects to that of the guns.

Subsection III.—*The System of Communications.*

These being governed by the chain of command, will run as follows:—

(*a*) From the Fortress Commander to the Section Commanders.

(*b*) From the Section Commander to the Fire Commanders.

(*c*) From the Fire Commander to the Battery Commanders.

(*d*) From the Battery Commander to the Range Groups, the Gun Groups, and to the Ammunition Officer.

(*e*) From the Range Groups to the Gun Groups.

(f) From the F.C.'s post, look-out station, or other convenient ot, to each group of Q.F. guns, 12-pr. and under, for purposes f intelligence only.

Subsection IV.—*Command Posts.*

Positions must be selected locally for command posts for the re Commander and Battery Commander. Such accommoda-, and if necessary protection, should be provided at the ected positions as would tend to facilitate the carrying out of e duties required of these officers and their staffs in action. e following general principles should be observed in the lection of positions for command posts :—

The F.C.'s Command Post must be at some point from which ere is a clear view of the whole of the water area over which is guns bear. There should be combined with this as extensive view as possible of water over which vessels of any type may pproach the defences. It is advantageous that the works under command should also be clearly visible. A high site is to be referred for the F.C.'s Command Post so as to give an extended w to seawards, and greater accuracy in the use of the range-ding and observing instrument usually provided for him. e staff of the F.C. for which accommodation must be provided nsists of an officer or other assistant according to local circum-nces, an observer at his instrument, if provided with one, ephone operators, orderlies, and signallers, as required locally.

The B C.'s Command Post must be at a spot from which he can rly see the whole of the water over which his guns bear, observe his fire. For the sake of efficient supervision and y transmission of orders, it should also be in close proximity his gun groups and afford a good view of them. Where R.F. may be required to be used, the B.C.'s post should be if sible immediately adjacent to the D.R.F. station, and for purpose it may be necessary, so long as black powder is d, and where there is more than one D.R.F. station, to

provide alternative command posts for the B.C. The above quirements are not applicable in the case of high-angle fire g

Subsection V.—*Lighting of Works.*

Means will be provided of illuminating all works to enable the guns to be fought at night when necessary.

Experiments have proved that although the lights of a fortre can be observed from the sea, they will not under normal condi tions enable an enemy to direct his fire upon any given work.

Advanced works which, owing to the siting of the guns position of P.F. cells, &c., may offer well defined marks for the enemy's guns, should be lighted up with caution. Experiments in each locality can alone determine the extent to which lighting can be safely carried, and the best means to be adopted to screen the lights so as to prevent the identification of the works.

Subsection VI.—*Storage and Supply of Ammunition.*

The mode of storage and supply of ammunition varies in different forts, according to their nature, size, &c.

There are usually, however :—

Expense cartridge and shell stores, for immediate supply to the guns.

Main magazines and main shell stores, from which such ex pense stores would be replenished when necessary.

The filling up of expense stores from the main magazines would usually take place at night, or when the fort was not in action.

Cartridges for all heavy guns are contained in zinc cylinders and are stored in the main magazines and in expense cartridge stores.

Shell are always stored, filled, in the main and expense she stores.

Shot are usually piled in rear of, or between the guns.

Tubes and fuzes are kept in main or expense shell stores.

Ammunition should be grouped by marks and dates, so as to secure even results in shooting.

Whether the guns are served directly from the main magazine and shell stores, or from expense stores, there are two methods of supply :—

(a) Where the stores are on the same floor with the guns.

(b) Where the ammunition has to be sent up to the gun-floor by lifts from stores below.

In existing open batteries, as a rule, the former system prevails ; but in casemated works, and in some open batteries, the stores are so situated as to require lifts to bring the ammunition to the gun-floor.

Where lifts are used, they should be marked, both above and below, with the group letters and numbers of the guns which they serve. Speaking tubes are always provided where lifts are used. The route of the ammunition from the stores to the foot of the lifts should be also distinctly marked with directing arrows, &c.

Where expense stores exist, they are told off to certain guns or groups of guns ; one store should never, if it can possibly be avoided, be used for more than one group.

These will be marked in the same manner as the guns which they supply.

Where there are no expense stores, the guns must be supplied with ammunition from temporary depôts placed in the most sheltered spots available, and refilled from the main magazines and shell stores.

Cartridge and shell recesses are found in many works. These are usually situated in the parapet or traverses.

The arrangements for the supply of ammunition must be such that no check is likely to occur.

Even the expense stores, however, cannot always be relied

on to meet the current demand of projectiles during ac
The rate of supply would generally be far too slow and
carious. Sheltered and convenient places on the gun-floor,
near the emplacements, must be selected as depôts, where sh
would be placed before coming into action. Where shell dep
are exposed, the danger of explosion can be minimised
placing a Palliser shot on either side of a common shell.

Cartridges can generally be supplied quicker than shell.
necessary, depôts must be selected for them in the sam
manner. The most sheltered places must be reserved for th
cartridges. A shrapnel bullet with a very moderate velocity
will explode a zinc cylinder containing either P. or P.² powder,
but the L.G. powders are comparatively safe. Prism brown
powder, if struck by a bullet with a high velocity, will
burn, but not explode, nor will it set fire to another cartridge
cylinder within 6 inches of it. Cylinders containing P. or P.
if struck by a bullet will explode each other if less than 6 feet
apart.

In some batteries the ammunition can be served direct from
the stores. The track of the shell barrows should be made as
direct and easy as possible.

With Q.F. guns the necessity for rapid and continuous supply
of ammunition is most urgent. Recesses or depôts in sheltered
positions immediately adjacent to each gun should be arranged,
both for cartridges and shells, and be capable of holding a
liberal supply. The supply to each gun should be from its own
recesses or depôts, and these should be filled up before action
and kept filled during action from the group expense stores.

Whatever the means provided for the supply of ammunition,
there should be careful study, in the case of every gun, of its
particular requirements in this respect, and detailed arrange-
ments must be made locally during peace time, both with regard
to the disposition of ammunition details and material, to ensure
that want of ammunition shall never check the rate of fire.

Subsection VII.—*Electric Light and Obstructions.*

Electric lights will, as a rule, be used only in connection with efence against raiding attacks by torpedo boats and torpedo oat destroyers, or to aid in the defence of mine fields.

For the purpose of defence against raiding attack, lights may either divergent or concentrated beams. The former will be ost invariably fixed and used to illuminate only certain hite areas. The latter may be either fixed or search lights.

Night attacks by large war vessels are not probable, and refore the use of electric lights must be considered principally regards their connection with Q.F. guns, and not with the avy armament of a fortress, unless they are provided with ecial case shot for this particular purpose.

The effective range of electric lights is a matter which it is ry difficult to settle definitely. Much depends on the weather, amount of dispersion given to the beam, the height at ich the projector and the observer or guns are placed, and position of the observer or guns with reference to the light. h a 16° dispersed beam from a projector of service pattern, the projector is near sea level, and the observer has a derate command but is fairly close to the projector, it is obable that about 800 yards is the extreme effective range. oving the observers or guns in a forward position and well to side of the beam increases the effective range, and in the e of an observer or guns considerably in advance of the pro- tor, objects may appear sufficiently well illuminated at a tance from the projector of 4,000 yards and upwards. In the e of concentrated beams the effective range is extended, but illuminated area is much diminished. Thick weather renders tric lights almost useless, except at very close ranges, and this reason would if possible be selected for attack.

is therefore necessary that boats should be obliged, in r to push home their attack, to pass over water which is at

close range from the electric lights. That fire may be effe
under all conditions of weather, the range from the guns sh
also be short. To obtain these advantages for the defence i
generally necessary to narrow artificially the waters thro
which attacking boats must pass, or to temporarily close th
altogether. This is done either by some form of permane
obstruction, such as breakwaters or piles, or by temporary
structions, such as booms. Where traffic demands it, which wou
be the case almost without exception, an entrance or gatew
must be left, and this would probably be closed only at nigh
This entrance is likely to be a weak spot, and its protectio
would demand especial forethought and vigilance. The wate
in front of it, and of the obstructions generally, should b
thoroughly well lit up, while the guns and the obstructions
themselves should be in darkness. At the same time the
locality of the obstructions should be in no way indicated by
the disposal of the lights if it can be avoided. The disposition
to be aimed at is such as will tend to conceal from the boats the
positions of the guns until they open fire, and of the obstructions
in general, and the gateway in particular. Manœuvres have
shown that boats, even when thoroughly acquainted with the
port, are likely to experience great difficulties in finding their
way, especially in thick weather, if proper dispositions are made.
The inner edge of the illuminated water should almost coincide
with the outer limit of the obstructions, otherwise boats
which have succeeded in passing the light may attempt the
destruction of obstacles under cover of the darkness, or if
brought up by the obstructions, may be out of view from the
guns. A boat attempting to charge obstructions would invari-
ably go at full speed, and if unsuccessful at the first attempt
must retire some distance in order to get up speed for a second
rush. The arrangements of the lights should prevent the
possibility of boats being able to do this unobserved.

Advanced concentrated beams, both fixed and search, termed

entry beams," are likely to be of great help to the defenders y detecting boats, and giving warning of their approach to the uns. The power of early detection which their use confers on he defence would also probably have an influence on the tactics of the boats by compelling them to pass at full speed through ny waters which the lights may cover, and so further expose emselves to detection from the noise of their engines, and en from the flame at their funnels.

The continuous illumination which will be required of ctric lights in war time imposes on them a task which peace nœuvres have shown them to be often unequal to. Occasional eak down of individual lights is at present inevitable. Lights ill therefore be disposed if possible in pairs, so that the mporary breakdown of one or two of them may not be so rious a disadvantage to the defence. The projectors of each ir should however be sufficiently far apart to prevent damage both from a single shell. A shell of the same power as that the 4·7-inch Q.F. is probably the most powerful which need considered in this connection, as guns of this calibre are the gest carried by craft of the class likely to be used in raiding acks.

Subsection VIII.—*Minefields.*

The minefields must be so chosen that they can be protected gun fire, otherwise any of the methods of rendering mines ctive referred to in Section II can be used at leisure. For is purpose the employment of electric lights as mentioned in bsection VII of this Section and of the Q.F. guns is a cessity for efficiency. Failing Q.F. guns, however, recourse y be had to heavy guns firing special case or even shrapnel, ed at fixed elevations and trainings so as to cover the mine-ds. They would probably be useful against attempts at aring a minefield by the slower methods, but have little effect inst countermining craft.

SUBSECTION IX.—*Regulation of Traffic in Defended Ports*

The following general rules have been approved for regulation of traffic and the safety of vessels in a defend port in time of war. Arrangements based on them, and accordance with the authorised printed "schedule" issued certain ports to officers concerned, must be made in peace tim and the officers who would be charged with carrying them o in time of war must be well acquainted with the duties whi would fall upon them :—

1. As it is necessary to maintain trade as far as possible in ti of war, the removal of buoys and lights can, under no circum stances, be allowed.

2. Anchorages should be easy of access and safe from raidi attacks by torpedo boats, and must therefore be inside t defences provided to meet such form of attack.

3. In order that none but friendly vessels may gain access to harbour, "examination anchorages" are selected for all defende ports.

4. The "examination anchorage" of a port is the positio outside the main mine fields where all vessels will, in time o war, have to bring to for examination; the inside limit of thi area is called the "examination line." This line will be draw through a battery or work called the "supporting battery," and beyond it no vessel will be allowed to pass without being identified, and, if necessary, examined, by an official called th "Examining Officer."

5. All officers of the Royal Artillery must know the position of the examination anchorage and of the examination line for th port at which they are stationed, and be acquainted with th signals prescribed locally for day and night use for the purpos of stopping vessels, of passing them as friendly, and of giving alarm.

6. Vessels will bring to at the examination anchorage until the

ceive permission to enter the port; a secret signal will then e hoisted by each vessel passed in and by the examining vessel o show that permission has been granted.

7. Any vessel attempting to enter the port without permission will be first warned by a shot fired across her bows from the porting battery; if this is disregarded she will, on crossing examination line, be treated as an enemy both by batteries mines without further question.

8. Vessels obviously hostile, or signalled to be such by the amining vessel, will of course be fired at as soon as their aracter becomes known, without waiting for them to cross the amination line.

9. Torpedo boats will be treated as hostile until they have oved themselves to be friendly, unless special directions to the ntrary are given.

10. After examination and the grant of permission, a friendly ssel will be conducted through the defences by a pilot supplied the examining officer.

11. In exceptional cases, when weather will not permit vessels stop on the examination ground, they may be permitted to ter without examination, the examining officer or his assistant alling accordingly to the shore; when possible however an amining vessel should provide pilotage for each vessel arriving the port, although it may not be possible to board her.

12. The examination and conduct through the defences of ssels will be carried out by the Queen's Harbour Master where re is one, and elsewhere by the local harbour authority.

13. These regulations will not be enforced at home without the proval of the Admiralty, or abroad without competent Naval proval whenever such is available.

SECTION X.—*Employment of Militia and Volunteer Artillery.*

n war the artillery defence of our coasts and harbours will in a great measure on the Militia and Volunteer Artille

These forces should therefore be trained with special refere to the work they will be called upon to man on mobilisation, individual officers, N.-C. officers and men should be allotted certain specific duties, and be rigidly kept to those special dut while training.

These duties should be such as the Auxiliary Artillery ha the best opportunities of practising and keeping themselv conversant with in time of peace, such as the fire direction, a service of the more common guns either of the fixed armamen or of the armament for general defence.

On the arrival of corps on mobilisation, steps should at on be taken to perfect the training of each in the duties allotted it, or to extend this training if required.

It is not desirable during peace time to attempt to tr auxiliary artillery at Q.F. guns, as such training can only of use when carried out continuously, thoroughly, and unde conditions approaching those of service. Facilities in this direc tion do not exist in the case of auxiliary artillery, and ever desultory training with Q.F. guns could only be given at th expense of that with other guns which they would first be called upon to man. On mobilisation, however, it will be advisable t at once train a proportion of them at Q.F. guns, so that in th event of the number of regular artillery available being decreased owing to the needs of foreign expeditions after the outbreak o war, there will be militia or volunteers competent to take thei places. Circumstances of this nature cannot arise until some time after mobilisation, so that ample opportunities for training could be afforded. Definite arrangements for the distribution training, accommodation, and supply of militia and volunteer details should be made during peace time, and permanent recorded.

Subsection XI.—*Fort Record Books.*

It is of the utmost importance that in every fort a permane

cord should be kept of all details of the fort, its general object, istory, and armament, as well as all details connected with its rganisation, both in peace and war, which should be in accord- ance with the provisions of the Defence Scheme.

It will therefore be the duty of the officer in charge to keep all details of the above nature in the Fort Record Book, Army ook 127, so complete that an officer on taking charge will d all information he can require ready to hand, and in the llest detail. It must be clearly indexed, kept as confidential, nd produced at the General Officers' inspection The book ould contain copies of the plan of the fort and of the Battery ommander's chart or charts.

It must also contain details of all the information referred to n this Manual, so far as his fort is concerned (so that if manning r other tables are lost, or figures in the gun emplacements or ange-finding stations are erased, they can be immediately store), also details on the following points, among many thers that will suggest themselves as useful, viz.:—

General description and object of the work, and its relation other works in the same scheme of defence.

Details of construction, such as thickness of cover or walls of agazine and ammunition stores, material and thickness of hields, nature of parapet, &c.

A concise account of all changes that may occur in the onstruction or armament of the work.

Height and set of tide, depth of channels, landing places, acilities for landing men or stores, and local features generally.

Barrack accommodation or camping grounds for garrison on obilisation, water supply.

Emplacements and positions for electric light, quick-firing and achine guns, or armanent for general defence on land or sea front.

A detail of the ordnance in the fort, how mounted and how ouped, and range and position-finding arrangements.

Full information as to communications, illustrated by drawings,

both as connecting the battery commander with the fire c
mander and with his own subordinate officers, and also as to
nature, extent and purpose of all telegraphic or other commu
cations.

A detailed account of the manner of fighting the fort und
various conditions of attack.

Actual contents and capacity of cartridge and shell stores a
magazines. Ammunition stores to be referred to on the plan.

Position of mine fields, with elevation and trainings for gun
to sweep them.

Transport and labour available on requisition, and where
can be procured.

Under the heading "Preparations for Defence" should be
inserted the names of the corps destined to form the garrison of
the fort on mobilisation, the approximate number of officers and
men to be expected, and a general statement of their distribu
tion and duties. Also a statement of the preparations to be
made when war is imminent. These include the construction of
additional traverses, shelters, and blindages, the formation of
ammunition depôts, if not already done, construction of wire
entanglements, provision of mantlets, if not already in position,
the strengthening of parapets, provided this can be done without
making them more comspicuous, and generally the performance
of such work as shall tend to increase the strength of the fort
and to render its capture by assault or surprise more difficult.

The elevation and training of the various guns and groups to
prominent objects, and in the case of a narrow channel to the
mid-channel line on various trainings.

A part of the book will be used as a journal in which will
be recorded, as they occur, all transactions permanently affecting
each work or likely to be historically or technically of use or
interest to future commanding officers. This book will be kept
carefully up to date by the officer in charge himself, be under
lock and key in a box permanently fixed in such a building o

art of the fort as he may consider safest and most suitable. t will be open to the use of the officers of Royal Engineers n charge of the district in which the fort is situated.

Officers in charge will make themselves masters of the contents of this book, and will be responsible for its safe custody, and they should point out to the C.R.A. for reference to the Section Commander of the Fortress Section any points that cannot be carried out, or that are capable of improvement, but they must not alter it without permission.

The "officer in charge," herein alluded to will be the accountant for the work.

SECTION IV.—CHARTS, MAPS, AND TABLES.

The materials required for the above will be supplied on application to the Under Secretary of State for War. Waterproof inks and copal varnish for charts, &c., will be demanded under authority. 57 Gen. No. 8391 dated 16th July, 1897.

SUBSECTION I.—*Section Charts and Maps.*

A thorough knowledge of the sea and land areas in the vicinity of a fortress section is necessary to those entrusted with its defence. With this object the latest Admiralty charts and ordnance maps are supplied.

From the Admiralty charts one should be prepared for the use of the artillery adviser of the Section Commander (if one is appointed) or Senior Fire Commander, showing the arcs of fire and effective range of each fort or battery in the command, the undefended spaces, channels, shoals, important soundings, position of mine fields, and of obstructions or fixed posts, if used.

All other useful information, such as the distances of permanent and conspicuous objects, should also be shown.

The sites decided on (and recorded in the general scheme of defence) for the armament for general defence under different conditions of action that may arise, should be marked on the chart.

The chart should have trainings marked on it, oriented to the recognised meridian, in order that by means of a graduated straight edge or pivoted arm, used in connection with a range finding instrument, it may be capable of determining the position of a target, and thus show what guns can be brought to bear.

For the land front of a fortress section a map (the ordnance map on the 6-inch scale will be found suitable) should be prepared which records the arcs of fire and effective ranges of all guns mounted for land defence, the distances to all prominent and important points, the sites for works for the armament for general defence, and the positions decided upon for the light portion of the same under various conditions.

These charts and maps should be mounted on boards, and when not required for use should be kept in a secure place.

Plans should also be made in every fort or battery showing the position of the guns, ammunition stores, magazines, lifts, hatches, &c. Such plans should show how the various guns are grouped, and what ammunition lifts, or expense shell and cartridge stores, are intended to supply them with their ammunition. These plans should be made out on as large a scale as is convenient, the guns and their ammunition stores being shown on the plan by their letters and numbers. The plan should also show the places of parade for manning details.

Subsection II.—*Fire Commander's Chart.*

A chart for each F.C. will be prepared in the following manner:—

A chart of the several forts and batteries in a fire command and of the water area covered by the fire of their guns is drawn to a scale of 3 inches to the mile, and divided into squares of 500 yards side, drawn north and south, and numbered as shown on the plate.

In order to facilitate the work of preparing charts, paper, with squares on it to the above scale, is issued as part of the appurtenances of D.R.F. instruments.

Each work in the fire command is given a colour, and the squares on the chart are divided into longitudinal strips, one for each work and one to spare.

The strips, or portions of them, in each square covered by effective fire of a work are given the same colour as that allo to the work, the shade deepening in proportion to the num of groups which bear. The spare strip is for the number of square.

The position of the Fire Commander's station is shown on chart, and from this angles of trainings are marked, and can read by means of a metal pivoted arm. This arm is gradua in yards to the scale of the chart.

By means of this chart, used in connection with a D.R.F. F.C.'s observing instrument, a Fire Commander is shown fire area of each group of guns in his command, and can see what nature and number of guns can bear upon any targ

The D.R.F. must be oriented to agree with the traini on the chart (that is, when it is directed due north the readi on the graduated arc should be 0°) and the range and training the target taken. By means of the pivoted, graduated ar worked for him by an assistant, the F.C. is enabled to find t square on his chart occupied by any vessel which comes with his fire area, and may sometimes be able, by sending the numb of this square to the Battery Commander (to be passed on the Range and Gun Groups concerned) to indicate the target wishes any unit to engage.

A Fire Commander is thus helped to maintain fire control his command.

Subsection III.—*Battery Commander's Chart.*

For the use of the Battery Commander a chart should b prepared, showing, in different colours, the extent of the arcs effective fire of his several groups of guns, as limited by th power of the pieces and by the elevation permitted by mounting and ports. See Plate.

The position of the B.C.'s command post is marked on th chart and at this point a metal arm, graduated in yards,

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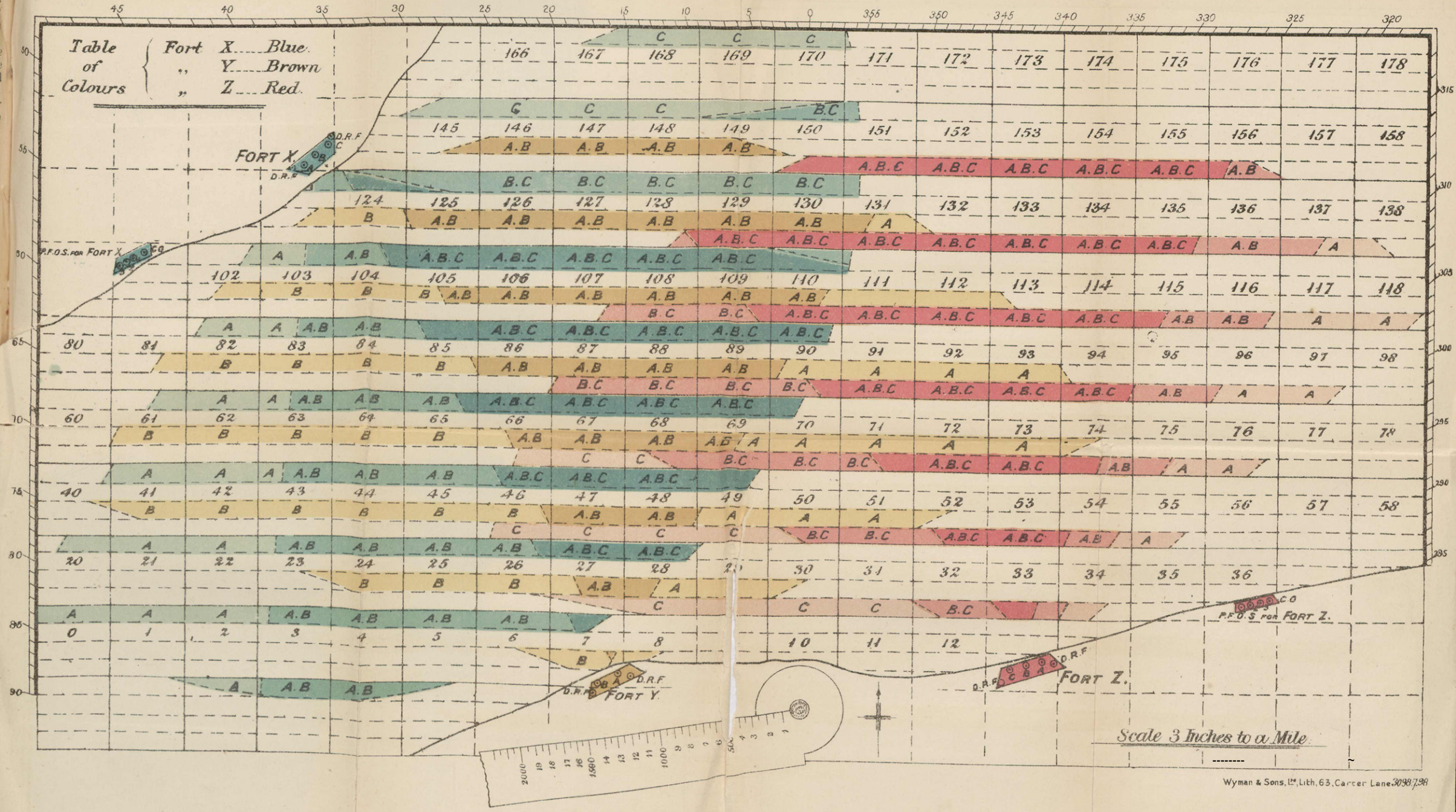
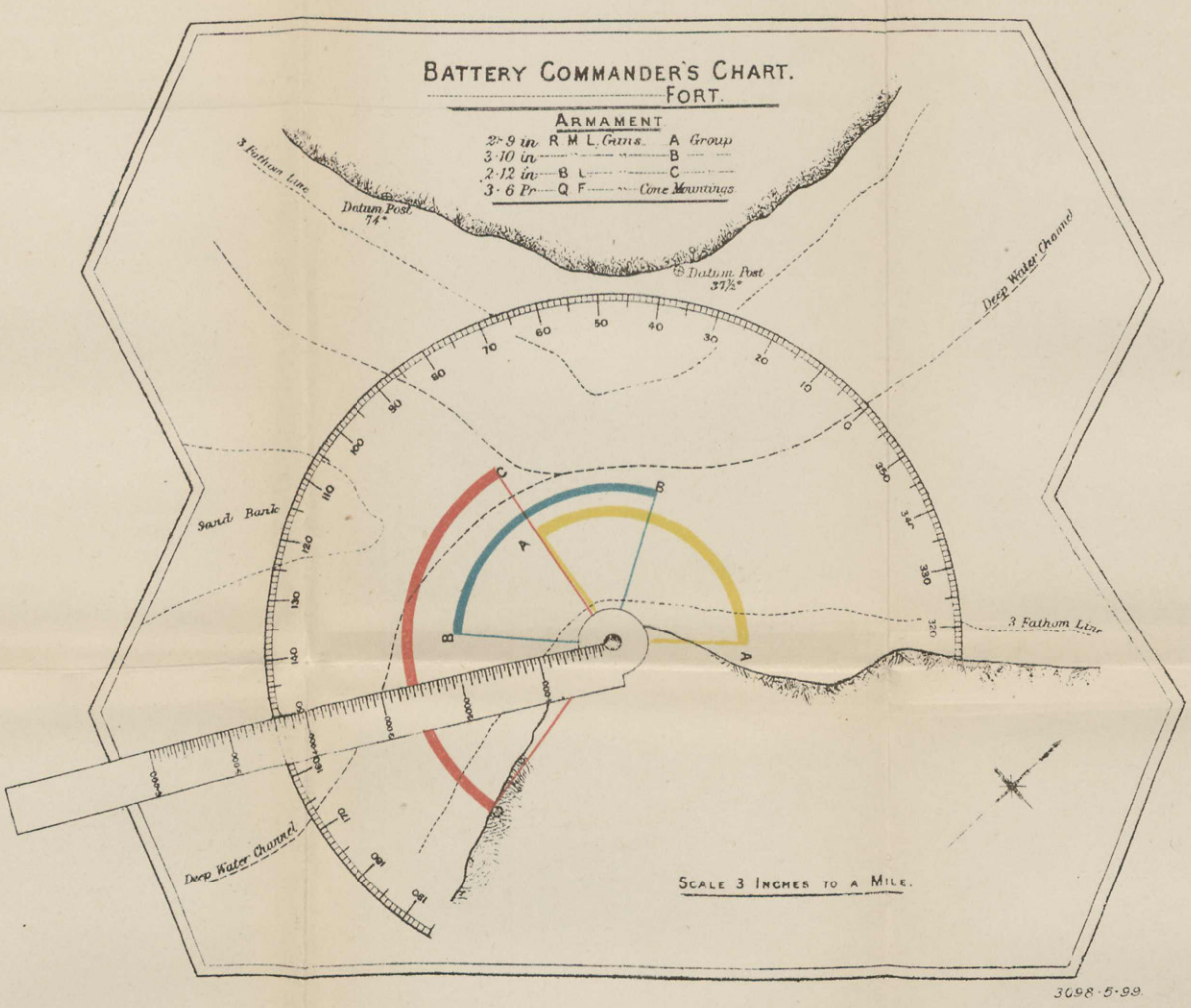
FIRE COMMANDER'S CHART.



Wyman & Sons, Ltd., Lith., 63, Carter Lane. 3098/7.98

To face page 186.



voted. The arm is fitted with rough sights, consisting of straight edge two inches in length and a foresight, by means f which it can be laid on a target. Angles of training are iven, either on an arc as shown in the plate, or they can, if ired, be marked on the edges of the chart.

The chart should show such useful information as the three thom lines, deep water channel, shoals, &c., but it must not be rowded as to make it difficult to see at a glance the arcs of of the gun groups.

he chart is to be mounted on a board, with notches cut in it shown in the plate, for the purpose of fixing it in a bed, rectly oriented and prepared for it on a parapet or other nvenient site. When such a bed is not used, the trainings of tum points should be marked as shown in the plate, and by eir means the chart can be correctly oriented when required.

The headings of the chart should give the nature and number the guns in each group of the B.C.'s command.

By means of such a chart the Battery Commander is enabled, n the help of a D.R.F. instrument, to see what gun groups of command can bear effectually upon a target.

he specimen chart, given in plate, is not drawn, to scale, as be seen on reference, the effective arc of fire of C group instance), which is composed of 12-inch B.L. guns, being wn as only 2,600 yards.

Subsection IV.—*Target Indicator Tables.*

n connection with the fire commander's chart to enable it to used as a target indicator, the observers at the D.R.F. rument, and the gun group commanders, are supplied with giving the range and training of the centre of each square e chart upon which their groups can be brought to bear.

ese ranges and trainings will be taken on the chart from the on of each D.R.F. station and from that of each group of

guns, and will be tabulated as in the following example, ta
for A group of fort Z in the specimen chart for fire comman

TARGET INDICATOR CARD.

Fort Z. A. Group.

No. of Square.	Range.	Training.	No. of Square.	Range.	Trainin
52	700	33	113	2000	3
53	800	7	114	2050	351
54	900	339	115	2100	341
55	1050	319	116	2300	331
71	1500	37	117	2450	323
72	1300	22	118	2750	316
73	1200	5	129	2950	35
74	1250	346	130	2750	27
...	.....	.....	...	.....	...

For convenience of reference the ranges should be entered
red ink, the squares and trainings in black, and the thick lin
showing where the numbers of squares do not follow consec
tively should be red.

The cards for the D.R.F. operators are made out in a simi
form, with the range and training of the centre of each squa
covered by the guns for which the D.R.F. works. The headi
must show the fort or battery it belongs to, and the D.R
station for which it is made out.

When indicating cards have been made out, a copy of th
should be entered in the fort record book, so that in case of t

lost or becoming defaced, fresh ones may be prepared ut delay.

receipt of the number of the square occupied by the which they are ordered to engage, G.G.C.'s and D.R.F. vers will proceed to identify it as follows :—

G.C. By laying a gun at the training proper to that re, and with the quadrant elevation due to the range of it ; setting the sights to the same elevation, looking over them noting what they bear upon.

R.F. Operators. By setting the instrument to the range training of the square, and noting the target on which the wires of the telescope bear.

rgets may be identified in a similar manner by R.G.C.'s or bservers. No target indicator is necessary in this case, as quares are inscribed on the chart of the P.F., and it is only ssary to place the pencil on the centre of the square, look gh the telescope, and note the object on which it bears.

Subsection V.—*Group Difference Tables.*

he following table is given for the purpose of saving calcula- in making out group difference tables.

Table of Angular Distances, Right and Left of x, through which Corrections for Displacement must be given.

Displacement.		200	187½	175	162½	150	137½	125	112½	100	87½	75	62½	50	37½	25
Correction	−200	20														
	−175	35	30	22												
	−150	47	43	38	33	23										
	−125	56	52	50	47	41	35	25								
	−100	64	62	60	62	54	50	45	39	29						
	− 75	72	71	69	69	65	67	60	56	52	45	33				
	− 50	80	78	78	77	75	74	72	71	68	64	60	53	41		
	− 25	86½	86	85	86	85	84	84	83	83	82	80	78	75	71	60
	± 0	93½	94	95	94	95	96	96	97	97	98	100	102	105	109	120
	+ 25	100	102	102	103	105	106	108	109	112	116	120	127	139	180	180
	+ 50	108	109	111	111	115	117	120	124	128	135	147	180	180		
	+ 75	116	118	120	118	126	130	135	141	151	180	180				
	+100	124	127	130	133	139	145	155	180	180						
	+125	133	137	142	147	157	180	180								
	+150	145	150	158	180	180										
	+175	160	180	180												
Correction	+200	180														

Displacement. 200 187½ 175 162½ 150 137½ 125 112½ 100 87½ 75 62½ 50 37½ 25

To find group differences by this method, the displacement must be measured on the ground, or from a plan. The displacements in the table are given in multiples of 12½ yards; the multiple which is nearest to the measured displacement must be taken.

Next, the training from the D.R.F. station to the centre of the group must be found by orienting the D.R.F., directing it on the centre of the group, and noting the angle indicated by the pointer on the graduated plate of the instrument.

The table gives the angular distances to the right and left of the training, on the traversing arc of the gun, through which the group differences noted opposite to them hold good.

Thus :—Suppose the training from the D.R.F. station to the centre of the group was found to be 70°, and the displacement about 175 yards, then, for 22° on each side of 70°, that is, from 48° to 70°, and from 70° to 92°, or, from 48° to 92°, the group difference would be about 175 yards. Then from these limits (48° and 92°) up to 38° to the right, or, left of 70°, viz :—from 32° to 48°, and from 92° to 108°, the group differences would be 150 yards and so on.

Only those trainings which actually appear on the traversing arc of the guns need be considered.

To further save calculation a "group difference disc" may be used, made in the following manner :—A disc about 6 inches in diameter is cut out of celluloid, and its circumference divided into degrees from 0° to 360°. It is pivoted at the centre so that it can revolve inside a circle drawn on paper and mounted on a board. This circle is graduated in degrees right and left from 0 to 180°, starting at any point on its circumference.

To use the group difference disc :—

Mark on the celluloid circle the limits of the arcs of fire of the guns.

Rotate the celluloid circle until the angle of training from

the D.R.F. station to the centre of the group (found as descri above) is opposite zero on the outer circle.

3. By aid of the table tick off the limits of each group differen

For example see plate. On the celluloid arc are marked diff ences for a gun arc reading from 100° to 180°, training fr D.R.F. to centre of group being 90°, and displacement of 75 yar They are arrived at as follows :—

90° + 33° = 123° From 100° to 123° difference is—75 yard
90° + 60° = 150° ,, 123° to 150° ,, ,, —50 ,,
90° + 80° = 170° ,, 150° to 170° ,, ,, —25 ,,
90° +100° = 190° ,, 170° to 180° ,, ,, ± 0 ,,

If the graduations on the celluloid are engraved, it can cleaned with a damp cloth or sponge as often as necessary.

With the results obtained by the above method, differen tables must be made out for each group, one for each D.R. station used in fighting the group, and mounted or painted on board, which will be kept in the group store or other convenien place as decided locally.

Difference tables will be made out as below :—

DIFFERENCE TABLE.
B Group.
D.R.F. on left flank.

Training.	Add.	Subtract.
100—123°	—	75
123—150°	—	50
150—170°	—	25
170—180°	—	—

SUBSECTION VI.—*Convergence Tables.*

In order that Battery Commanders may be able if desir

concentrate fire from a group of guns worked by P.F. se III, the G.G.C. should be supplied with a table giving the cessary corrections in training. The table should be made t in the form given below.

NEEDLES BATTERY.

"A" Group—4 Guns—Pivot Gun "A 2."

Range.	Angle of Convergence. Degrees.		
	A.1.	A.3.	A.4.
Yards.			
1,500 to 1,800	3/8	3/8	3/4
1,900 to 2,800	1/4	1/4	1/2
2,900 to 3,000	1/8	1/8	1/4

he table is compiled as follows :—The mean average distance et of the lines of fire of the guns from that of the pivot gun ultiplied by 1,146 and divided by the range in yards. This the angles of correction in minutes. Angles are expressed in $\frac{1}{8}$ of a degree, and the one nearest to the angle given by ormula is taken.

must be remembered that such a table is only correct when ine of fire is approximately at right angles to the front of roup.

Subsection VII.—*Racer Correction Tables.*

egularities in racers affect guns laid by quadrant elevation, t when hydro-clinometers are used. Racers should there- e tested as follows :—

the gun up, lay it at any mean range by the index and reader or elevation indicator. Set a large clinometer .a.d.)

to the elevation due to this range (taking into consider the height of the gun above mean tide), and place it on plane surface of the gun, or preferably on a straight edg the bore. Then by traversing the gun and watching the bu of the clinometer, it will be seen if the gun retains the p elevation at all trainings. If it does not, the difference in r due to any error in level can be ascertained by elevatin depressing the gun until the clinometer bubble is again in centre, and comparing the range then shown by the index or elevation indicator with the selected mean range. If range shown is less than the mean range, the difference bet them is the minus correction required, if more, the plus correc

The necessary correction should then be tabulated to nearest multiple of 25 yards, as in the example below, mounted on a board, to be kept as directed for difference ta

RACER CORRECTION TABLE FOR A RANGE OF 2,000 YARDS.

A_2 Gun.

Training.	Correction.
323°–346°	+ 50
346°—353°	+ 25
353°–14°	0
14°—21°	– 25

These corrections, if any, will be marked on the inside of t traversing arc of each gun similarly to group differences, a will be applied by the Gun Captain.

The range for which they are made out will be the mean those at which the gun is likely to be required to fire, or in case of guns commanding a narrow channel, it may be the rang the centre of the channel at the nearest point, as decided loca

are must be taken in testing for racer errors that the nometer is in adjustment, and also that errors due to faults trucks are not mistaken for racer errors. Errors in trucks not be corrected for in this manner.

Racer corrections are a complication which should be avoided ssible. They should only be regarded as a makeshift to be d until the racers can be relaid.

Subsection VIII.—*Tide Correction Tables.*

e means of giving quadrant elevation to guns being uated with reference to mean tide, tables showing the rence in range due to rise and fall of tide may be of help to C. in arriving at his initial correction, where the rise and is large compared with the height of the guns. They are required when Case I is employed.

he tables if required should be made out for every thousand s of range, showing corrections in multiples of 25 yards for ter tides, with mean tide, to which the quadrant elevation rrected, as the starting point, and be of the form given below

te of Tide.	Range.					
	1000	2000	3000	4000	5000	
ide	−100	−50	−25	−25	0	
,, ...	− 50	−25	−25	0	0	
... ...	0	0	0	0	0	
ide	+ 50	+25	+25	0	0	
,, ...	+100	+50	+25	+25	0	

The table of angles of arrival facing this page is intended help in compiling tide correction tables. It is used as follow

Find the angle of depression due to the height of gun a mean tide level by the formula—

$$\text{Angle of depression in minutes} = \frac{\text{height in feet} \times 114}{\text{range in yards}}$$

Add to this the angle of descent from the range table convert the slope into such angle).

This gives the angle of arrival for the range in question. a range table corrected for the height above sea level is avail the angle of arrival can be taken from it.

Refer to that column in the table which is headed by number of feet corresponding to the rise or fall of tide question. On a level with the line in which the angle of arr is included will be found the proper correction. If the hei of tide is above mean, the correction has to be added to range as given by the range finder, if below mean subtracte

Example :—Angle of arrival, 48 minutes. Difference in hei of quarter tide from mean, 4 feet. In column headed 4 ($r = 4'$), 48 minutes lies between 41 minutes and 52 minu The proper correction is therefore 100 yards, and as quar tide is below mean it is a minus correction.

Subsection IX.—*Manning Tables and Manning Parades.*

The manning detail of each battery command will be dra up on Army Form A 2008. A copy of this should be in possessi of the warrant or non-commissioned officer in charge of the fo If more than one battery command is included in the latter, form for each of them should be in his possession.

In the vicinity of each battery command a place of par will be allotted for the details required to man it. Opposite the spot at which each detail is to fall in on parade will legibly painted on a board or plate fixed to a wall or post

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TABLE OF ANGLES OF ARRIVAL,[1] SHOWING CORRECTIONS FOR TIDE.

Correction in yards	$r = 1'$	$r = 2'$	$r = 3'$	$r = 4'$	$r = 5'$	$r = 6'$	$r = 7'$	$r = 8'$	$r = 9'$	$r = 10'$
0	Above 1° 32′	Above 3° 57′	Above 4° 27′	Above 6° 5′	Above 7° 32′	Above 9° 5′	Above 10° 25′	Above 12° 57′	Above 13° 20′	Above 14° 55′
25	1° 32′ to 31′	3° 57′ to 1°	1° 27′ to 1° 32′	6° 5′ to 2° 2′	7° 32′ to 2° 20′	9° 5′ to 3° 7′	10° 25′ to 3° 26′	12° 57′ to 4° 26′	13° 20′ to 4° 27′	14° 55′ to 5° 55′
50	31′ „ 18′	1° „ 39′	1° 32′ „ 55′	2° 2′ „ 1° 13′	2° 20′ „ 1° 32′	3° 7′ „ 1° 59′	3° 26′ „ 2° 8′	4° 26′ „ 2° 26′	4° 27′ „ 2° 45′	5° 55′ „ 3° 57′
75	18′ „ 13′	39′ „ 26′	55′ „ 39′	1° 13′ „ 52′	1° 32′ „ 1° 5′	1° 50′ „ 1° 19′	2° 8′ „ 1° 32′	2° 26′ „ 1° 45′	2° 45′ „ 1° 58′	3° 57′ „ 2° 16′
100	13′ „ 10′	26′ „ 20′	39′ „ 31′	52′ „ 41′	1° 5′ „ 51′	1° 19′ „ 1° 1′	1° 32′ „ 1° 11′	1° 45′ „ 1° 21′	1° 58′ „ 1° 32′	2° 16′ „ 1° 42′
125	10′ „ 8′	20′ „ 17′	31′ „ 25′	41′ „ 33′	51′ „ 42′	1° 1′ „ 50′	1° 11′ „ 58′	1° 21′ „ 1° 7	1° 32′ „ 1° 15′	1° 42′ „ 1° 23′
150	8′ „ 7′	17′ „ 14′	25′ „ 21′	33′ „ 28′	42′ „ 35′	50′ „ 42′	58′ „ 49′	1° 7′ „ 56′	1° 15′ „ 1° 3′	1° 23′ „ 1° 10′
175	7′ „ 6′	14′ „ 12′	21′ „ 18′	28′ „ 24′	35′ „ 31′	42′ „ 37′	49′ „ 43′	56′ „ 49′	1° 3′ „ 55′	1° 10′ „ 1° 1′
200	6′ „ 5′	12′ „ 11′	18′ „ 16′	24′ „ 22′	31′ „ 27′	37′ „ 32′	43′ „ 38′	49′ „ 43′	55′ „ 49′	1° 1′ „ 54′
225	5′ „ 5′	11′ „ 9′	16′ „ 14′	22′ „ 19′	27′ „ 24′	32′ „ 29′	38′ „ 34′	43′ „ 38′	49′ „ 43′	54′ „ 48′
250	5′ „ 4′	9′ „ 9′	14′ „ 13′	19′ „ 17′	24′ „ 22′	29′ „ 26′	34′ „ 31′	38′ „ 36′	43′ „ 39′	48′ „ 44′
275	4′ „ 4′	9′ „ 8′	13′ „ 12′	17′ „ 16′	22′ „ 20′	26′ „ 24′	31′ „ 28′	36′ „ 32′	39′ „ 36′	44′ „ 40′
300	4′ „ —	8′ „ 7′	12′ „ 11′	16′ „ 15′	20′ „ 18′	24′ „ 22′	28′ „ 26′	32′ „ 29′	36′ „ 33′	40′ „ 37′

[1] The angle of arrival is the sum of the angle of descent due to the trajectory, as given in the Range Tables, and the angle of depression due to the site.

NOTE.—r = difference in feet of height of tide from mean.

mber of officers, N.C.O.'s and men composing it, B.C.'s staff, oup details, ammunition detail, &c.

In order to insure uniformity in painting manning tables, &c., forts the following table is inserted for guidance as regards nature and size of letters and numerals to be used—

Nature of letter or numeral.	Size.	Remarks.
Block Letter.	1″	The sizes and natures selected will be settled locally.
ic, or Roman numerals	1½″ or ⅞″	
an capitals, or small oman letters	1¼″ ⅞″ or ⅝″	

SECTION V.—COMMUNICATION AND TRANSMISSI OF ORDERS AND RANGES.

Subsection I.—*Telephones and Speaking Tubes.*

To ensure effective defence it is necessary to have systematic means of communication, as uniform as poss between the different links constituting the chain of comm It is considered that in all cases but those where the distan are very small, electric communications are to be preferr Telegraphy has the serious drawbacks that it is comparative slow, requires highly trained operators, and is incapable being used, even on emergency, by those without special kno ledge. Telephonic communication, therefore, is the me adopted. It must be established, except where speaking tu can be more conveniently used :—

1. From the Section Commander to each F.C.
2. From each F.C. to his several B.C.'s.
3. From each B.C. to his several G.G.C.'s when on accoun local conditions other means of communication are inefficient.
4. From each B.C. to his P.F. cells or to his R.G.C.
5. From the F.C. post or look-out station to each group Q.F. guns.

In addition to the above, it is desirable to establish di communication either by telephone or speaking tube.

6. From each P.F. cell to the group which it serves.

Since then such an important part is to be played by te phones in the general scheme of fire tactics, no pains should

pared in keeping the lines in good order, the instruments efficient, and the operators thoroughly trained and frequently practised in their care and use. This latter point is of the utmost importance, for a good operator can often do useful work under circumstances where an indifferent one is unable to get any message through. Experience shows that instruments are often blamed for the faults of operators. Clear articulation is of the utmost importance for telephone and speaking tube operators. Officers should accustom themselves to frame messages clearly and concisely, and should give them in the actual words they intend to be used, and allow no departure from them. Practice in framing messages is very necessary.

For instructions for telephone operators and testing for faults on a telephone circuit, see Part III, Section IX.

In addition to such means of communication as have been mentioned, it is possible that local conditions may occasionally render necessary or desirable others, such as bugle sounds, written orders, flag or lamp signals, or electric telegraph.

Subsection II.—*Trumpet and Bugle Sounds.*

Where trumpet and bugle sounds are used in fighting guns, the undermentioned calls will have the signification stated against each :—

Section V.—Communication and Transmission of Orders and Ranges.

Name of Call.	Trumpet and Bugle Sounds, 1895.		Employment and Signification.
	No. of Call.	Mounted or Dismounted.	
Assemble ... *followed by* Double	8 14	Dismounted ... Dismounted ...	Immediate manning of all guns and stores, each officer and man direct to his station in action.
Assemble ...	8	Dismounted ...	Manning of all guns and stores, each officer and man to his own ma ning parade.
Stand fast ...	27	Mounted ... ... (for Artillery only)	Detachments and various detail cease their work and remain *their then positions.*
Attention ...	19	Dismounted ...	All sitting or standing at attention ready for orders.
Advance... ...	3	Dismounted ...	Work to be proceeded with, me under cover going smartly to thei places in "Action."
Commence firing	6	Dismounted ...	Firing to commence, or to be recom menced, when it has been stoppe by order "Cease fire."
Sit at ease ...	18	Dismounted ...	Men going under cover on com pletion of work in hand, and sit ting at ease.
Cease firing ...	7	Dismounted ...	*Temporary* cessation of fire. Me still going on with the work.
Retire	4	Dismounted ...	Firing to cease *altogether*, and stores to be replaced. (*At Service Practice not to be sounded until the whole practice for the time being is over.*)
One "G" ...	...	...	Change in deflection or range.
Two or more "G's" prefixed to a call	...	...	To particularise a certain group.

It may sometimes be useful to convey an order to a particular roup by trumpet or bugle. The group it is intended to refer can be indicated by sounding a particular number of G's before e call, previous arrangements being made to this effect.

If local conditions require it, other calls may be used in dition, but care should be taken to ensure that all the details ncerned are well acquainted with the meaning to be attached each, and the calls to be used and the signification of each uld be permanently recorded.

Subsection III.—*Whistle Sounds.*

Every B.C. and, with Q.F. guns, every G.G.C., must in action provided with a whistle.

The whistle will not be used by any officer other than the or at Q F. guns the G.G.C., unless authorised by them.

The whistle sounds and their signification will be as follows:—

One blast.—"Stand Fast."

The pause is only to be of sufficient duration to enable orders be correctly passed and received, the G.G.C. giving "Go on" soon as this has been done.

At Q.F. guns "Stand fast" is only a momentary cessation of to enable orders to be heard. With this exception the ice of the gun is to proceed as usual, and the layer is to ow his target. Fire is to be continued immediately orders e been received and acted on.

Two blasts.—"Cease firing."

Subsection IV.—*Electric Order, Range and Training Dials.*

The above, although not generally approved for service, may ound in some stations. Electric order and range dials have ain advantages in casemated forts, and electric training dials useful for directing search lights from observing stations at stance.

ey are all similar in construction and principle; a handle

at the transmitting instrument actuates mechanically a point on the transmitting dial, and electrically another pointer on th receiving dial.

The transmitting and receiving dials are graduated or divide in an identical manner. With the order dials the face of each pair of dials is divided into sectors, each sector containing a order. With the range dials a scale of ranges is inscribed o each face, and with the training dials a scale of trainings.

To indicate any desired order, range, or training, the handl on the transmitting instrument is turned until its pointer i opposite the desired order, range, or training. The pointer o the receiving dial will then occupy a similar position wi reference to its scale.

With the order dial it is desirable to place a bell in the circu to call attention to orders, and also, by arranging that no ord is to be acted upon until the bell is rung, to guard against a order being conveyed and acted on by mistake, in case th pointer be allowed to stop momentarily on an intermediat order in passing from one to another.

The diagrams attached show the ordinary methods of connec ing up the dials.

The following points should be attended to in working th dials :—

1. See that both dials are back at "Stops" before beginni work. If the pointer of electric dial is not back, disconne line 3, run out pointer of mechanical dial, connect up, and r back. Repeat till both pointers are back. Check occasional during work. Always run back to "Stops" before disconnecti to replace stores.

2. If the reversing push of the mechanical dial is used, s that it is either quite up or quite down ; if half way the curre is cut off.

3. When the dials are not actually in motion, keep the hand of the mechanical dial in the rest position. Its resistance

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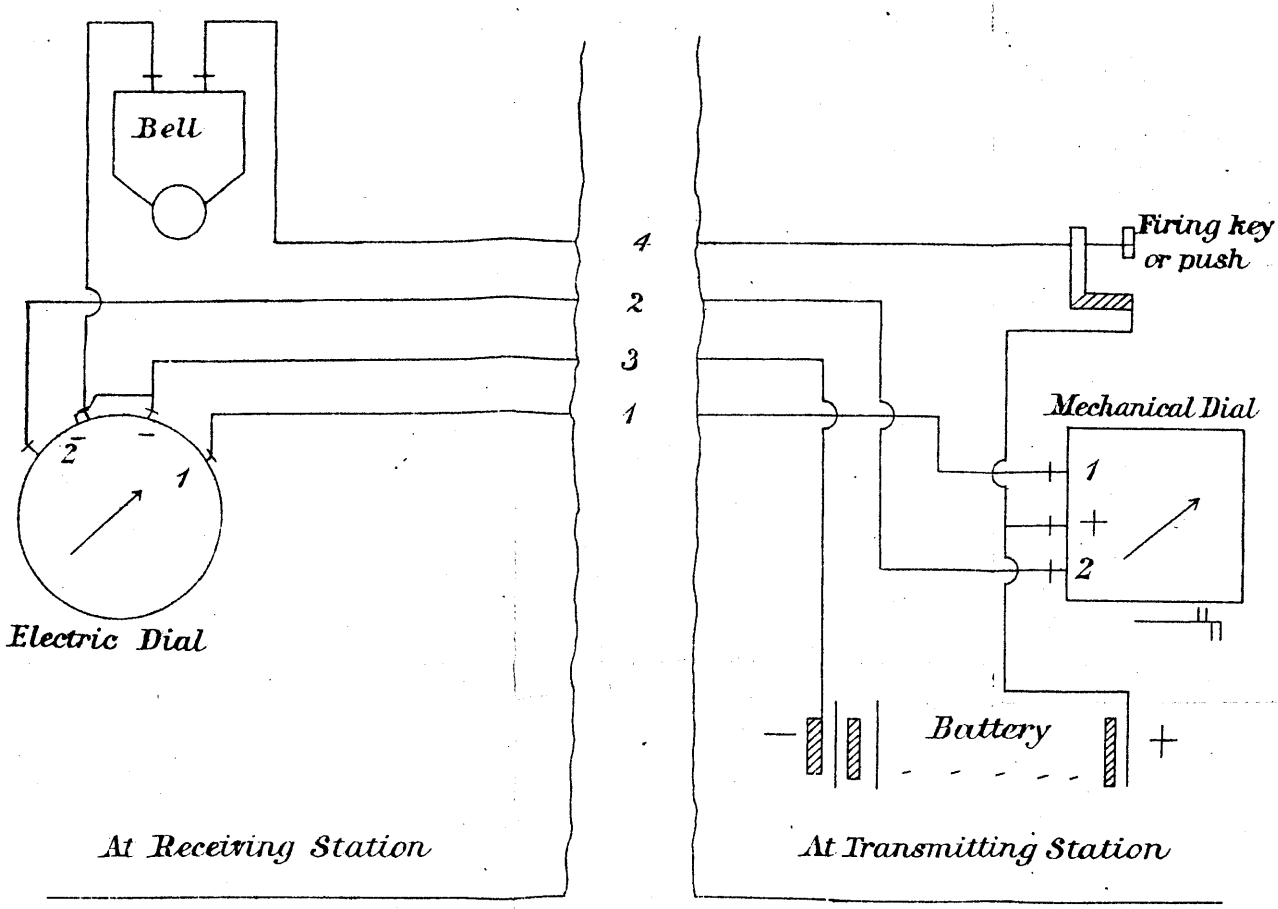
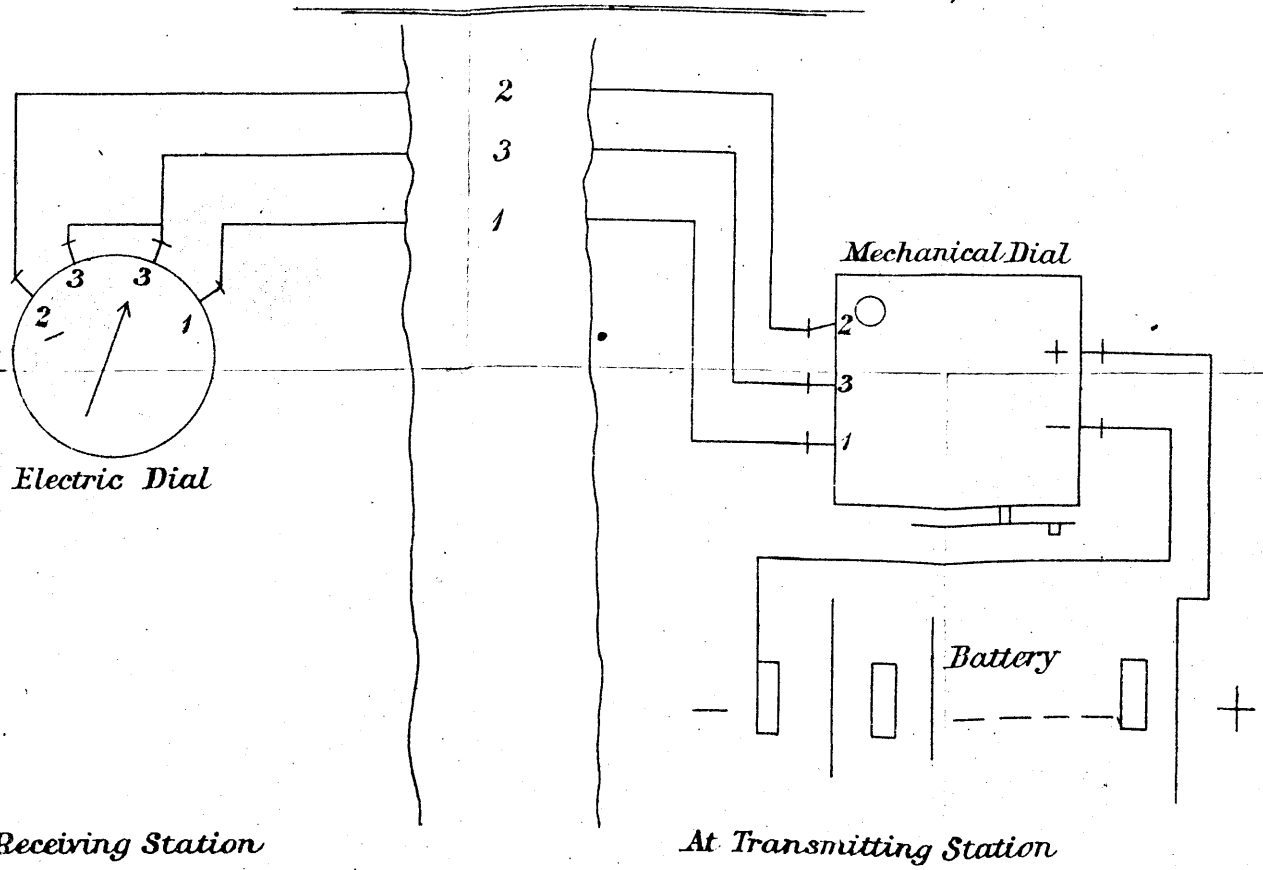
ELECTRIC ORDER DIAL



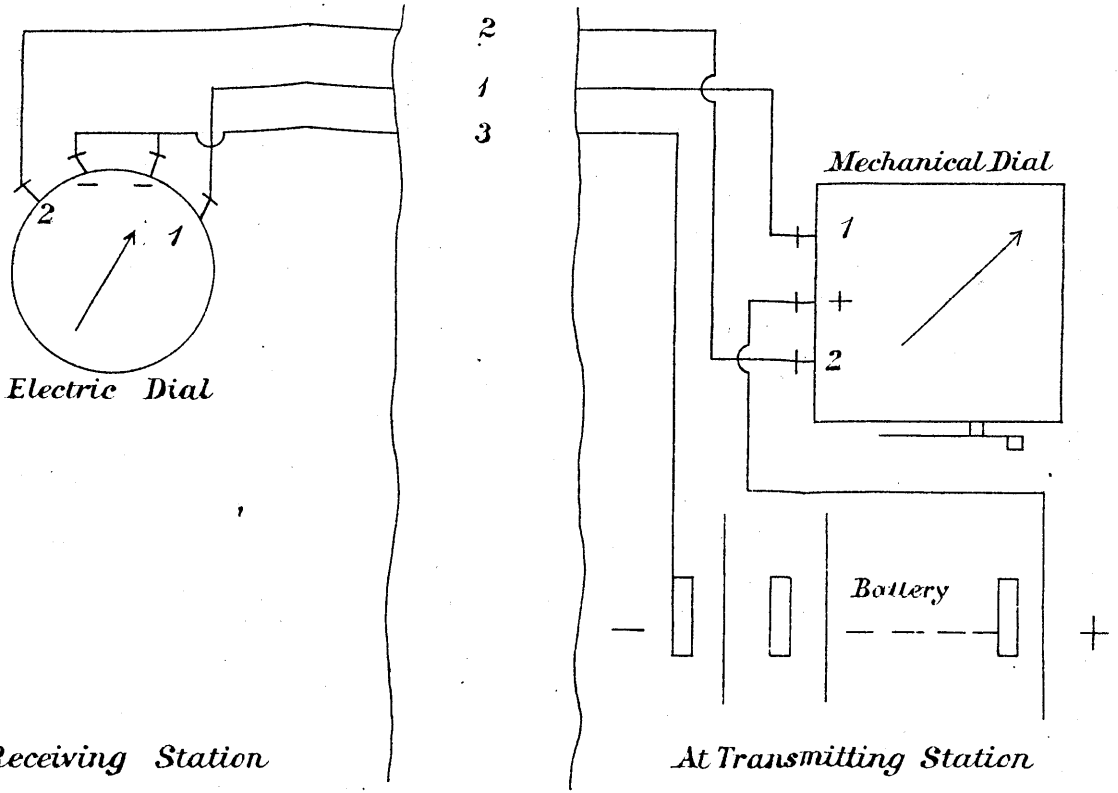
ELECTRIC RANGE DIAL



Wyman & Sons, Ltd. Lith. 3098. 9. 98.

To face page 202.

ELECTRIC TRAINING DIAL.



Wyman & Sons, Ltd., Lith, 3098·5·99.

rning will tell when it is so. Otherwise batteries quickly run own.

4. At least 12 P.F. Leclanché cells are required, and more if e distance from receiver to transmitter is considerable.

Subsection V.—*Range Indicator.*

The range indicator consists of a wooden clock face, painted hite, with Arabic numerals from 1 to 9, similar to those of a ock marked in black on it to represent the hundreds of yards the range. The intervals between each number are divided as to read to 25 yards (see Plate).

In the space between the 9 and 1 a hole is cut to allow a black ncentric disc to be seen, upon which figures from 1 to 5 are inted in white to represent the thousands of yards in the nge—the hole being only of sufficient size for one figure to be sible at a time.

On the face of the indicator, right and left of the figure 6, are inted in red, figures to show deflection, graduated to read to 15 inutes up to 2 degrees. The deflection scale can be read to $7\frac{1}{2}$ inutes by placing the hand half way between the markings. he letters R and L are also painted in red to denote the side to hich the required deflection is to be given.

Two hands are pivoted to the centre of the indicator, one ainted black, with an arrow head, and the other, a shorter one, ed with a diamond head. In order to avoid confusion in reading he dial, especially at night, when unless very well lighted up he colour of the deflection hand would not be very apparent, here should be a distinct difference between the lengths of the wo hands. The range arm should be under the deflection arm nd should be so pivotted that its arrow head is close to the face f the indicator. See § 7199.

A movable disc on a board which has the letters S and I it, to signify "Shortening" and "Increasing," and is fixed the top of the dial, shows whether the range is constant,

shortening, or increasing, according as it is vertical or inclined t
the S or I respectively.

The disc should be capable of being reversed; one side being
painted black for use in the daylight, and the other side white
for use when required to be artificially lighted up.

Disc vertical is a signal to the G.G.C. that he is to fire at
the ranges shown on the dial, corrected for group differences
without predicting.

Disc out of the vertical, to either S or I side, signifies to the
G.G.C. that he is to predict.

The range indicator is fixed on a wooden easel.

For the purpose of indicating the training of a target t
the gun group when using a D.R.F. instrument, a light iro
frame A (as in plate) capable of being folded down is fixed t
two supports at the back of the indicator. At the top of the fram
is a rod provided with hooks by means of which plates with
numbers, similar to those used for a cricket telegraph, can be
suspended. The dial number can turn the frame down to
within his reach, and when he has placed the numbers as
ordered, raise it up, and by means of a key clamp it in position.

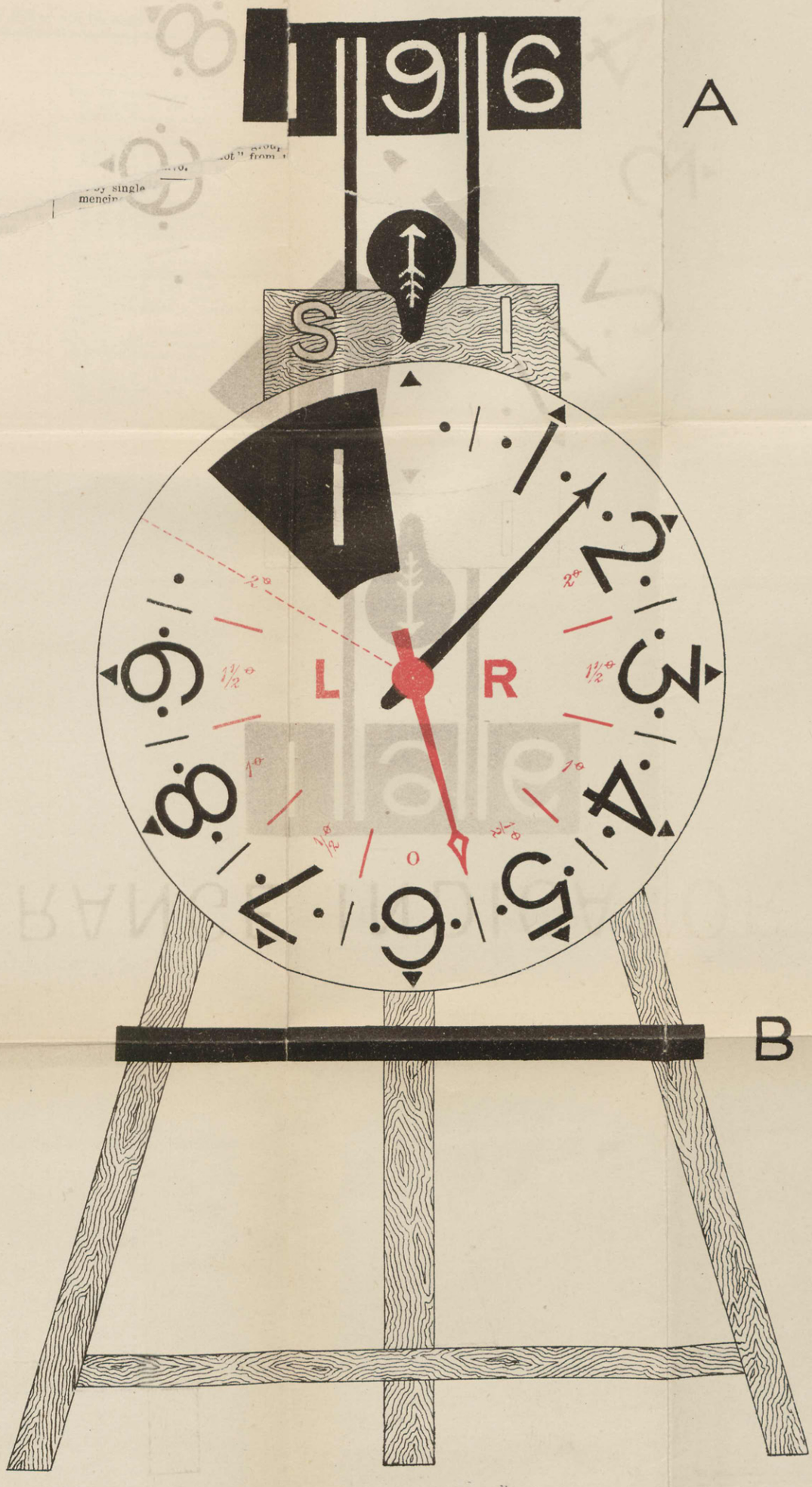
The fillet of wood B, shown as placed across the two front
legs of the easel, can be used for suspending the plates if the
indicator is used in a casemate where the height of the iron
frame A might be inconvenient.

Range indicators are made with a clock face of 3 ft. diameter;
it may, however, in some cases be necessary to have them of
larger dimensions to facilitate reading at a distance.

The indicators, as shown in the plate read as follows: Rang
1150 yards, constant, deflection 15 minutes right, training o
target 196 degrees.

To face page 204.

RANGE INDICATOR.



Wyman & Sons, Ltd. Lith. 63, Carter Lane. 3098.9.38.

SECTION VI.—ORDERS OF FIRE.

SUBSECTION I.—*The Fixed Armament, except Q.F. Guns.*

The following orders of fire will be used :—

Order of Fire.	Purport.
"Slow Fire."	Fire by single guns in a named group or groups, on the order "Shot" from the B.C. for each round.
"Slow Salvo Fire."	Fire by salvoes from a named group or groups on the order "Shot" from the B.C. for each salvo.
"Ordinary Fire," "from right (or left)."	Fire by single guns in succession, commencing from the flank of any named group or groups, until further orders, unless the number of rounds from each gun is specified by the B.C.
"Ordinary Salvo Fire," "from right (or left)."	Fire by salvoes in succession from the right (or left) group (unless any other is specified) continuing till further orders, unless the number of salvoes from each group is specified by the B.C.
"Independent Salvo Fire."	Fire by salvoes independently and as rapidly as possible until further orders.
"Running Past" ("R.P.").	Fire directed on Running Past points, the succession and rate being determined locally.

Section VI.—Orders of Fire.

In giving the order of fire, the B.C. will invariably prefix to the designation of the group or groups to which he intends it to apply, thus: "A Group, Slow Fire," or "B and F Groups, Ordinary Salvo Fire from the right."

In all the above cases, unless orders to the contrary are given by the B.C., guns, except H.A. fire guns, after firing will be at once reloaded with the same charge and projectile by command of their gun captains. At H.A. fire guns the order to load will be given by the G.G.C. in case a different charge may be required.

He will give the order with moving target immediately the prediction for the next round is received, with a standing target immediately the group has fired.

At slow fire or slow salvo fire the B.C. will give the G.G.C. the order "Shot" whenever he wishes a gun or a group to fire.

At slow fire the G.G.C. will select the particular gun which is to fire.

The other orders of fire will be followed by the order "Commence Firing," excepting that when changing from one order of fire to another, the new order of fire will be taken up by the next gun or group to fire, without any special order to commence firing.

When using salvo fire, either slow, ordinary, or independent, the guns of a group will fire as nearly as possible simultaneously, but in the event of one or more of the guns not being ready, the fire of the group is on no account to be delayed. The guns which are ready will be fired, and the remainder will wait for the next salvo.

During ordinary and ordinary salvo fire, the G.G.C. will give the order "Lay" to the gun or group when the gun or group next on the flank from which fire commenced has received the order "Commence Firing" from its G.G.C.

Further detail as to "Running Past" will be found in Section VIII.

The uses of the different orders of fire are, generally speaking, as follows :—

For ranging :—Slow fire or ordinary fire.

For general purposes :—Independent salvo fire, which usually gives the greatest rapidity, and still allows fire direction to remain in the hands of the B.C.

Where salvoes cannot be fired in any particular group on account of danger from blast :—Ordinary fire, by order of the G.G.C.

When the smoke from any group or groups is likely to interfere with the fire of adjacent groups :—Ordinary salvo fire from the leeward flank) or slow salvo fire.

In the event of forcing a passage being attempted, or in the case of guns firing special case, when used for defence against Raid :—Running past.

If salvo fire of any description has been ordered, and any group is unable to use it on account of danger from blast, the G.G.C. will (*a*) if independent salvo fire has been ordered, use ordinary fire until the training alters so as to enable him to use salvoes ; (*b*) if slow or ordinary salvo fire has been ordered, use a single gun of his group at the command "Shot" (at slow salvo fire), or when it comes to his turn (at ordinary salvo fire) until salvoes can safely be fired. He will take the earliest opportunity of informing the B.C. of the circumstances.

High angle fire guns will invariably use salvo fire, with, if necessary, five seconds' interval between guns, for purposes of observation.

Subsection II.—*Q.F. Guns of the Fixed Armament.*

The following Orders of Fire will be used :—

Order of Fire.	Purport.
"Slow Fire."	Fire to be by single guns at the target and with the range (except when automatic sights are used), and the deflection ordered by the G.G.C.; no gun firing without the G.G.C.'s orders.
"Rapid Fire."	Fire to begin at once and to go on independently, and as rapidly as possible until further orders, from each gun, at the target, and with the range (except when automatic sights are used) and deflection ordered by the G.G.C.
"Independent Fire."	Fire to begin at once, and to go on independently, and as rapidly as possible until further orders, from each gun, at the target selected by the gun layer (unless one is allotted by the G.G.C.) and (except when automatic sights are used) with the range and deflection estimated by the setter. If automatic sights are used the layer will estimate the deflection.

At slow fire the G.G.C. will give the order "Shot" when he wishes a gun to be fired, naming the gun which is to fire as

"A 2 Shot."

The different Orders of Fire will be used as under :—

Slow Fire :—By 6-inch and 4·7 inch Q.F. only if *absolutely necessary* to economise ammunition at long ranges. Never by other Q.F. (At peace practice, however, slow fire may be very

ceptionally used under the special conditions mentioned in art IV, Section VII.

Independent Fire :—When using automatic sighting ; or with rdinary sights, if the setter can observe the fire.

Rapid Fire :—Under circumstances other than the above.

In the case of 6-inch and 4·7-inch Q.F. when not used for efence against Raid, the B.C. will usually select the order of re to be used.

Subsection III.—*The Armament for General Defence.*

The orders of fire to be used with these guns will depend on eir nature and the conditions under which they have to act in ar, and must be settled locally, and permanently recorded.

Generally speaking Q.F. guns will follow the orders of fire id down for Q.F. guns of the fixed armament. Other guns ill conform to Field Artillery Drill, and howitzers to Siege rtillery Drill. The orders of fire for machine guns are laid wn in Part III, Section VI.

SECTION VII.—IDENTIFICATION OF SHIPS AND CHOICE OF PROJECTILES AND POINT OF ATTACK ON SHIPS.

The object of identifying ships is to enable the attack on the to be made with the most suitable projectiles, and to be directed on the parts of them which are most vulnerable.

Identification is to be performed under the F.C. Choice projectiles and point of attack is part of the duties in action the B.C. subject to any orders given previously by the F.C.

Subsection I.—*Identification of Ships.*

The F.C. is provided with a set of "Identification cards" each foreign navy, to be kept as confidential, and under lock and key, except when used for purposes of instruction or in action. On these cards are mounted photographs of typical ships of each of the various classes which may require attack by armour-piercing projectiles, each class being designated by a letter. The classes are grouped in the cards according to the leading features which are likely to be first made out as the vessel comes in sight, such as "three masts, low freeboard," &c. These are printed in large type at the head of the card. The observer as soon as he can make out the leading features of an attacking vessel selects the card on which these are printed, and by the aid of the different photographs on that card endeavours to decide to what class she belongs. If he finds that she does not belong to any of the classes illustrated on the cards, he reports her as "not classed," and she is then known to be unarmoured or only lightly armoured. If he is in doubt as to her class, he reports her "unknown."

To carry out identification satisfactorily, the observer must ve the use of a good telescope, and be situated so as to mmand a clear view to seaward from as high a site as possible. Where the F.C.'s command post is favourably situated it will rve the purpose of a look out station, and the F.C.'s observing strument will generally be available for use in identification. Where the view from the F.C.'s post is not sufficiently clear or tended some other spot fulfilling the necessary requirements must be chosen, not farther from F.C.'s post than is necessary. The observer must then be in direct communication by telephone otherwise with the F.C., to whom he will report vessels when t sighted, and their class as soon as identified.

For the other duties of observers in look out stations in nnection with raiding attack, see under "Manning and ghting Q.F. guns for defence against Raid," Section IX.

Subsection II.—*Choice of Projectiles and point of Attack.*

The projectiles available for use against ships are common ll, armour-piercing shot, Palliser shot, and Shrapnel shell. Palliser however is likely to become obsolete for B.L. guns, shrapnel for all guns. Palliser is apt to break up in the of B.L. guns, and the use of Shrapnel is superseded by hine gun fire.

The armour of ships may be either wrought iron, compound t is, iron steel faced), ordinary steel, or hardened steel (some- es called "treated" steel). The behaviour of wrought iron n struck by a projectile under given conditions is well wn, and penetrations in range tables always refer to wrought . The behaviour of compound or ordinary steel armour ively to wrought iron can be approximately gauged. lened steel however varies so widely in quality, and in its r of resistance to projectiles of different manufacture, that very difficult at present to forecast definitely the effect on any projectile except after experiments carried out under g.a.d.[1])

identical conditions. In the great majority of cases, especially now that its manufacture is better understood, immensely stronger than the first three kinds.

Wrought iron armour must be overcome by being perforated. If it is beyond the power of the gun, little harm is done, projectile, or head of it, remaining usually in the hole plugging it up. If the plate is perforated, the hole is a comparatively clean one and is easily stopped.

Ordinary or hardened steel armour yields always by fracture and though requiring greater energy and stronger projectiles overcome it, is for this reason more difficult to repair. armour which is proof against a single blow, will often yield to succession of blows which fall nearly in the same spot.

Compound armour may yield either by perforation or fracture according to circumstances.

The following table gives the comparative perforations of various kinds of armour which may be usually expected if they are attacked under the same conditions, the perforation through wrought iron being taken as the standard :—

Wrought Iron.	Compound.	Ordinary Steel.	Hardened Steel
1	$\frac{4}{5}$	$\frac{4}{5}$	$\frac{1}{2}$

The distinction between "perforation" and "penetration" must be noted. The above table applies only to perforation, not to partial penetration. For instance, a projectile which under given conditions will perforate a 10-inch wrought iron plate, should perforate a 5-inch hardened steel one under same conditions, but must not be expected to penetrate 5 inches into a hardened steel plate of greater thickness.

Common Shell forms part of the equipment of all guns.

n, it may perforate up to about half a calibre of wrought
n, and about ⅓ of a calibre of ordinary steel; if of cast steel, a
tle more in each case. It is not however intended for the
tack of any but light armour. Armour piercing (forged steel)
mmon shell may perforate something over one calibre of
dinary steel. It will be fired invariably with percussion
zes, which will cause it to burst explosively on passing
rough the lightest structures. Percussion fuzes are designed
allow of the burst taking place in the most favourable position
ll inside the structure.

he destructive effect of common shell is due to :—

(*a.*) The splinters of the shell.
(*b.*) The débris of the structure.
(*c.*) The bursting charge itself.

(*a*) and (*b*) have great effect against personnel, but little on
aterial; (*c*) with high explosives is likely to have both moral
d physical effect against personnel, especially between decks,
l to cause serious destruction to material in addition; with
wder bursting charges its incendiary effect is valuable.

t may be noted that 6-inch armour-piercing shell will per-
te 4 inches of ordinary steel at all angles of inclination up to
. Foreign ships have seldom better protection than 4 inches
rdinary steel for their Q.F. guns.

rmour-piercing and Palliser Shot are both intended for the
ack of armour. R.M.L. guns have Palliser shot only. B.L
ns at present have both A.P. and Palliser.

rmour-piercing shot may perforate up to about 3 calibres of
ought iron and about 1½ to 2 calibres of ordinary steel. They
be used for

.) Piercing the belt with a view to sinking a vessel or rendering her unmanageable.
.) Piercing the side armour with a view to injury to engines, guns, machinery, steering gear, means of

communications, and other matériel protected by them.

As regards (*a*), it must be remembered that the belt covers but a small portion of a vessel, that it must be struck on or below the water line; and that in the latter case a projectile, since it will soon be deflected and retarded, must enter the water very near the hull; hence only the most perfect practice can gain the end aimed at.

As regards (*b*) armour-piercing shot often remain nearly intact after perforation and develop very few splinters, so that the damage caused by them within the ship is generally small.

Palliser shot may perforate up to about 1½ calibres of wrought iron and over 1 calibre of ordinary steel. They might be used on old ships or against light armour with the objections to (*a*) or (*b*) given above, but in the case of (*a*) the same objection would hold. As regards (*b*) however, Palliser shot will break up in passing through wrought iron armour of a thickness of ½ the calibre or over. The energy of the fragments, however, is less owing to the absence of bursting charge.

The perforation of each of the above three classes of projectiles, besides being affected by the quality of armour and the structural strength of shell, is dependent on the striking velocity and the inclination of the trajectory to the surface of the armour. At least 1000 f.s. striking velocity is necessary for perforation of one calibre of wrought iron armour, and for other thicknesses the same proportion must hold. The velocities required in the cases of other kinds of armour can be deduced from the tables already given of comparative perforations. Caps for projectiles which are at present under trial, may, if introduced, increase the powers of penetration.

The amount of resistance of armour increases rapidly with the angle of inclination of the plates to the line of fire, and in the case of circular constructions there is only one vertical line along which maximum penetration is possible. The power to perforate

proportional to the sine of the angle at which the shot strikes. t must be remembered that the inclination is due not only to he course of the vessel, but the angle of descent of the projectile. *Shrapnel* if used with percussion fuzes has very little power of penetration. If used with time fuzes the difficulty of setting them at a quickly moving target, and of judging the position of burst from a high site are insuperable by any means which could be practically employed in action.

The selection of the projectile to use is therefore practically narrowed to a question of the use of either—

(1) Common shell or

(2) Armour-piercing or (with R.M.L. guns Palliser) shot. To assist officers in arriving at a decision, "Attack Sheets" for foreign navies are supplied. These would be available to the B.C. for reference during peace time, in order to enable him to issue any general instructions he may deem necessary, but in action would be in the hands of each B.C.

An attack sheet is provided for each class illustrated on the Identification Cards. At the head of the Attack Sheet is the photographic portrait of the typical ship, which also appears on the identification card. Immediately below is a drawing showing the structure of the ship, with a scale of yards beneath for horizontal measurement, and a vertical scale of feet fore and aft from the funnel. Below are directions for guidance in attack, and notes as to the ship's armament, thickness of armour, and vulnerable points. Unarmoured portions occupied by crew and lighter armament are shaded red, armour is shown dead black or shaded black, and any particularly vulnerable points are marked with a red star.

However heavily armoured a vessel may be, by far the larger part is open to the attack of common shell, and in this respect even the strongest ironclads are vulnerable, since thick armour cannot be placed everywhere, and the heavier it is in some parts, the lighter it must be in others; indeed, to such an extent is this

the case that the larger portion of every class of vessel, with very few exceptions, is open to this form of attack. A great part of this space is crowded with men manning the lighter guns, and with gear or machinery, the destruction of which would cause large quantities of splinters, entail loss to the crew, and diminished efficiency to the ship. In some cases the conning tower or the barbette guns, though heavily armoured themselves, may be much damaged by common shells bursting in the unarmoured portion below them.

From a consideration of all the foregoing points it is clear therefore that common shell should be in nearly all cases the projectile selected, armour-piercing or Palliser shot being reserved for the attack from heavy guns of an anchored or crippled armoured vessel at a short range.

When a vessel has been identified and her class communicated to a B.C., the attack sheet assists him in endeavouring to direct his fire on the most vulnerable or vital parts.

Where a vessel's class has not been communicated, or when time does not admit of reference to the attack sheets, a good general rule is to direct fire on the hull below the foremast, and this should always be done where ships are reported as "not classed" or "unknown." In masted vessels some of the principal guns and the conning tower are generally near the foot of the foremast, and the greater part of the crew are between the fore and mizen masts.

In the exceptional case of belt attack with armour-piercing shot, it is best to direct fire well forward, as, even if not sunk, a ship with a fore compartment filled would be down by the head and probably become unmanageable, and therefore an easy target.

SECTION VIII.—MANNING AND FIGHTING A BATTERY COMMAND.

SUBSECTION I.—*Manning a Battery Command.*

When troops are manning a battery command for the first me, the Manning Tables will show what its requirements are, nd officers and men can be allotted to the various duties at any nvenient time previous to or on their arrival at the work. he details, if any, belonging to the District Establishment will, possible, accompany the other details to the work. If this is ot practicable, they will meet them there. The details belonging o each battery command will be met as they arrive by the master nner or non-commissioned officer in charge, who will report naself to the B.C., direct him to the manning parade for his mmand, and give any information required.

When the details are well acquainted with the command they ve to man, the above arrangements will be unnecessary.

Two methods of manning may be employed, viz. :—

A. Manning as for instruction.

B. Manning as for action.

A. will be used only when details are not well acquainted th their places and duties ; B., the service method, at all other nes, whether for drill, practice, or action.

In the case of A all details will fall in on the manning parade, be marched from thence to their places in action, and every il of preparing for action will be gone through deliberately carefully.

n the case of B, details will go direct to their places in action. paration for action will not be less careful in this case, but, in

war, stores must be in their places, all tests carried out previous to manning, and at night all lamps lit. The procedure when manning for drill or practice by B. is based on this supposition.

The letters A, B, or both of them, are prefixed to those instructions below, which refer to A only, B only, or to both methods respectively.

The duties of the several officers, &c., on manning will be as follows :—

Battery Commander.

(A.) Immediately on arrival at the work (if the command is to be manned at once, otherwise on the "Assembly" sounding) the B.C. will form up the details as quickly as possible on the manning parade. As soon as the G.G.C.'s and seniors of other details have reported to the B.C. (as laid down in the following paragraphs), he will give them all the instructions that can conveniently be given before action, such as case of laying, means of range-finding, communicating orders, giving elevation, firing, ammunition supply to be used, measures to be taken on casualties to personnel or material.

If guns are not to be at once loaded with common shell he will give orders to that effect.

He will then give the order "Prepare for action," and go to his command post.

(B.) On the "Assembly," followed by the "Double," sounding, the B.C. will go straight to his command post. (If the details are fallen in under his command he will first give them the order, "Prepare for action, double.")

(A and B.) The B.C., on arriving at his command post will satisfy himself that his communications are in working order, charts, &c., ready to hand, and if D.R.F. is used, that it is properly set up.

If time admits he will await the report, "Ready for action," from his subordinates, and then make an inspection of the

groups, ammunition, stores, &c. Otherwise he will make this inspection as opportunity offers at any time before or during pauses in action.

As soon as his command is ready for action, he will report it so to the F.C.

Gun Group Commanders.

(A.) On the "Assembly" sounding, or on receiving orders to that effect from the B.C., he will fall in on the Manning Parade. As soon as his details are fallen in, he will give the order—

"..... Group, tell off," and when each detachment is told off,

"..... Group, number detachments from the front."

He will then personally make certain that the whole of his details are present, and know their places and duties in action, where to obtain their stores, &c. He will then order—

"..... Group, stand at ease," and report, "..... Group all present and correct" to the B.C., and fall in two paces from the centre of a flank of his details.

On the B.C.'s command, "Prepare for action," each G.G.C. will march his details to the group he is to man, and, arriving at the guns, will order—

"On your guns, double."

When he is satisfied that each detachment is in its place, he will order—

"..... Group, prepare for action," and see that carbines (if carried) are at once placed in the racks or receptacles provided.

(B.) On the "Assembly," followed by "Double," sounding on the B.C.'s order, "Prepare for action, double"), each G.G.C. will go at once to his group.

(A and B.) Unless stores are in position at the groups, each G.G.C. will bring from the group store any tables allotted for his use, and will see that each detachment brings up its stores in

a quick and orderly manner. He will ensure that those articles which are common to two or more guns, or to the group, are not omitted, and are placed in the positions allotted to them.

He will inspect the group store, and satisfy himself that nothing required for the working of his group remains in them.

At night he will see that the proper lamps are lighted and in the right places.

He will make sure that his G.C.'s thoroughly understand the case of laying, means of range-finding, and giving elevation, source of ammunition supply, &c., to be used, and the method of replacing casualties.

Where P.F. is installed, and Case I or II is to be used, he will see that every preparation is made for using Case III if required.

(A.) He will see that group differences are correctly marked on the gun floor, and superintend the testing of racers, yard scales, cylinders or buffers (P.F. dials and firing circuit if installed), and gauging of shell.

He will ascertain that all his communications, electrical or otherwise, are in working order.

He will inspect his shell and cartridge depôts, and see that projectiles and gaschecks are thoroughly clean, and gaschecks slightly smeared with oil.

As soon as all the guns are reported by the Gun Captains "Ready for action," he will make a formal and thorough inspection of his group, gun by gun. As each detachment is inspected it will be called to attention by its G.C. Each man will then sit or stand up in his proper place to attention. When the G.G.C. has passed, the G.C. will order, "Sit (or stand) at ease."

In default of orders to the contrary from the B.C., the G.G.C. will then give the order to the group to load with common shell and percussion fuze.

He will then report to the B.C.—

"..... Group, ready for action,"

(B.) In default of instructions to the contrary from the B.C., the G.G.C. will give the order to load with common shell and percussion fuze to each gun as soon as its G.C. reports it, "Ready for action." As soon as all are loaded and run up he will report to the B.C.—

"..... Group, ready for action."

He will superintend the tests, and make the inspection mentioned under A above as opportunity offers, but will not defer loading or making his report to the B.C. for the purpose of carrying them out.

(A and B.) If at any time he finds anything out of order which cannot immediately be put right, he will report to the B.C.

He will call his group to attention (if sitting at ease) when the B.C. inspects it, will accompany him on his inspection, and give "Sit at ease," when he leaves it, unless there is work to be carried out.

Gun Captains.

(A.) On the "Assembly" sounding (or on being ordered to fall in) each G.C. will fall in on the manning parade with his own detachment, and will at once satisfy himself that all his men are present, and in their proper places.

On the G.G.C.'s order to tell off, detachments will be told off simultaneously in the ordinary manner.

On the order, "Number detachments from the front," the G.C. of the leading detachment will number his detachment "Detachment A1" (or as the case may be), the others numbering similarly in succession.

On the command, "On your guns, double," each G.C. will form up his detachment in rear of the gun he is to man, and facing the front.

On the G.C.C.'s command, "Prepare for action," each G.C. will see that the carbines, if carried, are at once placed in the racks or receptacles provided for them, and will then lead his detach-

ment as quickly as possible to the group store, and see that each man brings up his appointed stores, and that preparation for action is correctly carried out, differences marked for his own gun, racers, yard scales, cylinders or buffers tested; also P.F. firing circuit if F.F. is installed, that his shell and gas checks are clear, and gas checks oiled. He will then place his men under cover, sitting (or standing) at ease, and report to the G.G.C.

When the G.G.C. inspects his gun, he will call the detachment to attention, accompanying the G.G.C., and order the detachment to sit (or stand) at ease when he has passed.

(B.) On the "Assembly," followed by "Double," sounding (or on the B.C.'s order, "Prepare for action, double"), each G.C. will go at once to his own gun, and see that his detachment do the same. He will see that his gun is in all respects ready for action, and will then report to the G.G.C.

He will make the tests and inspection mentioned above under A as opportunity offers, but will not defer his report to the G.G.C. for the purpose of carrying them out.

(A and B.) If at any time he finds anything out of order which cannot be immediately put right, he will report to the G.G.C.

Range Group Commander (or Senior non-commissioned Officer of the B.C.'s Staff).

(A.) On the "Assembly" sounding (or on receiving orders to that effect from the B.C.) he will fall in on the manning parade, and will see that all the B.C.'s staff are present and in their proper places, and know the duties they have to perform, where to obtain their stores, &c. He will then report to the B.C.—

"B.C.'s staff all present and correct" (and if R.G.C. fall in two paces from the centre of a flank of the B.C.'s staff).

On the B.C.'s order, "Prepare for action," the R.G.C. will go with the P.F. operator to the range group.

Other details will bring up their stores, go straight to their laces, and prepare for action.

The R.G.C., as soon as he is satisfied that the P.F. instruments ave been correctly prepared for action, will report to the B.C., Range Group ready for action."

(B.) On the "Assembly," followed by "Double, sounding, or n the B.C.'s order, "Prepare for action, double," the R.G.C. (if here is one) and all members of the B.C.'s staff will go as uickly as possible to their posts, and see that their instruments, c., are in all respects ready for action.

The R.G.C., as soon as he is satisfied that all the P.F. instruments have been correctly prepared for action, will report to the B.C., "Range Group ready for action."

mmunition Officer (or Senior N.C.O. of the Ammunition Detail).

(A.) On the "Assembly" sounding, or on receiving orders to he same effect from the B.C., he will fall in on the manning arade, and will see that all the ammunition detail are present, now the duties they have to perform, where to go, &c., and hat they are acquainted with the regulations for safety in agazines (see Part I, Section IV).

He will then report to the B.C., "Ammunition detail all resent and correct," and will fall in two paces from the centre a flank of the ammunition detail.

On the B.C.'s order, "Prepare for action," he will see that the etails go direct to their places in action and prepare to supply mmunition.

He will make an inspection of all sources of ammunition pply, main and expense magazines, cartridge and shell stores, nd ensure that his men are properly posted, and know which mmunition to issue, and in what order, that all appliances fts, &c.) are in working order, and lamps ready to light (or hted if required).

He will ensure that the regulation for magazines (see Part I Section IV) are carried out.

He will then report to the B.C., "Ammunition detail ready for action," and will continue to superintend the work of his men as may be required.

(B.) On the "Assembly," followed by the "Double," sounding (or on the B.C.'s order, "Prepare for action, double," the A.O. will see that his details go direct to their places as quickly as possible, and make all preparations mentioned under A. He will ensure that the proper precautions are observed as under A.

As soon as he is satisfied that everything is in working order, he will report to the B.C. as under A.

He will make a complete inspection as ordered under A, but will not defer his report to the B.C. in order to do so.

Permanent Staff.

(A and B.) The duties of the above in the case of A or B will be decided as laid down under Permanent Staff, Section X, Subsection VI.

As a general rule when a work has to be manned, whether by A or B method, the district gunners would proceed at once to their guns, so that all doors may be unlocked, lamps lighted, and stores ready for issue, if not kept so always, by the time the group details arrive.

"*Cease Firing. Replace Stores.*" (A and B.)—When "Retire" is sounded or "Cease firing. Replace stores," ordered, all details as soon as they have replaced their stores (unless orders to the contrary are given) will fall in in their places on the manning parade.

The Battery Commander will then collect reports as to casualties and expenditure of ammunition, and will transmit them in writing to the F.C.

Subsection II.—*Fighting a Battery Command.*

A battery command may be fought by either P.F. or D.R.F. (or some groups by one, and some by the other) in the ordinary way, or by running past points.

There is much variety in range-finding installations, and forts and batteries differ widely in their construction, and in the conditions under which they are intended to act. So that it is evident that the method of fighting a battery command cannot be satisfactorily laid down to meet all possible cases. All that can be done is to indicate principles of action. The particular methods most suitable in each case must be studied locally, and permanently recorded.

Four typical examples will be dealt with, viz.:—

(*a.*) An open work with P.F. installed.
(*b.*) A casemated work with P.F. installed.
(*c.*) An open work with one D.R.F. installed for each battery command.
(*d.*) A casemated work with one D.R.F. installed for each battery command.

Remarks on—

(*e.*) Fighting by running past points are added.

(*a.*) *An open work, with P.F. installed.*

The B.C.'s position will be normally at his command post, but he may leave it if necessary, provided that he arranges for a responsible person to remain there to receive and carry out orders from the F.C., and to observe and correct fire if the B.C. is unable to continue doing so.

Where observation of fire from B.C.'s post is difficult, arrangements should be made for carrying it out with the help of an (g.a.d.')

observer to a flank, or on a higher site, as described in Part IV Section VII, para. 6.

Indication of target.—When the enemy approaches, the F.C will inform the B.C. what target he wishes him to engage. The information may be conveyed to the B.C. by telling him the square the target occupies at the time, or by description, such as "leading ship," "second ship of starboard division," &c., according to circumstances. The square system is not recommended unless the target is stationary, or nearly so; and, even then, not unless description is impossible. It is rarely successful with a moving target. At the same time, the F.C. will, if possible, inform the B.C. of the class of the ship. Whatever the message may be, the B.C. will at once transmit it to his R.G.C. (or P.F. operators), and the P.F. instruments will be brought to bear as ordered.

It will generally be possible for the B.C. to assemble his G.G.C.'s, and actually point out to them the target, if using Case I or II. If so, this method is to be preferred, as target indicator tables are generally unsatisfactory at a moving target.

Case of laying.—Any Case can be employed as the B.C. thinks fit, but it should be borne in mind that whenever it is possible guns should be laid for direction over the sights.

Commencement of fire.—On receiving the order to commence firing from the F.C., the B.C. will lose no time in carrying it out, using the orders of fire most suitable to the case.

B.C.'s corrections in range and deflection will be made in accordance with Part IV, Section VII. Range corrections will be communicated to the R.G.C. (or P.F. operators). Deflection correction to the G.G.C., except with Case III, when they will be communicated to the R.G.C. (or P.F. operators).

Although fire should not, as a rule, be opened without the F.C.'s order, the B.C., if he has received no orders on the subject by the time the enemy has arrived within the fire area of any of his guns, will ask the F.C. for instructions, and, in default

iving any, will exercise his discretion as to the opening of
Want of orders may be due to interrupted communication,
undue delay may cause diminished effect.
t must however be borne in mind that guns not firing
keless powder must never be used when their smoke is
ly to inconvenience Q.F. guns in dealing with raiding attack.

Gun Group Commanders (Cases I and II).

s soon as each G.G.C. receives orders as to the target, he
point it out to his G.C.'s and G.L.'s, and see that his guns
kept trained on it with approximately the right elevation.
Ie will see that the orders as to deflection are carried out at
h gun.
As soon as he receives the order, "Shot" or "Commence
ng," he will make his prediction (if one is necessary), and
e the final range to his group, or that gun of it which is the
t to fire. (But he will not do this in the case of ordinary
vo fire, if fire does not begin with his group, till the group
t before his to fire has received the order, "Commence
ng," from its G.G.C.).
A G.G.C.'s prediction is the range selected by him, on the
earance of which on the dial he intends to order his group
gun to fire, and is in advance of that shown by the dial at
time by about the distance which he estimates that the
ge will increase or decrease before final laying is completed.
actual range given to the group or gun will not necessarily
the same as the predicted range, since this may be subject to
e of the corrections, such as that for displacement, which it
casionally the duty of the G.G.C. to make.
Where the range is "constant" no prediction is necessary.
Should the dial show the predicted range before the group or
is ready to fire, the G.G.C. can order "Fresh lay," and make
w prediction, but it is not advisable to incur the delay which
causes unless the range is likely to have altered considerably

before they are ready. To decide quickly on this point is often most difficult, and requires experience and readiness on the part of the G.G.C.

The following example illustrates the above explanation. The G.G.C. has noted that the range is decreasing at about the rate of 50 yards in 10 seconds. He receives the order to "Commence firing" when the dial is showing 2225, and he knows that it will take his guns about 10 seconds to be laid and ready. He therefore decides to fire when the dial shows 2175, and this is the predicted range. But there is a difference correction of + 25 yards, due to the P.F. in use being that belonging to another group. The final range which he gives to his guns is therefore 2200 yards. When the range 2175 appears on the dial he orders "Commence firing."

Considerable practice is required in making predictions for final range; if they are too long, valuable time is lost, if too short, the G.L.'s are hurried; knowledge of the channel will be of great value to the G.G.C. The rate of movement of the dials should be carefully noted, as well as what the detachments are doing; an officer of experience can generally estimate how soon they will be ready to fire.

The G.G.C. will insist on all work being carried out smartly and quickly, but will always take advantage of pauses in action to allow his men to go under cover and sit easy, so as not to fatigue them unnecessarily.

Gun Captains (Cases I and II).

As soon as the target is indicated by the G.G.C., the G.C. is responsible that the gun is kept trained on the target, and elevated according to the dial, so as to be ready for the final range.

He will make racer corrections if necessary.

When the G.G.C. orders, "Commence firing," he will be careful that all is correct before ordering his gun to fire.

He is responsible that drill is carried out smartly and correctly, far as his gun is concerned.

Gun Group Commanders (Case III).

He will order the switch to be put to lay at the time directed making his prediction under *Gun Group Commanders ases I and II).*

Gun Captains (Case III).

The principal duty of the G.C. peculiar to this case is care for safety of his detachment; he must never put in the firing g till all are clear, and if "Fresh lay" is given, permit no n to go to the gun until he has taken it out, and given the er, "Take post to lay."

Range Group Commander.

In all three cases the R.G.C. will carry out as complete super- on as possible of the observers, and will be careful to inform B.C. if anything goes wrong, either with the material or *onnel* of his command. He will receive and transmit to his ervers all the orders of the B.C., unless the location and mber of the cells renders this impossible.

He (or in his absence the senior observer) will at once report the Battery Commander if an instrument is out of order from cause, so that alternative methods of fighting the guns of group for which it was working may be taken up at once.

Ammunition Officer.

During action he will exercise a careful and constant super- over the whole of the supply, and keep note of all the nition expended.

The ammunition officer should do all in his power to assist B.C. in arriving at a knowledge of the state of his powder.

Though for peace practice it will often be advisable to use small batches of ammunition to prevent accumulation, in act war the main point would be to ensure the greatest uniform of shooting by using the largest batches possible.

A B.C. should always be informed when it becomes necess to issue cartridges from a fresh batch.

All temporary depôts and expense stores will be filled from the main magazine and shell stores as the ammunition them is expended, unless orders are given to the contrary.

After action he will see that all lights are extinguished, that all stores are properly closed and secured, unless orders the contrary are issued.

He will subsequently make a detailed statement to the Bat Commander (or other responsible officer) of all ammuni expended and the remains.

(*b.*) *A casemated work, with P.F. installed.*

Except as stated below, the remarks under (*a*) apply.

Indication of Target.—The *Indication of target to G.G.C.'s* Cases I and II will generally be a matter of difficulty. possible, the B.C. should assemble the G.G.C.'s, and person point out the target to them. With a slow target, the tar indicator tables might be successful. Or, the target hav been indicated to the P.F. operators, and picked up by the the B.C. might indicate it to G.G.C.'s by directing them refer to the dials for its range and training. They would th proceed as described in Section IV, Subsection IV.

Case of Laying.—It may sometimes happen that in instance Case III alone can be employed, and there may e be occasions when this is difficult to carry out. Local arran ments must then be made to meet the case, and permanent recorded.

Whenever possible, however, Case II should be employed.

Commencement of Fire.

With guns as crowded as they are in most casemated works, special care will probably have to be given to the order of fire, if Cases I or II are employed, to avoid groups inconveniencing each other by smoke.

(c.) *An open work, with one D.R.F. installed for each Battery Command.*

Except as stated below, the remarks under (*a*) apply.

Indication of Target.—To G.G.C.'s as under (*a*). The B.C. will personally point out the target as soon as possible to the D.R.F. operator.

Case of Laying.—Only Cases I and II can be employed.

Commencement of Fire.—The remarks on ranging and orders of fire under (*a*) apply, but B.C.'s range corrections will be put on the range indicator at the D.R.F.

Gun Group Commanders.—As under (*a*) G.G.C.; Cases I and II. The instructions for prediction under (*a*) apply equally to this case, D.R.F. and range indicators taking the places of P.F. and dials. Difference corrections will almost invariably have to be applied. Quickness and certainty in predicting can never be attained unless B.C. and G.G.C.'s are accustomed to work together, and place mutual trust in each other.

Gun Captains.—As under (*a*) G.C., Cases I and II.

Range Group Commander.—There will not be one.

(*d.*) *A Casemated Work, with one D.R.F. installed for each Battery Command.*

The remarks under (*a*) apply except as stated below.

Case of Laying.—See under (*c*).

Indication of Target.—See under (*b*), except so far as relates to indication by P.F.

Commencement of Fire.—See under (*c*).

Gun Group Commanders.—See under (*c*).
Gun Captains.—See under (*c*).
Range Group Commander.—There will not be one.

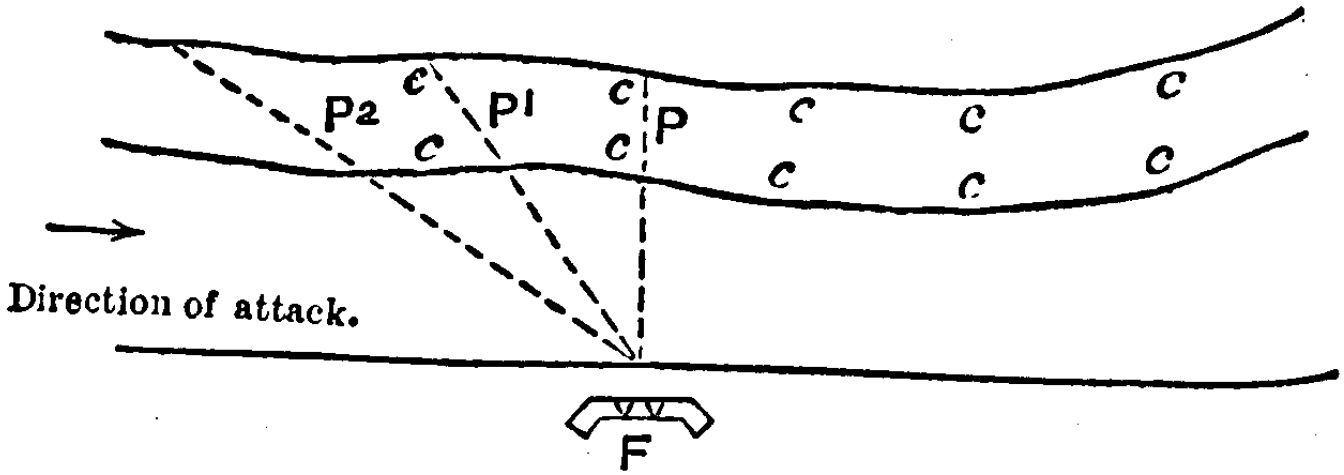
(*e.*) *Fighting by Running Past Points.*

1. *In the event of Forcing a Passage being attempted.*

There is one point at which fire is likely to be most effective, viz., when the ship is at the shortest range, and the line of fire is at right angles to her side.

Hence this is the spot where the heaviest fire should be poured in, and the whole scheme must be arranged so as to ensure its being done.

The following diagram will explain the principle which should be followed, such modifications as local considerations may necessitate being applied.



F is a fort protecting a channel *c c*, F P is the shortest range at which the line of fire is normal to the vessel's armour, and is the spot for the main salvo. Taking the highest speed at which ships can enter and the time necessary to ensure every gun being ready after a previous round, a second point P¹ should be laid down; this is the last spot at which a round should be permitted, any guns which cannot be fired here should reserve their fire.

At least three minutes should be allowed to ensure this round being ready; P^1 will be fixed so as to give this. Supposing the range of P to be 1,500 yards and the speed of the vessel 14 knots, the latter will pass over about 1,400 yards in three minutes. This will give P^1, and its range will be about 2,050 yards. A second point P^2 may be calculated on the same scale of time, and its range would be about 3,170 yards.

Under these conditions tables may be drawn up defining the points, and this information should be entered in the fort record book and fighting books, and the racers of the guns should also be marked for the direction.

The position and number of the points must vary according to the direction of, and range to the channel.

On the same principle fire can be defined, and continued beyond P on the inner side. This continuance will, however, in the case of the intermediate forts of a line of defence, be seldom judicious till the last ship is passing; their best and most necessary work lies with the ships at the most practical range.

It would appear desirable that every endeavour should be made to disable the leading ship—a vessel sinking, unmanageable, or unable to keep her station, would delay all behind her unless the channel were a wide one.

2. *Against Raiding Attack.*—Similar arrangements must be made in the case of guns provided with special case for use against torpedo boats. In this case it will probably not be desirable to attempt to traverse or elevate the guns.

A fixed elevation and training, different for each gun, so as to cover the channel, or the most important part of it, with the head of the shot is most likely to produce effect.

Details must, however, be arranged locally to meet the particular requirements of each case.

SECTION IX.—MANNING AND FIGHTING Q.F. AND MACHINE GUNS FOR DEFENCE AGAINST RAID.

In time of war the strain on the manning details at these guns is certain to be very severe. They must be on the alert day and night, perhaps for months, and ready to man the guns if required at a few seconds' notice. Under the most favourable circumstances warning of attack cannot be expected to reach them more then a few minutes before they are required to open fire, and when they do so their targets will probably be numerous, very speedy, under fire for a very short time, and perhaps only dimly visible. (See Sections II and III.)

It is clear therefore that officers and men must be particularly selected for smartness and activity, and that very special training and organisation are a necessity. In the absence of any war experience under like conditions, close study of the probable needs of service is indispensable before definitely fixing any details connected with manning and fighting these guns. The experience gained from the blank practice in combination with the Royal Navy should be of the greatest assistance.

Precise arrangements must be made with the utmost care locally after consideration of the special requirements of each case. The following instructions are intended to serve as a guide to this end.

Subsection I.—*Manning.*

Under the conditions outlined above, reliefs are a necessity, and accommodation for these must be provided in the immediate vicinity of the guns.

Two reliefs will probably be sufficient. The relief on duty will remain on the guns, and at night will bivouac alongside of them, making use of any shelter that is provided or can be improvised.

Where convenient depôts to hold an ample supply of ammunition exist in close proximity to each gun, a relief for the ammunition supply party will probably not be required, but they and the relief off duty must turn out at once on the first gun firing. The ammunition party will then proceed without further orders to replenish the ammunition depôts; the relief off duty should fall in at any convenient place, previously appointed, close to the guns, so as to be available to replace casualties, or men fatigued in action.

If fixed ammunition depôts close to each gun do not exist, some place convenient for rapid supply must be selected, and at all events a few rounds stored there.

All spare parts and stores belonging to the guns must be disposed under cover close to them, so as to be available for refitting at the shortest notice.

There should always be communication from each group, or where groups are not much scattered, from a central group to the look-out station or F.C. post. (See Section III, Subsection I.) The means of communication, telephonic, visual, or otherwise, must never be left unattended, and where it serves more than one group, orderlies will probably be required to carry warnings. Reliefs for these details must also be provided.

A relief going on duty will be carefully inspected by its G.G.C., who will satisfy himself that all details are present and know their duties. They will then be marched on their guns as soon as the relief going off duty has been withdrawn from them, and ordered to "Prepare for Action."

Although the guns should always in war be kept prepared for immediate action, it is desirable that preparation for action should be formally carried out when each relief goes on duty, in

order to prevent defects which may occur after the first preparation for action, going unnoticed. Each G.C. will report "All Correct" or otherwise to the G.G.C. as soon as he has prepared for action.

The relief going off duty will not be marched off or dismissed till the G.G.C. of the relief going on has satisfied himself that no stores are deficient.

The G.G.C. will be particularly careful to see that the breech and firing mechanism and firing batteries are in good working order, sights properly fitted (if automatic, adjusted), and means of illuminating them by night correct; ammunition ready for immediate issue, lamps ready for use, spare parts handy and ready for fitting, communications with the look-out station and elsewhere in good order, and that the man attending them understands any code or signals provided.

When sights are not provided with their own means of illumination, arrangements must be made to admit of laying by night. This is generally best effected by chalking the foresight, and causing a bull's eye lamp to be held or fixed so as to illuminate it.

Where there is a rise and fall of tide, automatic sights must be readjusted at frequent intervals.

Every firing battery should be tested once in each relief with a primer in an empty cartridge.

Spare parts should be occasionally fitted, but to avoid guns being out of action if required at short notice, this should be done gun by gun, and never at night or in thick weather.

Lamps should be lighted half an hour before dark.

When the G.G.C. is satisfied that everything is ready for immediate action, he will allow his detachments, with the exception of one man for watch duty at each gun, to break off, but will on no account himself leave the group, or allow any man of a detachment to leave the immediate vicinity of his gun without permission, which should be most sparingly given, and as a rule

only when the man can be temporarily replaced by one of the relief off duty.

The man on watch at each gun will be frequently relieved, in order to avoid tiring his sight. He will remain by his gun and keep a continuous and sharp look out to seaward, reporting to the G.G.C. at once any vessel which approaches. Where the siting of the group does not allow of a clear and extended view to seaward, it will be advisable to select an additional watch post, where one can be found, as near as possible to the group, and keep it constantly manned and relieved in the same way as the watches on the guns. Endeavours should be made to train men at watch duty at the guns by day and night, so that they may be able to recognise the different types of vessels and describe them and their position accurately.

At night or in thick weather, guns will be kept loaded, but the breech will be left open. Machine guns will be kept ready for rapid fire.

At night, it will probably be advisable to keep the guns of a group trained on divergent lines, so as to divide between them and cover the outer limit of the illuminated area, and to set the sights of each gun at a range corresponding to the distance of this limit at the training given. By this means wherever a boat may first appear, at least one gun should be ready to fire without delay.

Where guns are so close together that the flash from cordite charges has a blinding effect on detachments by night the endeavour should be made to erect screens so that men may not be exposed to the flash of adjacent guns; that from their own will generally be screened by the shield.

Subsection II.—*Fighting.*

Commencement of Fire.—If the G.G.C. receives warning from the look-out station of impending attack, he will at once order

his detachments to take post and load (if the guns are not loaded), and make every preparation for opening fire as soon as the enemy appears within range.

By day.—When any craft is reported by one of his men on watch, he will make a careful scrutiny of it, and if he considers it in any way suspicious, will refer to the look-out station for identification of it If obviously hostile, or if reported so by the look-out station or by the examining vessel, or in the case of a torpedo boat which is unable to prove itself friendly, he will (in the absence of any local orders to the contrary) open fire as early as possible.

By night.—He is responsible for the immediate opening of fire on any small craft he may see. When any boat or vessel is reported to him, he must come to an instant decision as to whether it is of a type which he is bound to attack. Torpedo boats will invariably be treated as hostile unless they can prove themselves to be friendly. It is extremely unlikely that friendly boats will be allowed to enter the illuminated area at night, owing to the impossibility of distinguishing at the guns between friend and foe, but should they be permitted to do so, some secret signal would doubtless be agreed upon locally, and promulgated to those concerned. Such permission, however, is strongly to be deprecated, as greatly enhancing the difficulties of the defence, and entailing responsibility and anxiety to the G.G.C., whose duties will in any case be onerous enough. In the absence of any special arrangements of this nature, a friendly boat entering the beam of a light does so at her own risk, and if sunk or disabled is alone to blame.

If the G.G.C. decides to open fire

(i) where automatic sights are in use, or if the setter can observe the fire, he will at once give the command "Independent Fire," and may allot to each gun its target, or leave the gun layers to select them as he considers best.

(ii.) Under other circumstances he will give the range and

deflection, and the command "Rapid Fire." Fire will then be carried on as laid down in Part IV, Section VII, B.

By night or in thick weather, when it is important to take advantage of every second that a boat is visible, the first round at each gun should be fired by the man on watch at it, but the detachment will immediately take post, and fire will be continued in the usual way.

Selection and indication of Target.—Where an attack is made in force, selection and indication of target will probably be matters of extreme difficulty, particularly at night, owing to the large number of boats in view at the same time. Efficient distribution of fire is of the utmost importance, and previous understanding between groups as to selection of targets would appear to be necessary, in order to avoid one or two boats drawing the whole of the fire, while the rest escape it. Whatever scheme for the distribution of targets is approved should be thoroughly understood by all G.G.C.'s and (in case of independent fire) gun layers concerned.

Indication of target can probably be best effected by both describing and pointing to the boat selected.

Orders of Fire.—On account of these difficulties and for the sake of rapidity "Independent Fire" will be the normal order of fire when automatic sighting is used, or when, with ordinary sights, the setter can observe the fire and correct the elevation. Under other circumstances "Rapid Fire" will be used.

Observation of Fire.—In all cases the G.G.C. must keep a careful watch on the effect of his fire. When using rapid fire and ordinary sights he should endeavour to gain assistance in estimating the range from a knowledge of local sea or shore marks, if any are visible. He must be careful not to be misled in his observation of fire by rounds fired at the wrong target, or from other groups, or, especially at night, by shells grazing short of the target, and bursting on ricochet.

Deflection and Point of Attack.—Deflection will require

watching. The endeavour should be made to direct fire as below :—

(1.) At the part of the boat occupied by the boilers, injury to which will entirely disable the boat. 6 and 3-pr. Q.F. guns have however hardly power enough for the effective attack of boilers, especially when the coal bunkers which protect them are fairly full. Or :—

(2.) At a point well forward, for choice in the bow wave, so that by filling forward the boat may become down by the head and unmanageable.

If (2) is aimed at, deflection may be almost disregarded if the bow water line is laid on, or at all events very little change will probably be necessary, as the travel due to the time of flight will tend to bring the projectile to the right spot.

But in the case of (1), if the bow water line is laid on, and the approach is, as usually happens, in a straight line diagonally across the front of the group, more deflection will be required as the target gets nearer, for the followlng reason :—The boilers of a torpedo boat or destroyer are situated about midway between stem and stern, or roughly (with a 1st class boat or destroyer) from 70 to 100 feet from the stem. At the beginning of a diagonal approach the keel of the boat will at most coincide with the direction of the line of fire, and therefore little or no deflection will be required. As the boat approaches and passes the group the line of fire will ultimately become almost perpendicular to the keel of the boat, and nearly the whole of the 70 to 100 feet will have to be allowed for by giving deflection *to the side from which the boat is coming.* The shell of a 12-pr. Q.F. laid without deflection on the stem of a boat distant about 300 yards, and moving 20 knots at right angles to the line of fire, will only strike about 15 ft. aft from the stem. Consequently to attack the boilers would require from about 4° degrees to 6½ degrees deflection towards the stern. This is a greater deflection than any sights admit of.

With the 12-pr. therefore, which has power enough to penetrate full bunkers and burst with destructive effect among boilers and machinery, it may be well to select the waterline under the foremost funnel as the part to lay on. With automatic sights this would also have the advantage of getting rid of the inaccuracy likely to be caused by false height due to the bow wave except at short ranges. With all sights it would reduce the deflection necessary to the same limits as in the case of (2).

SECTION X—SUMMARY OF DUTIES OF OFFICERS AND OTHERS.

SUBSECTION I.—*The Fire Commander.*

He is charged with Fire Control. (See Section III, Subsection II.)

On taking up his duties he becomes responsible to the Section Commander for the efficiency and general preparedness for war of his entire command in every detail.

He must be well acquainted with the general scheme of defence for the fortress, and especially with such portion of the artillery scheme as relates to his particular command, and will see that the provisions of it are carried out. (See Fighting Book Section III.)

Any defects or deficiencies he must endeavour to make good at once with whatever means may be at his disposal.

He must have a full knowledge of the nature and position of obstructions, electric lights and mine fields, and must have concerted action with the officers responsible for them either directly or through the Section Commander, as the latter may direct.

He must also be aware generally of the disposition, &c., of the infantry or field force, if any, protecting the rear of his command.

He must ensure that all his subordinates are conversant with the duties required of them under all circumstances, and are constantly practised in them; and that all permanent orders and instructions relating to them are carefully recorded and available for reference to those concerned

The Senior Fire Commander of a section will act as artillery adviser to the Section Commander.

Subsection II.—*The Battery Commander.*

He is charged with Fire Direction (Section III, Subsection II), and is responsible to the F.C. for its proper performance.

He is responsible to the F.C. for the efficiency and general preparedness for action of his command in every detail.

Any defects or deficiencies he must report to the F.C., and endeavour to make good at once with whatever means may be at his disposal.

He must be acquainted with the general scheme of defence for the fortress, and thoroughly conversant with such portions of the Artillery Scheme as relate to his particular command. (See Fighting Books, Section III.)

He will ensure that all his subordinates have a thorough knowledge of the duties required of them under all circumstances, and are constantly practised in them; and that all permanent orders and instructions relating to them are carefully recorded and available for reference to those concerned.

Subsection III.—*The Gun Group Commander.*

All guns except Q.F. guns used for defence against raid.

The G.G.C. is responsible to the B.C. that his group and all details and stores connected with it are efficient and fit for action. He will conform generally to the directions of Section VIII.

In action he will always be with his group, and is responsible for discipline in it, and for the quick, quiet, and efficient service of his guns.

He will ensure that the ammunition required for the immediate service of his guns is always ready to hand.

No gun of his group will be fired without his order.

He has normally nothing to do with selecting the order of fire, projectile, or target, with ordering the commencement of fire, or with observation of fire But in case of damage to range finding instruments or failure of the ordinary communications with the B.C., he must not hesitate to take upon himself the responsibility for independent action in these matters.

Q.F. guns used for defe nceagainst raid.

He is responsible for fire direction as defined in Section III, Subsection II.

He will be always present with his group, and will carry out the directions of Section IX, subject to any local orders which may be given.

Subsection IV.—*The Range Group Commander.*

He is responsible to the Battery Commander (or Battery Commanders) that all instruments in his charge, and the communications belonging to them, are in good order, and the operators properly trained.

In action he will exercise a general supervision over them. He must therefore have an intimate knowledge of the P.F. and the method of working it.

In action he will receive orders as to targets and correction of fire. Such orders must however be at once acted on by the operators at the different instruments in the event of his not being actually present in the particular cell at which an order is received.

He will conform to the directions of Section VIII, but the necessity or otherwise for a Range Group Commander depending entirely upon local conditions, the actual details of his charge and duties must to a great extent be decided by those in command at a station where he may be required.

Subsection V.—*Ammunition Officer.*

The duties of the ammunition officer and the detail under him go as far as the delivery of cartridges and shell either (*a*) at the doors or top of the lifts of the main magazine and shell stores, if these are used as expense stores; or (*b*) at the doors or top of the lifts of the expense stores; or (*c*) at the depôts, if used. The supply to the guns from the outside of the doors or top of lifts of the main magazine and shell stores in the case of (*a*), or from the outside of the doors or top of the lifts of expense stores in the case of (*b*), or from the depôts in the case of (*c*) will be carried out by the gun numbers.

The ammunition officer is responsible that everything connected with the supply as above is in good order, the men properly told off according to the Manning Table, and that they know their duties.

He will conform in action to the directions of Section VIII.

Subsection VI.—*The Permanent Staff.*

The officers forming the permanent staff of the artillery of a fortress have their stations and duties assigned to them at the discretion of the C.R.A. They include

C.R.A.
One or more staff officers.
Armament officers.
Instructor in gunnery.
Instructors in range finding.
District officers.

The duties of these officers in action will be settled locally, and be detailed in the Artillery Mobilization Tables and in all Fort Record Books.

Section X.—Summary of Duties of Officers.

The warrant officers, N.C.O.'s and men permanently attached, are as follows :—

Master gunners.	Machinery gunners.
Armament artificers.	District gunners, and Storemen.

The position in action of a master gunner is at the artillery store of the portion of the armament under his charge. He is in immediate charge of the district gunners, and is responsible for the custody and issue of stores of all kinds.

Artificers are detailed according to local requirements and are under the immediate command of the Inspector of ordnance machinery. Their positions in action will be decided locally.

Their duties are the care and preservation of the gun mountings, and of all mechanical details connected with the fort.

The district gunners are immediately responsible to the master gunner for the care and cleanliness of the guns, mountings, stores, &c., placed in their charge. They should, as far as is possible under the local conditions obtaining, be permanently employed in order that they may have an intimate knowledge of the gun and mounting, and all stores connected with it, which is under their care, and also of the storage and means of supply of the ammunition for the same.

As a great deal of the daily routine work of a district gunner has, especially where the guns of a master gunner's charge are much scattered, to be performed without constant personal supervision, it is most desirable that they should be reliable men, and not frequently changed.

The duties both generally and in action of district gunners, as well as the number required for each work, should be defined locally and recorded in the Fort Record Book.

SECTION XI.—EXERCISES IN COAST DEFENCE.

1. With a view to encouraging the study of the method whereby an attack by hostile vessels upon coast fortresses may be best prepared for and defeated, officers of Garrison Artillery will be required to solve problems during the winter months in connection with a supposed attack on the fortress in which they are quartered.

2. The solution of such problems will take the place of the reconnaissance and road sketches for officers of other branches, (*vide* Queen's Regulations).

3. The exercises will be set by the C.R.A., and after completion by the officers to whom they are allotted they will be criticised in writing by majors of batteries and lieutenant-colonels commanding. They will then be considered by the C.R.A., who will cause his remarks on them to be communicated to the officers concerned by lieutenant-colonels commanding.

4. In order to facilitate the preparation of such exercises, examples are given here showing the character which they should assume. These examples may be modified or enlarged as required. The "General Idea" and the Instructions are to be drawn up by the instructor, who may be the C.R.A., or an officer appointed by him, and to be given to the officer who is to execute the exercise.

5. The exercises drawn for any given fire command or battery command may be varied from time to time by introducing any casualties which would be likely to occur, by altering the number of men available, &c., &c.

6. It is desirable that every captain and subaltern officer should solve one of these problems during the winter months,

provided that the C.R.A. shall have full discretion to employ an officer in the preparation of charts, fort books, coast surveys, &c., or any other kind of practical and useful work, instead of employing him in the solution of such problems.

7. The books of reference required in the solution of these problems are those found in the company and sub-district offices, with the addition of the Fort Record Books and attack sheets.

EXERCISE No. I.

(*Note.*—This is an example of the form of exercise which should be set to officers supposed to be acting as Fire Commanders).

GENERAL IDEA.

(*To be made out by the Instructor.*)

(*a*) Name an actual fire command of the fortress in which the officer who is to solve the problem is stationed.

The fire command named is to be treated as it is, with the existing forts and communications.

(*b*) State nationality of enemy, probable ships to be expected, and date of commencement of hostilities.

(*c*) Detail the Artillery available to man the section, showing number of officers, N.C.O.s, and men, and the corps to which they belong.

(*d*) State the numbers and general disposition of the field force co-operating in the defence.

(*e*) Give the date of arrival of the several corps, and probable date of withdrawal of any portion.

(*f*) Give general positions of camping ground available.

(*g*) State what means of transport is available by road and by water.

(*h*) Indicate the locality of the mine fields, and the position and nature of any obstructions which would be made use of in time of war.

(*i*) State what electric lights are available, if these are not already established.

(*j*) Introduce any casualty which might be likely to occur to existing communications, &c., both before and during action.

ORDERS.

(*To be given by the Instructor to the Officer who is to carry out the Exercise.*)

1. Detail your own Staff.
2. Tell off the Troops, as given in General Idea (*c*) to the various works of the Fire Command.
3. Where Auxiliary Troops are employed arrange for a proper distribution of R.A., officers and specialists for instruments, &c., when required.
4. Draw up plans for the training of Auxiliary Corps on arrival, detailing the hours of drill, and arranging for the distribution of Instructors.
5. Arrange for the accommodation of troops in camps or forts, as required, stating what corps are to be encamped, and where, and what corps are to be accommodated in forts, &c.
6. Fix landing places for reinforcements and parties coming by water, stating the favourable times for these parties to arrive, considering state of tide and security from enemy's fire.
7. Frame orders to ensure the immediate and complete manning of your command in case of sudden attack, whether by day or night.
8. Draw up orders regarding the disposal of hammocks, arms, accoutrements, kits, &c., in action.

9. Frame fire orders and give orders regarding water supply and cooking both in camps and in forts.

10. Arrange for the temporary treatment and eventual removal of sick and wounded.

11. Arrange for all communications which you consider necessary to supplement those already established, or as alternatives in case of casualty.

12. Arrange for transport by water, where required, between your command post and the forts, and between the several forts, for orderlies, reinforcements, &c.

13. State what steps you consider advisable for strengthening works, improving cover, concealing emplacements, constructing temporary accommodation, &c.

14. Arrange for the early identification of hostile vessels, and the detection of raiding craft. If your command post is not conveniently placed for this service, state where look out posts are to be established and what communications must be provided.

15. State any alterations or additions which you recommend in the case of mine fields and sea obstructions.

16. Issue detailed orders for the distribution and use of the "armament for general defence."

17. Fix positions for electric lights, if not already established, and state what area you propose to illuminate with each, and whether any power of training is to be allowed to it. If the positions of lights are fixed, suggest any alterations which you consider advisable.

18. Issue any special instructions which you consider requisite for dealing with raiding and counter-mining attacks, whether by day or night, in clear or in thick weather.

19. Make arrangements for the safety of any command posts, P.F. or electric light emplacements which may be in situations exposed to a sudden rush.

20. Issue any orders which may be necessary with regard to the method of meeting the several possible forms of attack, the

proposed plan of action and the scheme for co-operation of the various forts.

21. Make such suggestions as may occur to you, as to any steps you consider necessary to complete the efficiency of your fire command.

EXERCISE No. II.

(*Note.*—This is an example of the form of exercise which should be set to officers supposed to be acting as Battery Commanders).

GENERAL IDEA.

(*To be made out by the Instructor.*)

(*a*) Name an actual Battery Commander's unit in the section in which the officer who is to solve the problem is stationed; the unit to be treated as it is, with its existing communications.

(*b*) Detail the Artillery available, showing the number of officers, non-commissioned officers, and men, and the corps to which they belong.

(*c*) Name the site of camp for the troops manning the fort, if any.

(*d*) State what electric lights are established and the areas which they illuminate.

INSTRUCTIONS.

(*To be given by the Instructor to the Officer who is to carry out the Exercise.*)

1. Draw up a complete manning table on the usual form, and explain the arrangements made for fighting those groups (if any) which cannot be regularly manned.

2. If reinforcements are to arrive by water, detail the arrangements to be made for landing them.

3. Show how you intend to distribute your men in camp and

in the works for accommodation, keeping in view the necessity for quartering groups and other units intact.

4. Give a detailed plan of the camp (if any) showing distribution of tents, and distribution of units in the camp.

5. Give a detailed statement of accommodation in the works, showing distribution of units and stating what hammocks, (if any) are required.

6. State the amount and sources of water supply, and whether sufficient.

7. Frame fire orders, and give instructions regarding use of water, cooking, &c.

8. Formulate orders concerning the temporary treatment and disposal of sick and wounded.

9. Detail the arrangements to be made for observing and communicating any preconcerted alarm signal.

10. Give orders regarding the parading of manning details.

11. Frame regulations for the disposal of hammocks, (if any) small arms and ammunition, kits, &c., in action.

12. Select your own command post, and those for any groups where it is essential that the G.G.C., should have "Fire Direction," and detail the stations of master gunners, district gunners and artificers.

13. Determine the means of range finding and of communicating ranges which you intend to employ.

14. Specify the means of communication to be employed between yourself and your Range Group and Gun Group Commanders and Ammunition Officer, and between the range finding stations and the groups, for the purpose of passing orders and information. Provide for alternative means of communication where a break down is to be contemplated.

15. Specify the method of laying to be employed, both normally and under any special circumstances.

16. Arrange for a system of observing fire both for line and elevation.

17. Explain the process of ranging you intend to adopt in the case of each form of attack with especial reference to the Orders of Fire which will be used.

18. Give special instructions relative to fighting by night where this necessitates any modification of the above. Arrange for the lighting of the gun floor, cartridge and shell stores, magazines, &c.

19. Explain in detail the arrangements made for a continuous supply of ammunition to the gun floor, and state the positions chosen for temporary depôts of ammunition (if any).

20. Make detailed arrangements for the safety of any posts, emplacements, &c., which may be in situations exposed to a sudden rush.

21. Give orders regaruing reinforcements to meet casualties to men in action, and for the relief of specialists and detachments where required.

22. Make suggestions as to any steps which you consider necessary to increase the efficiency of your command.

EXERCISE No. III.

GENERAL IDEA.

(To be made out by the Instructor.)

(*a*) Specify a harbour entrance or narrow passage provided with Q.F. guns, or with heavy guns firing special case for defence against raiding attack.

(*b*) Enumerate the guns which are included in the scheme.

(*c*) Specify the troops available, showing the number of officers, N.C.O.'s and men, and the Corps to which they belong.

(*d*) Name the sites of camps (if any), and nature and extent of any temporary accommodation authorised.

(*e*) State what electric lights are available, and define the areas which they illuminate

(*f*) Specify the exact situation, extent, and nature of the boom or other obstructions to be employed; whether the entrance for traffic is to be closed at night, and if so, how, and at what time closed and opened.

(*g*) Specify the alarm signal, and state from where it will be given. Detail the arrangements and communications which exist for giving warning of attack.

(*h*) State the strength of attack to be anticipated.

INSTRUCTIONS.

(To be given by the Instructor to the Officer who is to carry out the Exercise.)

1. Draw up a complete manning table on the usual form, showing reliefs.

2. Draw a plan of the entrance or passage, showing positions of the obstructions; position of the electric lights, and areas illuminated; position and effective fire area of each group; F.C. post (or look out station), and communications (if any) from thence to the guns.

3. Issue orders for the accommodation of the manning details.

4. Give a detailed plan of the accommodation, showing distribution of units.

5. Issue orders concerning the use of water, cooking, &c., and procedure in the event of fire, such as to be generally applicable to all troops included in the general idea.

6. Give orders regarding the temporary treatment and disposal of sick and wounded.

7. Detail the system of communications to be employed for alarm and general purposes, and make complete arrangements for its efficient application.

8. Detail fully the arrangements to be made for keeping an efficient look out without unduly harassing the manning details, and for observing and acting on any preconcerted alarm signal,

9. Give orders regarding the parading of details.

10. Issue orders as to the provision of reinforcements and replacement of casualties in action.

11. Make detailed arrangements for the lighting at the guns, expense stores, &c., at night.

12. Issue general instructions as to the selection of targets by groups, and the orders of fire to be employed, with a view to preventing fire being concentrated on a few boats while the others escape.

13. Give any general instructions which you consider advisable with regard to the choice of the point of attack on boats. (*See* Section IX.)

14. Give directions as to inspections and testing of guns, mountings, and other stores, and to the periodical fitting of spare parts.

15. Where heavy guns firing special case are included in the scheme, make all arrangements and issue all instructions for their efficient use. (*See* Subsection II, Section VIII.)

16. Make arrangements for careful training of all details from the moment that "mobilisation" is ordered.

17. Issue any further orders or make any additional arrangement or recommendations which you consider advisable.

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